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CANADA IN THE 21ST CENTURY

II. RESOURCES AND TECHNOLOGY

ECONOMICS AND THE ENVIRONMENT: THE RECENT CANADIAN EXPERIENCE AND PROSPECTS FOR THE FUTURE

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II. RESOURCES AND TECHNOLOGY

ECONOMICS AND THE ENVIRONMENT: THE RECENT CANADIAN EXPERIENCE AND PROSPECTS FOR THE FUTURE

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PREFACE

AS A NEW MILLENNIUM APPROACHES, Canadians are going through a time of dramatic economic change. Markets are becoming global and economic activity across nations is becoming increasingly integrated. Revolutionary developments in computer and communications technology are facilitating globalization, and are also altering a great deal the workplace and the lifestyles of Canadians. At the same time, largely as a consequence of the information revolution, knowledge-based activities are becoming increasingly important within the Canadian economy and the economies of other industrialized nations.

These and related major transformations of the economic environment invite a comparison with the Industrial Revolution of the 1800s. As in the earlier time, major structural changes are giving rise to uncertainties. Firms and workers are struggling to find their place in the new economic order. Canadians collectively face the question of whether their nation's physical, human and institutional resources will provide a firm foundation for continued prosperity. Many see Canada's prospects as being much less secure than in earlier years, when the country's rich natural resources played a major role in shaping the Canadian economy.

To examine fully the medium to longer-term opportunities and challenges of these developments, the Micro-Economic Policy Analysis Branch of Industry Canada asked a group of experts to provide their "vision" for Canada in the 21st Century on a number of important issues. Each author was required to undertake two formidable tasks: first, to identify major historical trends and develop scenarios to illustrate how developments in his/her respective area might unfold over the next ten to fifteen years; and second, to examine the medium-term consequences of these developments for the Canadian economy.

The papers coming out of this exercise are now being published under the general heading of "Canada in the 21st Century". This series consists of eleven papers on different aspects of Canada's medium-term outlook. The papers are divided into three major sections. The first section, *Scene Setting*, focuses on important developments that are going to shape the medium-term economic environment in Canada. The second section, *Resources and Technology*, looks at trends among some important components of Canada's wealth creation and considers the actions needed to ensure that these factors provide a firm foundation for continued prosperity. The last section, *Responding to the Challenges*, explores individual, corporate and government responses to the medium-term challenges and offers some options for appropriate course of action.

As part of the *Resources and Technology* section, this paper by Professor Brian Copeland of the University of British Columbia, casts the spotlight on an important, albeit sometimes overlooked, environmental component of the nation's economic wealth. The author finds that Canadian environmental policy has been a mixture of successes and failures. In reforming Canadian policy,

the author sees as a central requirement *commitment devices* that would make it more difficult for governments to retreat from sustainability objectives in the face of pressures to deal with short-term income and employment concerns. These could include: clear environmental targets, combined with a review process and reporting mechanisms that back negotiated or voluntary environmental agreements; national standards that help commit the provinces to ambient environmental quality goals; and international agreements that create national obligations to meet environmental standards.

The most serious environmental challenges are probably global. Multilateral solutions are required to address problems such as greenhouse gas emissions, ozone-depleting gas emissions and threats to biodiversity. As consumption levels increase, particularly in the rapidly growing economies of Asia, severe pressures will be placed on the global environment. The author underlines how these global issues are linked to important income distribution and equity issues.

SUMMARY

CANADA FACES TWO MAJOR ENVIRONMENTAL CHALLENGES in the immediate future. The first is to translate the rather vague concept of sustainable development into a consistent set of policies that can address the need to move the economy in a direction consistent with ecological constraints. The second and perhaps more serious challenge is that there is a looming global environmental crisis that Canada, on its own, can do little about.

CANADIAN PROBLEMS

CANADIAN ENVIRONMENTAL AND CONSERVATION POLICY has had significant successes during the past 25 years. Emissions of toxic substances such as lead and mercury have been dramatically reduced. Air and water quality have improved in some areas, despite growth in income and population. And large tracts of wilderness have been set aside for preservation. But there have also been notable failures. Fish populations off the east coast have collapsed. Air quality is still poor in some of our larger cities. And in spite of reductions in emissions of sulfur dioxide, Canada remains one of the highest emitters of SO₂ per capita in the world. Because of its sheer volume of production and consumption, Canada remains a big polluter.

In the past, environmental and conservation policy in Canada has suffered from two problems. First, policy has essentially been remedial — a piecemeal response to various problems of over-exploitation of natural systems. This has led to inconsistencies in government policy — one arm of government may provide subsidies to the fishing industry while another arm of government tries to reduce fishing effort to preserve the stock. The concept of sustainable development may potentially emerge as a unifying framework that forces a more integrated approach to policy, one that takes into account ecological constraints. However, we are still a long way from that point.

The second problem affecting policy has been a lack of commitment. One of the key problems in environmental policy is that short term re-election horizons combined with uneven distributional effects of environmental policies can expose governments to considerable political pressure to deal with short term income and employment concerns at the expense of long run sustainability issues. This means that it is important to develop an institutional framework in which it is difficult to back away from attaining policy objectives — that is, increased attention should be given to the role of *commitment devices* in environmental policy.

Such a perspective has a number of implications for future policy. Among these are: (1) clear environmental quality targets should be set, and a review process should be put in place to ensure that they are met; (2) good information about environmental quality should be provided by the government to the public so that failure to meet targets cannot be hidden; (3) voluntary or negoti-

ated agreements to attain environmental standards must be backed up by strong enforcement; (4) national standards for ambient environmental quality can act as commitment devices for provinces; (5) international agreements may be useful to help commit to environmental goals, particularly if there is a linkage to trade access or aid, and (6) economic instruments that increase the degree of commitment to an environmental goal should be considered — a pollution tax applied as a matter of course may be more effective than a standard backed up by the threat of a fine that is rarely carried out.

Although command and control methods have dominated environmental policy in most western economies, the time may be ripe for a gradual introduction of more incentive-based policies for the following reasons:

Revenue — There is considerable pressure not to raise general tax rates, and so environmentally friendly taxes and user fees may be, politically, a more palatable way of raising revenue to finance investments in the infrastructure needed to maintain or improve environmental quality.

Increasing abatement costs — Pollution control costs will likely rise in the future because (1) growth will put more pressure on the environment; and (2) the easier environmental problems were solved first in part because the other problems were more costly to deal with. This will increase the need for cost-effective policies. New taxes on business will not, however, be popular in a context of rising costs. Rather, policies which are revenue-neutral from an industry perspective (such as allowing limited transferability of pollution permits) are likely to be more feasible.

Increasing relative importance of non-point sources of pollution — The use of economic instruments may be useful to deal with complex problems involving large numbers of polluters who are difficult to monitor. For example, taxes can target inputs highly correlated with pollution (such as fuel and pesticides).

Tax reform and the double dividend — Canada's tax system contains many undesirable disincentive effects. Revenue raised from environmental taxes may be used to finance reductions in distortionary taxes, such as payroll taxes.

One problem with policies that attempt to recover the full costs of environmental services from users is that they may be regressive — there is some evidence that the cost of environmental policies as a fraction of income has been greater for lower income groups than for higher income groups. An expansion of the use of environmental taxes and user fees could be regressive. But the regressiveness of any individual instruments does not mean that the underlying policy is undesirable. Rather it means that environmental policy must be integrated and coordinated with other activities of government. Some European countries have introduced environmental taxes as part of a major tax reform.

Although individual tax changes may be regressive, the overall package of reforms need not be.

GLOBAL PROBLEMS

AT THE GLOBAL LEVEL, TWO CRISES ARE LOOMING IN THE NEAR FUTURE. The first is that some very poor countries may be unable to sustain their current consumption of their own environmental services and may not be able to generate enough income from other activities (such as manufacturing) to import environmental services (especially food) from other countries. Canada will be confronted with a serious ethical dilemma about how to reconcile its wealth with significant human suffering in other parts of the world.

The second crisis looming arises from countries with relatively large populations that are also currently undergoing rapid rates of economic growth. This will affect Canada directly. The net international demand for Canada's environmental services will likely increase as the need for food, minerals, and forest products rises with income and population, and with the depletion of the resource base in some countries. However, this trend will yield benefits only if resource stocks and environmental services are properly managed. Many environmental services are based on common property resources (such as air and water). Canada has only partially succeeded in controlling access to these resources. Growing international trade can be harmful for an economy that exports the services of open access resources. Therefore, Canada's trade policy must be coordinated with its conservation policy. More liberalized trade requires increased conservation efforts in order to ensure sustainability. If Canada is unable to ensure that proper conservation measures are put in place, it should not commit to open foreign access to its resources.

As consumption levels increase, particularly in the rapidly growing economies of Asia, severe pressure will be placed on the global environment. Even if one accepts the optimistic scenario that higher income eventually leads to improved environmental quality, projections suggest that global environmental quality will get much worse before it gets better. Carbon emissions will increase, biodiversity will be threatened, the health of the oceans will be placed in jeopardy, and there will be further pressure on the ozone layer. Although Canada's consumption of environmental services may well be sustainable if the consumption of the rest of the world stays low, it is extremely unlikely that the world could sustain the spread of North American levels of consumption to a significant fraction of the earth's population. Therein lies the dilemma. Global sustainability will require some coordination among countries to reduce the emissions of key pollutants.

The distribution of the right to pollute among countries will be one of the key international policy issues in the next few years. An equitable approach to this problem would involve equal access to environmental resources per capita across the globe. But such a principle would involve significant reductions in

the consumption of environmental services by richer countries. A more likely scenario is that power and wealth will continue to determine access to environmental services. This in itself can exacerbate global problems, because the incentive for countries to increase their wealth and power to stake a claim on global environmental services will add to the strains exerted on the earth's life-supporting resources. Even in a power-driven scenario, however, it will be in the interest of richer countries to help poorer countries reduce and control environmental damage.

Canada should continue to play an active role towards the development of a multilateral approach to dealing with global pollution problems. At the same time, it should also ensure that defensive measures are taken at home. It should resort to commitment devices to ensure that long run environmental goals are achieved. It should set clear goals for ambient environmental quality and move to put in place a review process to ensure that these targets are met. And it should diversify its environmental risks. In a world increasingly committed to free trade, Canada should adopt a conservative and cautious approach to allowing access to common property resources.

INTRODUCTION

SINCE THE SECOND WORLD WAR, and especially in the last 25 or 30 years, our public policies have gradually begun treating the natural environment as a life-sustaining system that must be nurtured and protected instead of something that can be exploited at will. While this transition is by no means complete, and Canadians do not all agree about how we should relate to the environment, there have been profound changes.

Much of the significant environmental legislation at both the federal and provincial levels was developed in the last 25 years. The federal Department of the Environment (now Environment Canada) dates back only to 1970, the same year the United States created the Environmental Protection Agency. There was also a growing public awareness and commitment to environmental issues during this period, reflected in part by the proliferation of environmental groups. Greenpeace, for example, was founded in 1971.

With these developments, Canada experienced some significant successes in environmental and conservation policy:

- Emissions of toxins such as lead and mercury were dramatically reduced;
- Air and water quality improved in some areas, despite growth in income and population; and
- Large tracts of wilderness were set aside for preservation.

However, there were also notable failures:

- Fish populations off the east coast have collapsed;
- Urban air quality is still poor in some of our larger cities; and
- Despite emission reductions, Canada remains one of the highest per-capita emitters of sulphur dioxide in the world.

Because of its sheer volume of production and consumption, Canada remains a big polluter. As well, there are indications of serious environmental problems looming at the global level. These include the possibility of global climate change, significant reductions in biodiversity, and depletion of the ozone layer. Rapid population growth in low-income and resource-poor countries in areas such as sub-Saharan Africa may also lead to environmental deterioration.

In this paper, I review some recent Canadian trends in the interaction between the economy and the natural environment, and consider policy implications for the near future. I focus on two major challenges: ensuring that economic activity is consistent with ecological constraints, and the impact on Canada of global environmental problems. The notion of sustainable development must be translated into a consistent set of policies that are able to withstand fluctuations in public opinion. The near future may bring increases in

income inequality, persistent unemployment, increased global competition for capital and output, and leaner government. These and other pressures can conflict with environmental goals, and a policy regime must be designed with such future challenges in mind. Since global environmental problems are inextricably linked to international income distribution, they will provide significant challenges in the future, because there is little that individual countries can do on their own to resolve the problems.

Chapter 2 of the paper provides a brief conceptual overview of the subject, focusing on issues such as sustainable development, the limits of free markets in dealing with environmental challenges, and the constraints facing government policy. Chapter 3 briefly reviews some trends in resource scarcity and environmental quality. The recent interest in pursuing strategies of sustainable development requires an understanding of the relationship between economic growth and environmental quality. The state of current knowledge in this area is also reviewed. Chapter 4 assesses the implications of this relationship for the future. Chapter 5 discusses the main challenges facing policy-makers and outlines the general attributes that policy will need to have in the coming years. The role of commitment devices and the policy implications of income distribution are also discussed. Chapter 6 reviews recent innovative approaches to environmental policy, and their implications for future policy. Green gross domestic product (GDP) accounting is discussed in chapter 7, globalization in chapter 8, and concluding comments are presented in the final chapter.

CONSTRAINTS ON POLICY

ALTHOUGH THE RELATIONSHIP between the environment and the economy is complex, it is useful to focus on two underlying causes of environmental problems: inappropriate or unsustainable goals, and ineffective ways of achieving those goals.

INAPPROPRIATE GOALS

THE FIRST PROBLEM IS, IN PART, ONE OF VALUES. There are trade-offs between human consumption and environmental quality, and between the size of human populations and the size and variety of non-human populations. Although we do not fully understand these trade-offs, it is clear that they exist. A Canada with a few hundred thousand people living in small rural communities would support a much larger wildlife population than a Canada with tens of millions of people. While both scenarios may be viable in the long run, there may be disagreements within Canada about which type of society, on balance, we should choose.

The natural environment places ecological constraints on economic activity. Because excessive and inappropriate human activity can harm the natural environment's capacity to support life, there are upper bounds on the levels of human consumption that can be sustained in the long run. A value system that emphasizes high consumption, population growth and 'taming the wilderness' may impinge on the ability of future generations to maintain a comfortable standard of living.

UNSUSTAINABLE GOALS

IN THE PAST 10 OR 15 YEARS, the notion of *sustainable development* has emerged as a framework within which to think about the relationship between ecological constraints and economic activity. The key idea is that the economy and the environment are integrated, that our economic and other goals should reflect the presence of ecological constraints, and that we should ensure that our current activities do not reduce the ability of future generations to meet their needs.¹ The concept of sustainable development is imprecise and can mean very different things to different people. This is part of the reason why so many diverse groups seem comfortable with the concept. In many quarters, the ideology of sustainable development cannot be separated from issues of global equity, feminism, justice, and culture issues, which themselves provoke much disagreement. While the notion of sustainable development has forced some to re-evaluate their goals and values, a consensus has not yet emerged.

INEFFECTIVE METHODS OF ACHIEVING GOALS

EVEN IF OUR GOALS ARE SUSTAINABLE, we may not be able to attain them if we use inappropriate instruments. This is the second major source of environmental problems; we rely on markets to organize much of our economic activity. One of the key insights of modern economics, however, is that free markets do a poor job of managing environmental services.² For a market to function properly, prices must convey information about the full cost of a good or activity. However, many of the resources that are essential for our survival — such as air and water — are held in common. Because access to these resources is open to all, prices do not reflect the cost of using them. Not surprisingly, since prices for access to natural environmental services are either absent or too low, an unfettered market economy will pollute too much and deplete open-access resources. Some form of collective activity is required to manage environmental resources and, in a large, mobile society such as ours, the government must intervene in the market and play a leading role in environmental management.

Twenty-five years ago, when the federal Department of the Environment was formed, it was widely accepted that governments would play an important role in the economy. Since then, this view has gradually faded, and public policy increasingly reflects a renewed commitment to markets. Previously sheltered industries, such as telecommunications and transport, are now open to competition. International trade agreements, such as the North American Free Trade Agreement and the World Trade Organization, have limited governments' ability to shield domestic industries from foreign competition. The government no longer sees job creation as one of its direct responsibilities; instead, it prefers to foster a healthy business climate, hoping that jobs will follow.

This renewed commitment to freer markets — not just in Canada, but in many parts of the world — presents both dangers and opportunities for the natural environment and for the long-term sustainability of our lifestyle. One of the great challenges Canada will face in the next few years is reconciling some notion of environmental sustainability with its reliance on free markets and economic growth.

While free markets do poorly at caring for the natural environment, moving to leaner governments and increased market discipline can also create opportunities. Traditionally, environmentalists have been very skeptical of, and in many cases hostile to, using market incentives to control pollution and induce conservation. Governments have, for the most part, relied on regulations to correct the failings of the market. More recently, all parties seem to be receptive to considering new ways of managing environmental resources. Moreover, pressure to streamline governments and foster competitiveness may stimulate the evolution of more cost-effective pollution-control regulations that rely on market incentives.

KEY CONSTRAINTS ON POLICY

THERE IS MUCH COMMON GROUND between the sustainable-development approach to environmental problems, and the more traditional market-failure approach that many economists adopt. Both approaches must acknowledge that governments face a number of important constraints in responding to environmental problems and integrating environmental concerns with other government policies. Good policy must recognize the following realities:

Sustainability is a long-term issue, but public opinion and the realities of politics encourage a focus on the short term. The cost of programs to improve environmental quality and promote conservation have to be borne immediately, while the benefits can take many years to materialize. Conversely, the benefits of harvesting a resource in an unsustainable manner may appear to be very large in the short run, while the costs relating to the collapse of the resource are deferred to future generations and governments. Short-run re-election horizons can create a bias toward policies that have immediate returns.

There is considerable uncertainty about the effects of many types of human activity on ecosystems, and of many types of pollutants on human health. Scientists cannot predict accurately how human-driven changes affect the ecosystem. Even if this information were available, economists do not agree on how to assign dollar values to environmental changes. This leads to great uncertainty about the physical and economic effects of environmental policies.

Sustainability issues must be dealt with in an era of globalization. Improved transportation and communication, rapidly growing economies in Asia, and commitments under the North American Free Trade Agreement and the World Trade Organization have all forced Canada to become more aware of how its policies affect its international competitiveness.

The distributional effects of environmental and conservation policies are crucial to their success. The benefits and costs of moving to sustainability are not evenly distributed among Canadians. This is not unusual for policies — for example, the Canada-U.S. Free-Trade Agreement imposed substantial costs on many Canadians and yielded benefits to others.

Some important environmental problems are international in scope and cannot be solved unilaterally. Problems such as acid rain require the cooperation of the United States to be solved, and problems such as the thinning of the ozone layer require widespread multilateral cooperation.

These constraints play a key role in the policy discussions presented throughout this paper.

TRENDS IN RESOURCE USE AND ENVIRONMENTAL QUALITY

TO PUT ENVIRONMENTAL ISSUES IN PERSPECTIVE, I begin with a brief overview of how the natural environment directly affects the Canadian economy. I also provide some indicators of environmental quality.

IMPORTANCE OF THE RESOURCE SECTOR

NATURAL RESOURCES HAVE ALWAYS PLAYED AN IMPORTANT ROLE in generating income and employment in Canada. However, although output from the resource sector has continued to grow, its growth has not kept pace with the rest of the economy. As Table 1 indicates, primary industries declined from about 9 percent of GDP in the early 1970s, to just above 6 percent in 1990. If the definition of resource-dependent industries includes manufacturing industries that process raw materials, then the share of GDP was about 10 percent in 1990. This sector accounts for roughly 10 percent of employment. Although resource industries now represent a relatively small fraction of GDP, they still account for a large portion of Canada's exports. Resource-based materials account for about half of merchandise exports.³ Canada's terms of trade are therefore much affected by changing global patterns of resource scarcity.

RESOURCE SCARCITY

ABOUT 25 YEARS AGO, in *Limits to Growth*, Meadows et al. (1972) predicted a crisis driven in part by the impending exhaustion of the supply of natural resources. Somewhat paradoxically, despite rapid economic growth and increasing population in some parts of the world, prices of exhaustible resources have not risen appreciably in recent years, and many prices have fallen. As Table 2 indicates, real fuel prices have fallen significantly since the early 1980s, non-metallic mineral prices have been falling and, while the pricing of ferrous and non-ferrous minerals is cyclical, on average it has not kept pace with other price increases.

Slade (1982) provides one resolution of this paradox, arguing that exhaustible-resource prices may follow a U-shaped path. First, as new discoveries increase supplies and technical innovation reduces extraction costs, the prices fall. However, with diminishing returns to both of these activities, declining stocks should eventually push up prices. In a recent paper, Berck and Roberts (1996) look for evidence of an impending up-turn in the U-shaped curve, but are unable to find strong evidence that it is imminent.

Although the time paths of prices do not suggest looming mineral-resource scarcities on a global level, mineral resources in Canada are getting scarcer. By nature, mining is not a sustainable activity, since resource stocks gradually diminish. As Table 3 shows, Canada's mineral reserves have generally

TABLE 1
DISTRIBUTION OF GROSS DOMESTIC PRODUCT AT FACTOR COST BY INDUSTRY
 PERCENTAGE

Industry	1971	1973	1975	1977	1979	1981	1983	1985	1987	1989	1990
Agriculture	3.2	4.1	4.1	3.0	3.3	3.3	2.5	2.3	2.1	1.9	1.9
Fishing and Trapping	0.2	0.2	0.1	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.2
Logging and Forestry	0.7	0.8	0.6	0.7	0.8	0.6	0.6	0.6	0.7	0.7	0.6
Mining, Quarries and Oil Wells	3.5	4.4	4.5	4.7	5.7	5.5	5.9	6.3	4.1	3.6	3.5
Total, Primary Industries	7.6	9.5	9.3	8.6	10.1	9.6	9.2	9.4	7.2	6.4	6.3

Source: Statistics Canada, Gross Domestic Product by Industry, Catalogue No. 15-001.

TABLE 2

RAW MATERIAL PRICE INDEXES

Year	Wood	Non-Metallic Minerals	Ferrous Metals	Non-Ferrous Metals	Mineral Fuels
1981	121.2	103.7	120.1	147.8	152.6
1982	105.1	104.3	105.0	118.2	165.6
1983	103.5	101.6	100.9	116.5	167.7
1984	101.2	99.1	104.3	109.3	160.9
1985	98.5	100.6	102.6	99.6	162.8
1986	100.0	100.0	100.0	100.0	100.0
1987	107.3	95.5	95.6	109.7	105.5
1988	112.9	95.1	96.5	124.5	80.7
1989	109.3	92.3	89.4	113.9	87.7
1990	104.3	88.4	79.7	98.2	100.7
1991	102.5	85.7	74.5	80.1	88.7
1992	112.2	81.3	76.3	79.7	85.4
1993	146.7	80.0	84.2	76.0	79.8
1994	159.8	81.2	94.4	95.4	79.7
1995	170.6	82.5	95.0	111.8	84.6

Source: Statistics Canada, Catalogue No. 11-210-XPB, 1995/96.
Deflated to constant 1986 dollars using CPI.

fallen over the past 25 years. Increased restrictions on land use and environmental regulations will also limit future expansion of this industry. Relative to other industries, the costs of complying with environmental regulations tend to be high in the primary-metal industry, as Table 4 indicates.

RENEWABLE RESOURCES

THREATS TO RENEWABLE RESOURCES and to the earth's life-supporting ecosystems are potentially much more serious than the exhaustion of mineral resources. There are several indications that serious problems lie ahead.

The collapse of fish stocks off the Atlantic coast is an early warning of the need for caution and conservative harvesting policies in managing renewable resources. The total catch of Atlantic cod has declined dramatically over the past 25 years, and collapsing stocks have led to the closure of the fishery. As well, other fish stocks off the east coast have been subject to pressure; the Atlantic salmon fishery has collapsed. These events have devastated local economies. In the past seven years, Newfoundland's fishery income has fallen by a factor of almost two. Although the fisheries on the west coast have so far escaped collapse, there are early indications that some species of salmon may be threatened, since harvests have declined in the past two years.

TRENDS IN RESOURCE USE AND ENVIRONMENTAL QUALITY

TABLE 3**PROVEN AND PROBABLE RESERVES OF MAJOR METALS**

Year	Copper	Nickel	Lead	Zinc	Molybden	Silver	Gold
	(Reserve life in years)						
1974	21	27	32	25	25	21	7
1975	23	30	26	27	26	23	7
1976	23	30	35	28	25	24	8
1977	22	32	32	25	23	22	7
1978	24	55	28	25	33	23	8
1979	26	57	31	26	50	28	11
1980	24	45	40	33	46	31	16
1981	22	50	38	32	40	28	17
1982	23	85	33	27	35	24	13
1983	23	59	33	27	45	26	17
1984	20	42	34	25	33	24	15
1985	19	41	30	23	45	24	16
1986	19	41	21	23	31	25	15
1987	16	35	18	18	16	19	16
1988	17	32	20	15	16	19	14
1989	17	31	26	17	17	20	11
1990	15	30	27	17	16	17	9
1991	14	30	20	15	17	15	8

Source: Statistics Canada, *Human Activity and Environment*, Catalogue No. 11-509E.**TABLE 4****POLLUTION ABATEMENT AND CONTROL INVESTMENTS
AS A PERCENTAGE OF TOTAL INVESTMENTS**

Industry	1985	1986	1987	1988	1989	1990	1991	1992
Forestry							0.6	
Mines			3.9	5.9	3.9	7.2	8.9	4.5
Food and Beverages			1.1	0.4			0.7	2.1
Paper and Allied Products	1.5	1.8	1.5	2.6	3.1	11.4	12.6	10.3
Primary Metals	3.4	3.3	4.9	7.9	11.0	13.6	10.6	13.9
Fabricated Metal Products	0.8	1.0	1.6	1.7	2.6	1.8		
Transportation Equipment	0.2	0.7	0.2	0.6	0.6	0.9	0.8	0.1
Non-Metallic Mineral Products	1.1	1.1		0.7	0.7	0.3		
Refined Oil and Coal Products	0.4		0.5	0.5		1.3	1.8	2.6
Chemicals and Chemical Products	1.3	2.7	2.2	2.7	7.6	1.6	2.0	4.1
Electricity, Gas and Utilities				0.6	0.9	1.5	3.0	17.1

Source: Statistics Canada.

In contrast to the shrinking resource base of the fish industry, Canada's forest cover has increased in recent years, in part because of reforestation. As well, unlike minerals, prices for wood products have tended to increase over time, as Table 2 indicates. The major challenge facing the forest industry is the conflict of claims on land use. Forests provide habitat for wildlife and recreational opportunities for people, and they help to control global warming by acting as a sink for carbon. There is great resistance to harvesting trees in old-growth wilderness areas on the Pacific coast, and to harvesting in areas close to population centres. This resistance has provoked local conflicts, and has attracted the attention of international environmental groups.

POLLUTION

CANADA HAS HAD A MIXED RECORD IN CONTROLLING POLLUTION over the past 25 years.⁴ Canada's air and water quality is comparable to other OECD countries, and is much better than that of most of the world, as Table 5, comparing air quality in Canadian cities and large Asian cities, illustrates. Despite a high per-capita rate of consumption and large emissions of some major pollutants, Canada has been able to protect its population from the immediate effects of much of its pollution by enacting zoning regulations that require heavy industry to locate outside of urban areas, by reducing emissions, and by treating effluent.

There has been significant progress in reducing effluent from stationary sources. By 1991, the sewage of 61 percent of the Canadian population was channelled to wastewater treatment plants, although there remains significant variation across the country.⁵ Only 14 percent of the sewage in the Maritimes is treated, and the sewage of 51 percent of the population of British Columbia is subjected only to primary treatment. However, in Ontario, fully 58 percent of sewage is subject to tertiary treatment. This disparity reflects differences in the environmental sensitivity of discharge points — although much environmental policy in Canada falls under provincial jurisdiction, there is no commitment to national water-quality standards.

Water quality in the Great Lakes has improved significantly because waste-water treatment has been improved and toxic discharges have been reduced. However, significant problems remain with persistent toxic substances and other pollution problems. Elsewhere, the St. Lawrence, Fraser, and other rivers are polluted by poorly treated sewage, pollutants from industrial plants, and run-off from forestry and agriculture. Non-point sources of pollution, such as agricultural run-off, have proven to be more difficult to deal with than end-of-pipe pollutants, which are dealt with through regulation.

There have been some improvements in measures of ambient air quality. With the elimination of lead in gasoline, lead has almost been eliminated from the air. Sulphur-dioxide and nitrogen-oxide concentrations in urban air have tended to drop over the last 25 years. Ground-level ozone, however, has not fallen significantly.

TABLE 5

**CONCENTRATIONS OF SUSPENDED PARTICULATE MATTER IN
MAJOR URBAN CENTRES**
MEAN ANNUAL VALUES, $\mu\text{g}/\text{m}^3$ **

Country	City	1981	1989
Canada	Vancouver	73	51
	Toronto	59	66
China	Beijing	422	407
	Guangzhou	260	159
	Shanghai	205	231
	Shenyang	406	422
	Xian	350	526
Hong Kong	Hong Kong		95**
Japan	Tokyo	63	47
Thailand	Bangkok***	118	115

* Measurement taken in citycentre commercial districts.
 ** 1988.
 *** Measured in suburban residential area.
 Source: United Nations Environment Programme (1993).

TABLE 6

SULPHUR-DIOXIDE EMISSIONS FROM HUMAN-MADE SOURCES
THOUSANDS OF TONS PER YEAR

Country	Total Emissions				Per Capita	Per GDP*
	1975	1980	1985	1990	1990	1990
Canada	5,319	4,643	3,704	3,800	143.3	6.7
United States	25,900	23,400	21,100	21,100	84.7	3.9
France	3,328	3,338	1,470	1,206	21.5	1.0
West Germany	3,350	3,194	2,396	1,002	16.6	0.7
The Netherlands	386	466	276	238	16.1	0.9
United Kingdom	5,310	4,898	3,724	3,774	66.3	3.9
China	10,180	13,370	17,260	19,990	17.7	54.8
Indonesia	201	329	435	485	2.7	4.5
Japan	2,570	1,600	1,180	1,140	9.2	0.4
South Korea	234	271	324	333	7.9	1.4
Thailand	224	420	507	612	11.2	7.6

* Kg/year.
 Source: United Nations Environment Programme (1993).

TABLE 7
PERCENT REDUCTIONS IN SO_x EMISSIONS, G-7 COUNTRIES

Country	1970-1992	1980-1992	Target 1980-2000
United States	-30	-16	-30
Canada	-55	-35	-31
West Germany	-77	-72	-83
France	-59	-64	-74
Italy	-41	-48	-65
United Kingdom	-46	-29	-50
Japan	-82	-31	-

Source: OECD (1996).

TABLE 8
NITROGEN-OXIDE EMISSIONS FROM HUMAN-MADE SOURCES
 THOUSANDS OF TONS PER YEAR

Country	Total Emissions				Per Capita Per GDP*	
	1975	1980	1985	1990	1990	1990
Canada	1,756	1,959	1,959	1,943	73.3	3.4
United States	19,200	20,400	19,800	19,800	79.8	3.7
France	1,608	1,823	1,615	1,742	31.0	1.5
West Germany	2,571	2,980	2,959	2,707	44.7	1.8
Netherlands	464	553	544	529	35.9	1.9
United Kingdom	2,427	2,442	2,402	2,690	47.3	2.8
China	3,730	4,910	6,360	7,370	6.5	20.2
Indonesia	331	465	561	639	3.6	6.0
Japan	2,330	2,130	1,950	1,940	15.7	0.7
South Korea	325	383	456	468	21.5	17.6
Thailand	182	255	327	384	7.0	4.8

* Kg/year.
 Source: United Nations Environment Programme (1993).

TABLE 9**CARBON-DIOXIDE EMISSIONS FROM INDUSTRIAL SOURCES, SELECTED COUNTRIES**
THOUSANDS OF TONS OF CARBON PER YEAR

Country	Total Emissions				Per Capita Per GDP*	
	1960	1970	1980	1990	1990	1990
Canada	52,700	90,610	115,820	115,260	4.35	0.20
United States	799,544	1,165,477	1,259,281	1,310,341	5.26	0.24
Mexico	17,223	28,914	71,001	89,396	1.01	0.38
France	74,791	116,176	132,129	97,432	1.74	0.08
West Germany	148,614	200,858	208,021	180,554	2.94	0.18
The Netherlands	20,173	34,813	41,364	37,916	2.54	0.14
United Kingdom	160,770	175,397	160,551	152,773	2.65	0.16
Madagascar	109	248	436	265	0.02	0.10
China	215,295	211,607	406,440	678,016	0.61	1.86
Indonesia	5,844	9,050	25,825	38,506	0.21	0.36
Japan	63,997	202,973	254,881	289,288	2.34	0.10
South Korea	3,455	14,230	34,312	65,884	1.54	0.28
Thailand	1,012	4,190	10,921	25,535	0.46	0.32
World	2,568,000	4,091,000	5,264,000	6,097,000	1.15	–

* Kg/year.
Source: United Nations Environment Programme (1993).

Sulphur-dioxide (SO₂) emissions have fallen significantly, as indicated in Table 6. However, Canada's per-capita SO₂ emissions are still the highest in the OECD, and among the highest in the world. Moreover, as Table 7 indicates, other OECD countries except the United States have reduced SO₂ emissions more rapidly than Canada, and have committed to making larger reductions in the future. Canada's per-capita nitrogen-oxide (NO_x) emissions are also very large compared to the rest of the world, as Table 8 illustrates. Canada has had little success in reducing emissions, which reflects in part how difficult it is to control non-point sources. Automobiles are a major source of NO_x, and per-capita automobile use has continued to rise over the past 25 years.

Per-capita carbon emissions in Canada are very high, as indicated in Table 9, and are expected to increase. Despite costly recycling programs, municipal waste continues to increase. Per capita, Canadians are also high consumers of energy.

WILDERNESS

ABOUT 9 PERCENT OF CANADA'S LAND is found in some form of wilderness protection area, much of which is remote from populated centres and about half of which is in ecological reserves or parks. This percentage is higher than in most OECD countries, and Canada has set an overall goal of 12 percent of the land base for wilderness protection. Protection of land is somewhat weaker outside ecological reserves and parks. This has led to disparities in the level of protection accorded to different types of ecosystems. Land-use conflicts continue to occur, especially in more accessible areas that tend to be underprotected. This has serious implications for the forest industry, especially on the west coast.

POPULATION

CANADA'S BIRTH RATE IS LOW, and the future rate of population growth will be heavily influenced by choices made regarding immigration levels. In the past 25 years, the population has increased 36 percent from about 22 million to around 30 million. Statistics Canada projects that, in the next 15 years, the population will rise to somewhere between 33 and 37 million, depending on assumptions made about immigration.

GLOBAL ISSUES

THERE IS CONSIDERABLE VARIATION in environmental problems around the world. The other OECD countries have high consumption levels and account for a high percentage of global resource use. However, as in Canada, they have invested heavily in pollution control and have dealt with any immediate threats to human health from pollution. Longer term problems such as toxic emissions, cancer-causing chemicals, threats to the global atmosphere, and habitat preservation for non-human life continue to be priority issues.

Since many poor countries in Africa and parts of Asia have high population-growth rates, in the next decades, their economies' resource bases may become unable to support the population. While population pressures have led to significant loss of wildlife habitat and soil erosion, immediate threats to human health from unsafe water and disease remain of paramount concern.

Another set of countries, in the Asia-Pacific region and elsewhere, is undergoing significant economic growth, which is leading to a number of environmental problems (see Brandon and Ramankutty, 1993, and Edmonds, 1994). There are rapid rates of deforestation in South America and Southeast Asia. China faces serious erosion problems. Rapid industrialization in the Asia-Pacific countries has worsened air and water quality. Perhaps more foreboding for the future is the fact that, while per-capita emission rates of carbon, sulphur oxides and nitrogen oxides are very low in rapidly growing countries such as China, the population base is high. The emission rates per unit of GDP are high compared to OECD countries, as Tables 6, 8 and 9 illustrate. This suggests that, in the

near future, continued economic growth will bring significant increases in global pollution. Even if newly industrializing countries were to adopt OECD pollution-control standards, total emissions would continue to rise dramatically because of their large population and strong economic growth.

ENVIRONMENT AND GROWTH

TO ANTICIPATE FUTURE TRENDS IN ENVIRONMENTAL QUALITY, it is essential to understand the relationship between economic growth and environmental quality. Paradoxically, both high and low economic growth rates in different parts of the world are likely to contribute to serious environmental problems in the years to come. In studying the effects of growth on environmental quality, we must rely on the historical record. However, much of the recent concern about sustainable development involves trying to *change* the relationship between growth and environmental quality. To understand the forces that lie behind that relationship, we must do more than review the historical record.

The relationship between growth and environmental quality is complex. As aggregate income grew in Canada, carbon emissions increased and sulphur-dioxide emissions fell. With growth, water quality in the Great Lakes first declined, and later improved. Moreover, the effects of growth on water quality vary across the country, as the quality of water in some lakes continues to decline.

Growth can affect the environment in three different ways.⁶ First, there is a *scale effect*. Consider a case where, as the economy grew, production and consumption patterns were maintained and pollution regulations stayed the same. In this case, growth would correspond to a simple scaling up of economic activity, with an accompanying rise in pollution and resource use. The scale effect is bad for the environment.

Typically, however, growth is uneven, and do not correspond to a simple scaling up of economic activity. During the last 25 years, the economy's service sector has expanded, while other sectors have become less important. With growth, therefore, the composition of both production and consumption changes. This *composition effect* is the second way that growth affects the environment. If growth is biased toward industries that use environmental services intensively, then the composition effect reinforces the scale effect, and both drag down environmental quality. On the other hand, if growth is biased toward cleaner activities, then the composition effect counters the scale effect. If growth is accompanied by a big enough shift away from the use of environmental services, then environmental quality may increase.

Finally, there is a *technique effect*. This captures the effects of changes in pollution and conservation regulations, or investments in public infrastructure that alter the way wastes enter the environment. For example, if an increase in income were accompanied by the installation of more abatement equipment in pulp mills, or a shift from gasoline-powered cars to efficient mass transit, then this change in production or consumption could improve environmental quality.

The technique effect is usually good for the environment. A variety of evidence suggests that, when income increases, the demand for environmental quality also rises. Consequently, there should be greater pressure on the government for stricter pollution controls and improved conservation. However,

this effect is not automatic. First, rather than reducing pollution intensities, high- and middle-income people may insulate themselves from environmental deterioration by moving to cleaner places. Second, many aspects of environmental quality require active changes in government policy — even if there is an increase in demand for investments in environmental quality, change will not occur unless the political system can translate the citizens' preferences into action. While the scale and composition effects occur more or less automatically, the technique effect is largely discretionary and depends critically on government response.

The work of Grossman and Krueger (1993, 1995) is perhaps the most widely cited empirical study on the relationship between growth and environmental quality. The authors use data on urban air quality, and obtain an inverted-U-shaped relationship between measures of air pollution from sulphur dioxide and suspended particulates, and per-capita income. Pollution first rises, and then falls with higher per-capita income, with the peak occurring at about US\$5,000 per year. Shafik (1994) obtains similar results using similar data. Seldon and Song use data on aggregate national emissions, and also obtain a similar relationship, although in their case the peak is at about US\$8,000 per year. However, similar relationships are not observed for all pollutants. Carbon emissions and municipal waste per capita tend to rise with per-capita income. Heavy-metal concentrations in lakes and rivers show no apparent trend, and tend to remain flat after industrialization. On the other hand, the fraction of the population without access to safe drinking water and urban sanitation systems tends to fall with rising per-capita income.

This suggests that, as income rises, the environmental problems that pose immediate threats to human health are solved first. Those problems that tend to worsen with economic growth — problems that pose more long-term threats to health and that make life unpleasant but bearable — are addressed later. Finally, some problems, such as carbon emissions and waste generation, tend to worsen steadily with growth.

To interpret this work, one can tell a story about what might lie behind the relationships. For example, in the case of access to clean drinking water, it is plausible to suggest that there is a strong technique effect — as income rises, the demand for better sanitation rises quickly, and governments or community organizations respond. In this case, we can be fairly confident because we are directly measuring techniques such as the presence or absence of sewage and water systems. However, for most pollutants, because we cannot directly measure pollution intensities, it is more difficult to interpret the relationships. In the case of carbon emissions, the technique effect is likely weak, because governments have done little. The scale effect dominates, which probably accounts for the observed correlation between carbon emissions and growth.

The inverse-U relationship, however, illustrates the problems of interpretation that arise for most pollutants. The *optimistic scenario* states that, in the early stages of growth, the scale and composition effects dominate, pushing up

pollution as the economy industrializes. Eventually, however, higher incomes translate into greater demand for environmental quality, so the government increases the stringency of pollution regulations. This, in turn, leads to improved environmental quality. Growth may also increase the size of relatively cleaner sectors such as services, which reinforces the technique effect.

However, another possible scenario shows the technique effect as relatively weak, and instead has international trade playing a significant role in determining the relationship between growth and income. This is the *pessimistic scenario*. According to this view, as countries grow, they gradually lose their comparative advantage in pollution-intensive industries. Increased competition from lower wage countries, stricter pollution regulations, or both, may lead to a gradual relocation of pollution-intensive industry to lower income countries. In either case, environmental quality improves in higher income countries mainly because of the composition effect — as pollution-intensive industries leave, average environmental quality improves. At the same time, environmental quality worsens in lower income developing countries as pollution-intensive industries relocate there. This scenario is pessimistic because, if it is mainly a composition effect that is driving the changes in environmental quality, eventually there will be no location to which the polluting industries can move. In this scenario, higher income countries do not really solve the pollution problem, they just shift it elsewhere. Newly developing countries may not necessarily be able to look forward to the same improvements in environmental quality as earlier developers did. In other words, if it is mainly a composition effect that is at work, then the strategy in developing countries of adopting cleaner techniques entails a much higher cost than one might think.

At this point, we do not know which scenario is the correct interpretation. There is some evidence that pollution-intensive industries have been migrating to lower income countries over the past 25 years. Low and Yeats (1992) found that the share of products from pollution-intensive industries exported from Southeast Asia rose from 3.4 percent to 8.4 percent between 1965 and 1988, while North America's share of these exports fell. Robison (1988) also found that the United States has increased its imports of pollution-intensive goods. In a study of two-way trade between Japan and Indonesia, Lee and Roland-Holst (1993) found that Indonesia's exports to Japan are about six times as pollution-intensive as Japan's exports to Indonesia. While this is consistent with the development of a comparative advantage in pollution-intensive activities in low-income countries, more comprehensive studies of a large sample of countries are required to confirm this.

There is also some evidence that the compositional effect of international trade may be important. Lucas, Wheeler and Hettige (1992) found that, while the pollution intensity of national production has tended to *fall* in high-income countries, effluents per unit of manufacturing output have tended to rise over time. These seemingly conflicting results are consistent with a weak technique effect and a strong composition effect — even if the pollution intensity per unit

of manufacturing production does not fall in rich countries, overall pollution intensities do fall as manufacturing moves away from high-income countries.

Direct measures of the technique effect are hard to come by, because such data are available only for the United States. Dessus et al. (1994) construct indirect estimates by using pollution estimates generated from various types of U.S. inputs, and then using data on input patterns in different countries to predict pollution intensities there. They find a variation in pollution intensities across countries, with many lower income countries using higher pollution intensities.

The preliminary evidence suggests that we cannot rule out the importance of compositional effects in generating the inverse-U-shaped relationship between growth and pollution. The role of international trade and capital mobility is critical to understanding this linkage, and more investigation is required.

It is important to emphasize that even the optimistic scenario yields relatively bad news for the immediate future. Suppose my concerns about compositional effects are invalid. Suppose that there really is a strong technique effect, and that the inverse-U relationship holds for many critical pollutants. Does this mean that more economic growth will solve the world's environmental problems? Seldon and Song (1994) address this scenario by asking what would happen to global pollution if poor countries followed the same path as rich countries have — with pollution intensities first rising, and then declining. Two points are critical: first, many countries have incomes far below the estimated turning points for pollution intensities, and second, many of these countries have large populations. As a result, Seldon and Song project large increases in pollution emissions over the next half-century. Environmental quality will get much worse before it gets better, even in the optimistic scenario. It is important to note that not all pollutants have followed the inverse-U relationship, particularly carbon emissions or waste generation. If the past is a guide to the future, these and many other pressures on the natural environment will tend to increase with income.

In the above discussion, I have focused on the relationship between growth and pollution. This is only one of the channels through which increased economic activity can affect environmental quality. Patterns of renewable-resource use, habitat destruction, and other effects on ecosystems also vary with income.⁷ Moreover, international trade provides a vehicle through which an increase in income in one country can lead to increased pressure on natural systems in other countries. For example, much of the exploitation of Canada's resources has been driven by export markets. While more work that quantifies these relationships is required, the literature on pollution and growth is very suggestive: unless significant behavioural changes are made, increased economic growth is likely to reduce environmental quality during the lifetime of most people alive today.

Finally, we should not forget that, while growth affects environmental quality, environmental quality also affects growth. An instructive historical example is discussed in Brander and Taylor (1996), who have recently given an economic interpretation of the population collapse on Easter Island. In their interpretation, the culture of migrants from other Polynesian islands was adapted to relatively fast-growing palm trees. When they arrived on Easter Island, there was an abundant forest, and the human population began to grow. However, because the palm trees on Easter Island were very slow-growing, population growth eventually surpassed the sustainable level. A Malthusian crisis ensued, leading to warfare and population collapse. Closer to home, the collapse of the east-coast fishery has depressed local economies, indicating the importance of a healthy natural environment to sustain incomes. Dasgupta (1996) and others have argued that some regions of sub-Saharan Africa may be in a downward ecological spiral as a result of extreme population pressure on the resource base.

THE POLICY RESPONSE

ONE OF THE MAIN CONCLUSIONS DRAWN in the literature on growth and environmental quality is that sustainable development requires a strong set of institutions to ensure that the technique effect translates increased demand for environmental quality into action. This chapter outlines some guiding principles on which a policy regime might be based. The next chapter considers some specific policies.

As noted in chapter 2, good policy must recognize the realities of short re-election time horizons, uncertainty about the effects of human activity on ecosystems, globalization, unequal income distribution, and the international scope of some problems. This suggests that a policy regime should reflect four key attributes: commitment, caution, cost-effectiveness, and fairness. I consider each of these attributes in turn.

COMMITMENT

THERE IS ALWAYS A TENSION between the need for policy to be flexible, and the need for it to be able to endure challenges. Because we are still learning how human activity affects natural ecosystems, environmental policy must be able to adapt to new information. For example, rigid rules that force all firms to reduce emissions of a pollutant by 50 percent are inefficient ways of achieving aggregate emission reduction targets. Consequently, there is a need for flexibility in implementing regulations meant to improve environmental quality.

At the same time, however, a strong degree of *commitment* in environmental and conservation policy is critical because of two important constraints. Short-term re-election horizons, combined with uneven distributional effects of environmental policies, can expose governments to considerable political pressure to deal with short-term income and employment concerns at the expense of long-run sustainability issues. For example, governments in most developing countries have passed environmental regulations, but in many cases they do not enforce them. The fact that governments are able to get away with not enforcing the regulations reflects a weak commitment to the policy. Even if a government comes into power with a strong desire to implement a policy, it may find strong lobbying pressure forces it to back down or to delay implementation.

In designing environmental policy, it is critical that we develop an approach that reflects a strong degree of commitment to attaining environmental quality objectives, while at the same time allowing flexibility in how we maintain these objectives. In the past, Canada's environmental policy regime did not reflect a strong commitment. There are various ways through which this commitment can be achieved. Accepting a common ideology or belief in principles can be an important component of developing a commitment to an objective, but is unlikely to be enough. Some principles, such as the principle

of sustainable development, are open to so many different interpretations that they do not impose enough discipline on policy. As well, principles may be compromised for political expediency. What we need instead are concrete factors that change the incentives of government and ensure that it is in the government's best political interest to implement a policy objective. Words are not enough. A good policy regime must be able to withstand attempts to undermine it. This notion of commitment is fundamental to the success of policies that have long-term horizons.

Lessons can be learned from other types of government policy — it is worth reflecting on a couple of examples of commitment playing a successful role in policy. In monetary policy, commitment is key to the success of the Bank of Canada's price-stability policy. Interest rates will stay low only if investors believe that the Bank of Canada will not inflate the money supply. The institution of open international capital markets therefore acts as one form of commitment. If the Bank deviates from its policy, investors will respond with a capital outflow.⁸ A second form of commitment is the Bank's institutional structure. By ensuring that the Bank of Canada is independent of political masters, Parliament has indicated a commitment that it will avoid responding to short-term political pressures that would undermine the effectiveness of the price-stability policy.

International trade policy provides a second example of how a commitment has strengthened policy. Canada's external trade barriers have been reduced remarkably since the Second World War, in spite of considerable pressure on the government to protect vulnerable industries. The key to the success of trade liberalization is that it has taken place in cooperation with our trading partners via international institutions such as the General Agreement on Tariffs and Trade and the North American Free Trade Agreement. As one of their most important features, trade agreements tie the hands of governments: they commit governments to forsaking the use of certain policy instruments. If the government is pressured to cave in to a special interest group that wants trade protection, it has to consider not only how domestic consumers will react, but also how its trading partners will respond. Domestic response might be mild because the costs are spread thinly over a large number of individuals. It is the fear of retaliation from trading partners, combined with the reputational effects of adhering to international agreements, that has sustained a regime of relatively low trade barriers.⁹ Moreover, it is politically expedient — the government does not have to be seen *choosing* to deny protection to a petitioning industry. Instead, it can simply say that its hands are tied and point to the relevant international agreements. International agreements and organizations therefore act as an important commitment device in international trade policy.

The commitment effects of international trade agreements can also go beyond trade. It has been argued that one of the main purposes of the North American Free Trade Agreement (NAFTA) was to commit future Mexican governments to following the course of economic liberalization carried out

under the Salinas government. Some also argue that the Canada-U.S. Free-Trade Agreement played a similar role in Canada, acting as a device by which the Conservative government of the time committed future governments to following a less interventionist approach to the economy.

In the past, Canada's approach to environmental policy tended to under-exploit the potential for using commitment devices. For example, Canada's approach to environmental policy is often characterized as being much more cooperative and less confrontational than that of the United States. Compliance schedules are often negotiated with firms, and prosecution is rarely used to enforce compliance. Sinclair (1991) documents the failure of the negotiated approach in forcing pulp mills to comply with environmental standards during the 1970s and 1980s. Harrison (1995) compared compliance rates in Canada with those in the United States, and found that the more litigious U.S. approach was more effective in making firms comply. The main reason for this is that the negotiated approach has failed to incorporate a strong commitment device.

To see this most starkly, suppose that Canada ran its trade policy in this way. The government would announce general guidelines and then negotiate with each industry or firm and agree to levels of protection on a case-by-case basis. Firms would threaten to shut down or move, and the government would have to decide whether or not to call their bluff. Canada does not run its trade policy in this way because it knows that it would lead to inefficiently high tariff protection. Instead, it makes broad commitments, backed up by the threat of sanctions from its trading partners. There is extensive bargaining and consultation with industry while Canada negotiates the trade agreement, but once the agreement is signed, the negotiation phase is over, and industry has to live with binding tariff reductions.

Let us now consider various ways in which Canada can incorporate a stronger degree of commitment into the country's environmental policies.

International agreements — I have already discussed the case for international agreements as a commitment device. For transboundary environmental problems, international agreements are essential because of international free-rider problems — the benefits of reducing pollution extend beyond the country that pays for the reduction. The Montreal Protocol on ozone-depleting gases is a prime example of a coordinated international approach to dealing with such problems, and it has been very successful in lowering CFC emissions. This agreement was also backed up with commitment devices — it included provisions for using trade sanctions against non-compliant countries. The Montreal Protocol is an exception, however, in that most international environmental agreements do not include strong enforcement devices. The fact that the world included them in this agreement reflects the generalized alarm over

the thinning of the ozone layer. When urgent action was needed, governments agreed to incorporate commitment devices into a treaty.

International agreements may also be useful for increasing the degree of commitment, even in cases where pollution does not cross a boundary. Esty (1994) has suggested creating a Global Environmental Organization, along the lines of the World Trade Organization, to deal with a variety of pollution problems.

Incorporating environmental standards into trade agreements may also be a way to increase commitment to environmental and conservation policies. Canada objected to this idea during the NAFTA negotiations, and there is considerable resistance in the trade-policy community. However, such a move could act as a commitment device. If Canada had to meet certain environmental standards to gain access to foreign markets, then the country's incentive to meet these standards would increase. There is clearly a trade-off — Canada sacrifices some sovereignty over environmental policy to open up a potential loophole for more contingent protection — but the commitment benefits should not be overlooked.

Information — Information is a public good; it sometimes requires a high cost to produce but, once compiled, it can be distributed at little cost. With modern technology like the Internet, the costs of disseminating information are close to zero. In itself, this is a strong argument for having the government collect data on environmental quality. Providing information can also act as a commitment device, particularly if the government announces clear environmental quality and conservation targets. Governments can use information that environmental quality is worsening to bolster support for tough policies. Governments can also use information that environmental quality is improving to help bolster support for the political party in power, just as they now routinely take credit for good economic news.

Government can enhance the commitment effects of information if it processes the information so that large numbers of people can easily interpret it. Just as the media report interest rates, inflation rates and leading economic indicators, they could also routinely report leading indicators of environmental quality. Imaginative packaging of the information is needed to market it to media outlets.

There are many ways to enhance how information is provided. Canada has already agreed to have the OECD review its environmental performance. These appear to be rather soft reviews that take care not to offend (OECD, 1995a). A more rigorous review process, perhaps along the lines of what the Auditor General does for public finances, would be one way of exploiting the commitment effects of information.

Many environmentalists also argue for the adoption of green GDP accounting. I am less convinced that adjusting a highly aggregated num-

ber such as GDP would have much influence on policy or perceptions, but some believe that national accounting methods which take into account the economy's effects on the natural environment would help to gradually move the norm for what we consider success away from per-capita income toward a measurement of quality of life, perhaps combined with a sustainability index.

There seems to be a dearth of information in Canada on estimating conservation benefits and improvements to environmental quality (OECD, 1995a). There is very little readily available cost-benefit assessment of federal and provincial environmental policies. In part, this can likely be attributed to the relatively small number of empirical environmental economists working in Canadian universities today. In contrast, there is a large amount of such work being done in the United States. While cost-benefit analysis is only one of several tools that can help support consistent policy-making, the increased availability of estimates of non-market conservation benefits and improvements to environmental quality can help increase commitment to environmental policies.

Funding environmental groups and environmental research — Environmental regulations can impose high costs on a relatively small group of firms or individuals, and can yield large benefits spread over large numbers of people. Opposition to a regulation may therefore be very focused. For this reason, those who are harmed by the regulation may find it easier to raise money to oppose the regulation than those who benefit from the policy. To ensure a strong commitment to socially desirable environmental policy, it is important to have a counterbalance. One way to do this is to have public funding of environmental research activities, and forums that bring environmental groups, industry and government together.

National standards — The federal and provincial governments share the responsibility for environmental policy. Even if, as is the trend, the provinces are left to enforce the policies, the central government has an important role to play, either in setting national standards or acting as a facilitator to convince the provinces to agree to national standards. Often, the justification for national standards is to prevent individual states or provinces from trying to attract investment by offering weaker environmental regulations than their neighbours. In addition, announcing and enforcing environmental standards can act as a commitment device, much as international treaties accomplish for countries. Provinces have an incentive to commit to national standards to strengthen their bargaining position with local firms that want to be exempted from tough environmental rules.

Because pollution emissions have very different effects on environmental quality across the country, the preferred types of national stan-

dards are ambient quality standards — for example, rather than a rule requiring all cities to have tertiary treatment for their sewage, the preferred rule would set acceptable levels of water quality, and provide for an enforcement device.

Foreign pressure groups and extra-territoriality — Many environmental groups have shifted their focus to international issues, and some have become multinational organizations. As well, those industries that are subject to environmental regulation in their own country are voicing concerns about having to compete with imports from countries with weaker environmental regulations. This has led to efforts to coerce foreign countries into altering their environmental policies, even in cases where there appears to be no direct transboundary pollution. The targeted industries sometimes view this trend with outrage, particularly when the foreign pressure group has incomplete or distorted information, but is nevertheless successful in using the media to further its cause. Sometimes, however, there is a silver lining that accompanies foreign meddling. Foreign pressure can be exploited as a commitment device — a domestic government, pursuing a sustainable development strategy that will impose some costs on the current generation of resource users in return for long-term benefits, can exploit foreign pressure to place the blame for short-term costs on the foreigners. Even without an explicit international environmental agreement, the threat of foreign retaliation, even when seemingly random, can bolster political resolve to pursue good policy. For example, it is not likely that threats of boycotts of B.C. forest products went unnoticed while the government was developing the new *Forest Practices Code*.

Economic instruments — Economic instruments can also be used to increase the degree of commitment to enforcing and maintaining environmental and conservation policy. Where feasible, a tax on pollution emissions has a similar effect on environmental quality as a regulation that prescribes a fine for non-compliance. The difference between the two approaches, however, is that once pollution emissions are measured, tax payments are essentially automatic, while fines for non-compliance are discretionary. In Canada, non-compliance may engender a series of warnings and negotiations. If there is no prosecution, it is time-consuming and costly. This reduces the incentive effect of a regulatory approach. A non-discretionary tax, on the other hand, can reflect a commitment to the environmental quality target.

Similarly, individual transferable quotas for fishing or for pollution emissions can formalize a commitment to a certain harvest level or emissions target. Because the target is fixed at the sum of all the quotas, a great deal of discretion is removed from the enforcement process. Moreover, if the permits are transferable in markets, the government creates a power-

ful lobby to dissuade it from lax enforcement, since those who have purchased permits see the value of their investment drop if there is poor enforcement.

Community involvement -- The importance of local community involvement in managing environmental quality is a theme that runs through much of the environmentalist and conservationist community. It also shows up in some of the economic literature on local public goods, and is consistent with the movement by some provincial governments to shift more power from the federal government to the provinces. One of the ideas behind this view is that if local communities have a stake in the resource, they will have an incentive to protect and nurture it. There is much literature in anthropology and sociology that describes the various ways in which small communities in different cultures have developed institutions to protect common property resources (see Ostrom, 1990).

Daly and Goodland (1994) have also used this type of argument to support the view that free trade should be curtailed. Trade separates the location where environmental services are consumed from the location where they are produced. That is, because I live in a city and import fruits and metal and plastic, I do not have to live with the consequences of pesticides leaching into water, strip mining, or toxic emissions. Since I do not see the environmental consequences of my consumption, I will be less committed to policies that are aimed at improving environmental quality. Moreover, with mobile capital, business does not need to develop a strong commitment to local environmental quality. If local environmental resources are degraded, the business can move to another location. The decision-makers do not bear the consequences of environmental damage; that is left for the local communities. The argument, then, is that commitment to maintaining environmental quality will be increased if power is devolved to communities, and if communities become more self-sustaining.

For some types of environmental problems, community control may make a lot of sense. For example, allocating fishing quotas to fishing communities may better sustain those communities than would allocating those quotas to a large corporation. Making municipalities responsible for managing their own waste should foster appropriate incentives for deciding between incineration, landfill, recycling, and waste reduction.

However, it is important not to push this argument too far. Relying too much on decentralization can work against some of the commitment factors reviewed above. First, the same studies that showed how traditional communities manage their common property resources also showed how these management regimes can break down when confronted with the opportunity to trade, with increased labour and capital mobility, and with increased difficulties in controlling outside access to the resource base. In reality, communities are not static and stable, but are subject to

a great deal of migration. The option, for people and capital, of easily moving elsewhere can undercut a community's ability to commit to good resource management. Moreover, majority rule in communities can lead to perverse outcomes.

Consider a province- or country-wide situation where 60 percent of the population is in favour of commercially developing wilderness areas, while 40 percent support preservation. In such a case, the nation or province that reflects diverse preferences should set aside significant wilderness tracts. Otherwise, if these issues are decided on a case-by-case basis in individual communities, majority rule may well lead to excessive development. Finally, many resources are shared between communities and generations. The benefits of preserving ecosystems and improving conservation may go far beyond the individual community that pays for it. Again, in such cases, excessive decentralization will not work.

CAUTION

THE NEED FOR CAUTION IN ENVIRONMENTAL AND CONSERVATION POLICIES follows from our uncertainty about the effects of pollution on human health, how ecosystems respond to pollution and other forms of human intervention, and the long-time horizons involved. Caution is especially important when there are effective irreversibilities — that is, where it may take an extremely long time for the environment to regenerate. We can also argue for caution with respect to the economic consequences of environmental policies. Excessive regulations can cause capital to flee and impose high economic costs on some individuals.

Weitzman (1974) performed the classic analysis of caution in environmental policy, which is still relevant today. The key idea is to assess the costs of making a mistake. If the economic costs at the margin are very high relative to the ecological costs, then policies minimizing economic risks are needed. On the other hand, if the potential ecological costs of an error are high, then rigid environmental standards are needed.

The need for caution has important implications for the types of policy instruments used and for the stringency of policy.

Taxes versus standards — In cases where the ecological or human-health consequences of a mistake are relatively large, policy should set stringent environmental quality standards or conservation targets and provide for rigid enforcement. Taxes and other price instruments are not suitable instruments in this case, because they can lead to excessive development if costs are unexpectedly lower, or if investment or population growth is greater than expected. In these cases, the pressure on the environment can be high. If the costs of CFC emissions are thought to be high, for example, a rigid aggregate national and global target is an appro-

appropriate response. If a tax on CFCs were used instead and set too low, emissions could be excessive. In contrast, the marginal cost of excessive production of municipal waste is probably not high compared to the economic costs of rigid waste-management rules. In this case, a tax or charge for waste disposal may well be a suitable instrument.

Zoning — Zoning can be an appropriate solution to diversify risks in response to some potential or actual environmental problems. For example, because the effect of human intervention on ecosystems is unknown, it makes sense to set aside wilderness areas. The British Columbia Agricultural Land Reserve policy is a good example of the use of zoning to reflect caution in public policy.

Planning — Long-run planning for land use and population growth is essential when faced with uncertainty — it is important to diversify risks, and this is better handled when one makes integrated decisions, rather than case-by-case decisions on land use.

COST-EFFECTIVENESS

POLICIES ARE COST-EFFECTIVE IF THEY MINIMIZE THE COST of achieving their target. That is, an evaluation of the cost-effectiveness of a policy does not question whether the target is desirable, but rather compares the costs of different ways of achieving the same goal. Costs include both direct compliance costs to firms, restrictions on the freedom of individuals — such as limitations on the opportunity to go fishing or to smoke in public places — and costs of administering government policies. While cost-effectiveness in regulatory policy is always desirable, it will be crucial in the coming decades because of fiscal pressure on governments and because of increased exposure to international competition.

There is a huge economic literature on the cost-effectiveness of environmental policies, which need not be reviewed here. This literature states that, in theory, economic instruments that allow firms some flexibility in how they achieve environmental quality objectives are more cost-effective than the traditional command-and-control approach. The latter approach might, for example, impose best-practice technology or rigid emission requirements on all firms. Unfortunately, because the use of economic instruments is still rather limited, there is relatively little empirical testing of this proposition available.

However, the experience with transferable permits for sulphur-dioxide (SO₂) emissions in the United States does provide some evidence. Prices for pollution permits turned out to be much lower than anticipated, which suggests that compliance costs are lower than anticipated. Burtraw (1996) suggests that the main benefit of the SO₂ program was not so much that permits were marketed, but rather that firms were given clear emission targets and allowed to choose how to meet these targets. Many firms, for example, chose to switch to

coal with a lower sulphur content rather than buy emission permits. The key to success seems to have been the combination of rigid targets, good monitoring (firms must install expensive automatic monitoring devices), and automatic enforcement mechanisms (there is a high tax or fine charged if a firm does not have enough permits to cover its emissions), with flexibility in how to meet the targets.

There are several important issues concerning cost-effectiveness:

Overlapping governmental jurisdictions -- Because jurisdiction for environmental policy is divided between the federal and provincial governments, it is important to avoid duplicating services and imposing excessive red tape on firms. Federal and provincial actions should be coordinated, or certain regulatory powers should be assigned exclusively to one level of government. At the same time, we should not overlook the commitment benefits of having two levels of government with a stake in environmental quality.

Periodic reviews of the cost-effectiveness of policies -- Many environmental policies in Canada appear to have become entrenched without a clear understanding of their cost-effectiveness relative to other ways of meeting the same target. For example, the Aircare program in British Columbia is similar to programs in the United States which were not cost-effective (see McConnell, 1990). As well, large and costly municipal recycling programs have evolved in Canada without a clear understanding of their cost-effectiveness. Good environmental policy requires a more careful assessment of cost-effectiveness than has been done in the past.

Negotiation -- I argued above that Canada's approach to negotiating compliance with environmental policy has a weak commitment effect. However, in theory, it should yield benefits from a cost-effectiveness perspective. In principle, if economic instruments are ruled out as impractical or unpalatable to polluters, then an alternative route to increasing flexibility and cost-effectiveness in environmental policy is to negotiate with polluters rather than simply impose regulations on them. I do not know of any studies that have assessed this point empirically, but it would be worth investigating. Ideally, this form of regulation should follow a three-stage procedure — announcing environmental quality targets to ensure commitment to a clean environment, negotiating how to achieve each emission reduction target (flexibility enters at this stage), then rigidly enforcing the targets to ensure commitment.

FAIRNESS AND DISTRIBUTIVE ISSUES

INCOME DISTRIBUTION PLAYS A CRITICAL ROLE IN ENVIRONMENTAL and conservation policy, within Canada and at the international level. Within Canada, income distribution is important because of general concerns with fairness, and because the effects of a policy on income distribution can in many cases determine whether or not it is politically feasible. As well, if the sustainable development of communities is a goal, then the effect of environmental policies on communities can also be critical.

At the heart of the income-distribution problem, policies promoting increases in environmental quality have three effects, depending in part on the type of policy. First, benefits in the form of improved environmental quality are generated, but the distribution of the benefits may be uneven. Second, public investments in environmental quality, such as wilderness preservation, have to be funded. Finally, whereas in earlier years polluters essentially had free access to environmental services because of weak or non-existent regulations, governments have used environmental policies in the last 25 years to reclaim their property rights on the use of environmental services. Imposing tough environmental regulations represents a public assertion of ownership of these rights. Since a reassertion of ownership inevitably leads to a transfer of income, part of the distribution problem is transitional. However, the ongoing issue relates to the terms of access to environmental services. The choice of policy instrument can have a major impact on who reaps the benefits from access to environmental services, and who bears the costs of reducing the impact of human activity on the environment.

Because the demand for environmental quality rises with income levels, if a tax proportional to income is used to finance improvements in some types of environmental quality, the main benefit may accrue to higher income groups. The strength of this effect, however, depends on the type of policy. At very low levels of income, policies that provide clean drinking water and access to urban sanitation systems can dramatically improve quality of life for the poor. In richer countries, there is some evidence that air-quality improvements raise property values. Consequently, air quality in poor parts of cities may be worse than in high-income areas (Asch and Seneca, 1978). A policy that enforces minimum air-quality standards could provide relatively larger environmental benefits for the poor. However, some have suggested that the benefits would eventually go to land owners rather than renters, as property values rise with environmental quality. Similarly, there is evidence that the use of wilderness recreation areas tends to be correlated with income. This suggests that higher income groups might benefit relatively more from the preservation of such areas.

Many improvements in environmental quality need financing, either through direct charges or increased prices for goods that use the environment intensively. There have been a number of studies on the effects of these tax or

price changes on income distribution. Christensen and Tietenberg (1985) and Harrison (1994) reviewed this work and found that most of these policies tend to be regressive, in that lower income groups end up paying a larger fraction of their income to support improvements in environmental quality. For example, Robison (1985) used a general-equilibrium input-output model to determine who paid for the costs of industrial pollution abatement in the United States in the mid-1970s. He found that the lowest income groups paid 1.1 percent of their income, while the proportion for the highest income groups was 0.2 percent.

As discussed in detail later, while dealing with global pollution issues involves significant conflicts between the aims of rich and poor countries, these issues also have an impact on internal income distribution, since many of the proposed solutions tend to be at least mildly regressive. Recently, Hamilton and Cameron (1994) examined the distributional implications of a carbon tax in Canada and found that the burden fell more heavily on low-income groups — the disposable income of the lowest income quintile would drop by about 1.1 percent more than that of the highest income quintile.

The regressivity of environmental policies has probably not been a serious obstacle to their implementation in the past, in part because using environmental standards and regulations rather than taxes means that their costs become buried in other prices. This tends to render any opposition mute. Because advocates for the poor have focused on other, larger, sources of inequity in society, opposition has been further reduced. Aside from issues of fairness, however, regressivity may become a more important issue in the future for two reasons. First, compliance costs are likely to rise because of increased pressure on the environment and because many of the more difficult environmental problems remain unsolved. Second, governments are short of money, and there will be a trend toward increased reliance on user fees. This will probably increase regressivity, magnify the source of real-income drops, and provide a focal point for opposition.

A more significant obstacle to implementing environmental policy is the distribution of its effects across industries, firms and communities. As Table 4 shows, some industries, such as primary metals, pulp and paper, and mining have had much higher environmental compliance costs than others. As well, many resource-based communities rely heavily on environmental services, and can be particularly hard hit by changes in land-use policy or environmental regulations. For example, Sinclair (1991) outlines the success of pulp mills in the 1970s in using the threat of job losses as an argument against speedy compliance with pollution regulations.

In cases where the cost of complying with an environmental policy falls on a clearly defined group, there is an incentive for that group to organize, and the distributional effects can then be critical to achieving the policy objective. In some cases, there may be no way to avoid a very uneven distribution of costs, and some form of adjustment assistance may be needed to defuse opposition. In

other cases, however, the choice of policy instrument can have a critical impact on the degree of support for the policy.

Weitzman provides a good example of this problem, which is also described in Baumol and Oates (1988). They give a simple example of how using taxes to solve a common property problem can make all users of the resource worse off. Consider a fishery with the standard problem of excessive entry, because individuals ignore the social costs of excessive fishing that they impose on others. Consequently, the stock is run down and fishing costs rise for everyone because fish become harder to find. The same issue arises with traffic congestion. Individuals drive too much, ignoring the contribution of their own driving to congestion. In these situations, we would be better off if we all agreed to fish less or drive less. Economists often propose using taxes to solve the problem. However, using a tax to induce this behaviour may in fact make us all worse off. The tax does indeed induce everyone to fish less or drive less. However, for the tax to work, the increased value for each person, in terms of increased availability of fish or reduced traffic congestion, are typically lower than the value of the tax, making all fishers or drivers worse off. Of course, someone has to benefit, and who benefits depends on the use that is made of the revenue. If resource users do not receive the tax revenue, or some tangible benefit such as access to a good mass transit system, then they have a strong, rational incentive to oppose the tax, even if they are aware of the problems associated with overusing the resource.

The key point here is that taxes have both a revenue effect and an efficiency effect. Economists have tended to focus too much on the efficiency effect, and so taxes have not been used to address environmental problems. This has implications for the future, as we move to a climate that is more tolerant of the user-pay principle for environmental services.

First, providing equal access to public infrastructure such as roads is one of the ways in which income is redistributed in this country. It is more politically acceptable than just giving money to the poor. Policy-makers should recognize the implications of renegeing on this implicit contract, especially at a time when income distribution is likely to get worse. If user-pay policies such as toll roads are introduced, the burden on the poor could be softened by, for example, increasing tax credits or issuing free passes for a fixed amount of access to controlled-use services.

Second, if taxes are used, either the revenue-distribution issue has to be addressed, or the taxes have to be imposed coercively. One option is to use tax-credit systems. In Sweden, the proceeds of a tax on sulphur dioxide (OECD, 1995b) were rebated to industry. This resulted in a tax on high polluters and a subsidy to low polluters. The size of the rebate must not increase with the level of pollution, however, or the incentive effect of the tax could be eliminated.

Another option is to target revenues to programs that invest in environmental quality to the benefit of those who are taxed. This is a common approach for many types of user fees. For example, sewer levies are used to build

sewers, and stumpage fees in British Columbia are used in part for reforestation. This option can have the perverse effect, however, of investing in projects that benefit polluters.

A third option is to integrate environmental policy with other branches of government. Instead of avoiding the use of particular policy instruments because they are regressive, these environmental policy instruments must be accompanied by broader reforms that simultaneously address income distribution issues. Sweden adopted this approach in 1991 when it introduced new environmental taxes as part of a general tax reform (Bohm, 1994). While environmental taxes were increased, high marginal tax rates on earned income were reduced. If the tax reform is roughly revenue neutral, and if many changes take place at once, then it is easier to introduce reform. This approach is also used in trade-policy reform. Rather than attempting to remove one tariff at a time, many tariffs are reduced simultaneously, thus diffusing the potential opposition.

The double-dividend argument (see Goulder, 1995, for a survey) is related to this point. According to this argument, one might, for example, reduce payroll taxes and, at the same time, introduce a carbon tax. The idea here is to use the revenue from environmental taxes to finance reductions in distortionary taxes. There is some evidence (see McKittrick, 1996, for a Canadian application) that such policies would lower the effective social cost of improving environmental quality. While most of the double-dividend literature is concerned with efficiency, the same argument could be used for distribution. The revenue from new environmental taxes could be targeted toward the poor or those in groups expected to be most adversely affected by the policy.

If the revenue effects of taxes cannot be dealt with satisfactorily, then alternative instruments must be found. Using individual transferable quotas has two potential advantages over taxes. First, the use of environmental services is effectively rationed, so there is less environmental risk. Second, the quotas can be given away, which can dampen the adverse effect on income distribution.

For these reasons, permits are more attractive to many firms and environmentalists. However, because many environmental problems are complex, the transaction costs of a transferable permit system are high. As long as pollution outputs can be monitored, however, one can achieve the major benefits of a permit system, which include giving firms clear pollution targets and flexibility in how they attain these targets.

Finally, the various types of command-and-control policies vary in their distributional effects. A restriction on emissions per unit of output, for example, has a different impact on output and employment than a requirement that best-practice abatement equipment be installed up front (Helfand, 1991). The distributional effects of different types of regulations vary by industry and pollutant. Negotiation and consultation with those affected by pollution-control requirements can be valuable tools in dealing with distributional effects. However, the regulator must be backed up by a strong commitment to enforce ambient environmental quality standards.

While resource-conservation problems involve many of the same distributional conflicts that arise in pollution regulation, the issue of equity between current and future generations is more germane to the conservation issue. For example, the collapse of the east-coast fishery is a warning that preoccupation with current distributional problems can lead to bigger distributional problems in the future. If a resource is not being managed in a sustainable way now, there will inevitably be an income-distribution crisis in the future when the resource collapses. In such cases, it is better to deal with this issue sooner rather than later.

The same point holds for land-use conflicts. Although Canada's forest stock is increasing, in some areas, easily accessible timber is being overlogged. If excessive logging means that local jobs will disappear in a few years, we can either choose to defer the income-distribution problem until later, when there are no more local jobs and old-growth forests, or we can face the income-distribution problem now, while the trees are still there. Long-term land-use planning is essential, especially to pinpoint local issues of non-sustainability.

If maintaining sustainable communities is a policy goal, Canada may have to take some care in how it rations access to a resource. For example, in the case of a fishery, an efficiency argument can be made for auctioning permits to the highest bidder. However, one can also make the case that, in the long-run interests of the resource and the community, a fishing community itself should hold the permits and ensure that those using them have ties to the community. Simply maximizing rents is not necessarily in the best interests of a community. When the sustainability of a community requires assured continued access to the resource, the distribution of permits is crucial. This issue is fundamental to some of the land-use and resource-management conflicts that will arise in resource-based communities in the future.

ECONOMIC INSTRUMENTS AND ENVIRONMENTAL POLICY

THERE ARE TWO TRADITIONAL TYPES of environmental management in Canada: the first uses common law to enforce property rights, and the second uses regulations. There is a long history of courts enforcing property rights for environmental damage. For example, those injured by pollution can sue the polluter for damages, or can attempt to obtain an injunction to stop the pollution. This approach, however, has not succeeded in controlling the pollution that an industrial society generates. Many pollutants come from a variety of sources, so it is not clear whom to sue. As well, many pollutants have uncertain effects on the environment and on human health, and the standards of proof that the courts require to assign liability cannot be met (see Menell, 1991). In addition, governments that were more concerned with economic development than with damage to the environment have not sued when public lands have been damaged. Dewees and Halewood (1992) show how government action has weakened the ability of individual property owners to sue for damages caused by pollution from smelters in Sudbury, Ontario.

Instead, most industrial countries, including Canada, have adopted a regulatory approach to environmental management. With mixed results, governments have placed restrictions on the levels of emissions and the types of technology and chemicals that can be used or discharged, and have controlled access to renewable resources. While there has been much progress, there is still more to be done.

The regulatory approach can be costly. A number of simulation studies in the United States have demonstrated that a certain pattern of regulations imposed on polluting firms yields significantly higher compliance costs compared to a cost-minimizing strategy (see Bohm and Russell, 1985, for a review). This suggests that there is some potential for efficiency gains if alternative regulatory approaches are explored.

Since at least the 1920s, economists have advocated using economic incentives to deal with pollution. In this view, environmental problems arise because the price of environmental services is too low. While pollution of the air and water harms other users or keeps them from using these environmental services, a firm does not have to pay for the right to use these inputs. Not surprisingly, if the firm sees some inputs as cheap, it has an incentive to overuse them. The result is too much pollution.

Since, in this view, the problem exists where some key prices are missing from the market, one can solve this problem by fixing up the market and introducing prices for scarce environmental services. Pollution taxes or charges can be introduced to reflect the social cost of the firm's use of environmental services. Another approach, introduced by Dales in the 1960s, is to use transferable permits. Once again, this is a way of patching up the market. If regulators decide that the atmosphere can withstand only X tons of sulphur-dioxide

emissions per year, then Y permits can be granted, and firms can compete for them. In this case, access to environmental services is made scarce and valuable by restricting the supply of permits, just as access to skilled labour is valuable because of its limited supply.

Other approaches to using economic incentives include variations on taxes and permits. Pollution or environmental taxes vary in how directly they target environmental damage — they may apply directly to emissions, or indirectly to certain types of inputs, like carbon, or outputs, like batteries. User charges are fees for using environmental services. Their primary purpose is to recover costs for things such as sewer systems. Deposit-refund schemes are essentially refundable taxes: the user pays a deposit for a product. If the used product is thrown away, causing environmental damage, the deposit is forfeited. If the product is returned to a collection system, some or all of the deposit is reimbursed.

In theory, economic instruments have several advantages over traditional regulations. Perhaps the most important advantage is cost-effectiveness — they allow firms a great deal of flexibility in determining how to reduce environmental damage. They should also entail lower compliance costs. If the firm knows that it has to pay for its pollution, then it has an incentive to find the cheapest way to reduce pollution. It does not have to follow arbitrary rules set by a regulator. As well, if firms differ in their costs of reducing emissions, then it is cost-effective from a societal perspective for those firms with the lowest abatement costs to clean up first. A tax or permit system provides an incentive to do this. The low-cost firms find it cheaper to cut pollution than to pay for the right to pollute; the high-cost firms pay the fee.

It is also expected that economic instruments would encourage firms to develop innovative ways to reduce pollution. Just as firms look for ways to reduce their labour costs when wages are high, they should be given incentives to look for ways to reduce pollution-control costs when the cost of polluting is high. The world market for pollution control is likely to increase significantly over the next decades, and new techniques may find a ready export market. In contrast, traditional regulatory approaches often require firms to install certain abatement equipment. Once the equipment is installed and the firm receives approval to produce, it has little further incentive to look for ways to reduce the cost of polluting.

Economic instruments may also promote industrial renewal and in this way improve the overall competitiveness of an industry. When regulations are negotiated with incumbent firms, the regulations may favour the existing firms and deter entry to the industry by, for example, imposing tighter emission controls on new firms. With fees or permits, on the other hand, anyone can enter the industry as long as they can make a profit. Under a permit system, increased entry into an industry would automatically push up permit prices, increasing the incentive to cut pollution, and forcing the least efficient firms out, just as the price mechanism works with any other input, such as labour. In principle,

a tax system could work the same way. However, government would have to increase taxes on new firms to maintain the target level of environmental quality. Because this can be politically difficult, the government may opt to restrict entry instead.

The other advantage of an economic incentive system, and especially a tax system, is that its effects can filter through the entire market system. Our economic system deals with scarcity by using price signals to ration goods. We ration scarce goods, such as choice house locations, with prices. We then do not have to rely on notions of social responsibility to decide if, for example, by buying a particular house we are depriving someone else of the opportunity to live there. In the realm of environmental problems, there have been many attempts to change behaviour by trying to raise environmental consciousness — we are exhorted to drive cars less to reduce pollution, eat less meat because its environmental footprint is larger, buy goods with less packaging, and so on. Behavioural norms are important, but when consumers have limited information about the environmental consequences of their consumption, deciding on the socially responsible thing to do can be confusing. Regulations already partly result in changed price signals for consumers by raising the costs of pollution-intensive goods. Using environmental taxes goes one step further, by using the power of prices to ration scarce environmental services.

Canada has had relatively little experience with using economic instruments to control pollution (see OECD, 1994, 1995a), and has not used transferable permit schemes. There are a few subsidy programs to promote investment in pollution control, to rehabilitate wetlands and to improve energy efficiency. Taxes and charges are used to recover part of the cost of such things as water use, but Canada has made only very limited use of charges as disincentives. For example, there is an excise tax on automobile air conditioners, and taxes on products such as tires, batteries, and disposable diapers. The fee structures for municipal waste disposal vary across Canada, and in some cases fees increase with the volume of disposal. Some industries face water effluent charges that vary depending on the volume of discharge and the pollution load. Deposit-refund systems are used for beverage containers.

The experience of other countries is also rather limited, although several have gone further than Canada. Recently, there has been a trend toward a more innovative use of policy instruments.

PERMITS

THE UNITED STATES HAS BEEN THE MAIN PROPONENT of transferable permits. During the 1970s and 1980s, the United States allowed limited transferability of pollution permits among sources within the same firm, under 'netting' and 'bubble' programs.¹⁰ These programs gave firms some flexibility in complying with emission targets. An offset program allowed limited trading of emission credits between firms. Although some trading did occur, transaction costs were

high because of the need for regulatory approval. As such, the impact of these programs was limited. The United States also used tradable permits to phase out lead in gasoline, and to implement the CFC-reduction program under the Montreal Protocol. The most significant experiment with transferable permits is the SO₂ allowance trading program. This program will cap emissions of SO₂ and allow trading among 2,200 power plants. Because of the relative ease of trading compared with earlier programs, it will provide the best test to date of the idea of creating a market for the right to pollute.

The United States has also used a transferable-permit approach to promote the conservation of renewable resources. Under a system of individual transferable fishing quotas (ITQs), fishers are issued permits giving them the right to catch a fixed number of fish. They can trade these permits. This creates a market for access to the resource which would not otherwise exist. A number of countries are beginning to use this approach. Since 1990, Iceland has used a system of ITQs for all of its fisheries, with the fishing industry paying for the administrative costs.

INCENTIVE TAXES

MANY COUNTRIES USE CHARGES MAINLY TO GENERATE REVENUE, but some are structuring charges for environmental services to exploit their incentive effects. Sweden's tax on NO_x emissions from heat and power producers (OECD, 1994, p. 59) affects about 6.5 percent of all Swedish NO_x emissions. The tax is revenue neutral. While it is based on actual emissions, if a producer does not measure its emissions, a high flat rate applies. This encourages producers to install measuring equipment. This system rebates the proceeds to producers in proportion to their final energy production, transferring income from high polluters to low polluters, and providing an incentive to reduce emissions. Sweden also levies a tax on the sulphur content of fuels. According to the OECD (1994), the sulphur content of oil fell by 30 percent between 1990 and 1992 as a result of the tax. Administrative costs are less than 1 percent of revenues.

Several countries apply differential tax rates to automobiles based on their emission standards or fuel efficiency. The United States has a 'gas-guzzler' tax on cars with a fuel-efficiency rate of less than 22.5 miles to the gallon. The tax is significant, varying from \$1,000 to \$7,700, depending on fuel efficiency (OECD, 1995).

Most countries levy taxes on fossil fuels and other forms of energy. Since using energy significantly affects emissions of pollutants into the air, these taxes have an environmental component. In some countries, the revenue from such taxes is substantial: for example, in 1993, taxes on energy, fuels and motor vehicles generated more than 10 percent of Norway's revenue (OECD, 1995b). By OECD standards, Canada's taxes on fuels are rather low (see OECD, 1995b) — our taxes on gasoline amounted to 50 percent of the end-user price in 1994. This percentage is high compared to the United States, however, where taxes

accounted for only 34.4 percent of the final price. But the United States is an outlier among OECD countries, where taxes represent between 65 and 75 percent of the final end-user price of gasoline.

Denmark, Finland, the Netherlands, Norway and Sweden have introduced carbon taxes on top of existing fuel taxes. In Finland and the Netherlands, the rate is set very low, but in Norway and Sweden, the carbon tax rate is quite high and may well have significant incentive effects.

Various other taxes are also used to target environmental problems. Sweden levies taxes on fertilizers and pesticides. Some countries, such as Belgium, levy charges on packaging materials to reduce waste. Deposit-refund systems for beverage containers are common in many countries. Since 1975, Sweden has had a deposit-refund system for car hulks to discourage people from abandoning old cars (Bohm, 1994).

EVALUATION

WHILE MOST ECONOMISTS SUPPORT USING ECONOMIC INSTRUMENTS to control pollution, tax-based measures account for a minor component of environmental policy throughout the world. Why is this?¹¹

Serious coordinated efforts to improve environmental quality are still a relatively new concept in industrial countries, so the policy process may not yet be mature. With time and experimentation, a more efficient mix of instruments may be adopted. The gradual evolution of the U.S. transferable-permit system is consistent with this point of view.

Distributional problems have also impeded the adoption of tax-based measures. A regulatory system rations access to environmental services, without actually charging for access. A tax or permit system, on the other hand, takes the right to limited free access to the environment away from individuals and firms, and begins to charge for its use like any other input. Naturally, those affected are opposed to such a change. Permit systems have the advantage of separating the conversion to a price system from the allocation of ownership. With the SO₂ permit system in the United States, firms received free permits based on their previous emissions. Not surprisingly, firms are showing increased interest in transferable permits because they can take advantage of the flexibility without taking the revenue hit that taxes would introduce.

Environmental groups have identified problems with economic instruments. In some cases, they see the economic system as the cause of environmental problems, and do not sanction a mere patching up of the system. In other cases, they see pollution as unethical, and believe the government should not be in the business of allowing market transactions in unethical behaviour. They assert that, because poor information is available about how polluters would respond to the tax, there would be uncertain environmental outcomes. They also point out that, if there are no restrictions on trading transferable pollution permits, it is possible for environmental quality to worsen under a permit system compared to a purely regulatory system.

However, the most important reason why economic instruments have found only limited application may be that they are not as simple to implement in practice as they seem in theory.

First, both permit and tax systems require the monitoring of emissions. In some cases, when this is too costly, it is sufficient to monitor an input or output that is correlated with the targeted pollutant. For many pollutants emitted from stationary pipes or smokestacks, this concept is feasible in principle, but often costly. For other pollutants, the concept is not so feasible. In contrast, if regulation requires the installation of certain pollution-abatement equipment, then inspectors need only ensure that the equipment is installed, and check from time to time that it is working.

Second, as I pointed out earlier, the effect of taxes depends on supply-and-demand elasticities, which may be unknown. In some cases, high taxes may be needed to induce significant emission reductions. Changes in technology or market conditions can lead to big changes in emissions, as firms grow, or as they enter or exit industries. This may lead to considerable tinkering with tax rates, creating unwanted uncertainty for firms and environmental quality.

Third, not all emissions of a given pollutant are equally damaging. A wood stove has a much different effect on air quality in a crowded city than it does on an isolated ranch. Prevailing winds, ocean currents, and population densities all influence the amount of environmental damage that pollution causes. This means that, to ensure cost-effectiveness, tax rates for emissions should not be the same for different sources. Instead, theory says that charges for environmental damage should be the same for different sources. This adds to the complexity of a tax-based system, since it requires calculating differential taxes based on damage rather than emissions. Of course, regulatory systems also have to confront this problem. The point is, however, that once we confront the reality of pollution problems, the simplicity of tax-based textbook solutions tends to dissipate. In practice, an ideal set of differential taxes is too complex to implement, making it necessary to compare the merits of an imperfect tax system with the existing imperfect regulatory system. From a cost-effectiveness point of view, the preferred system would vary with different pollution problems.

Marketable pollution permits create similar problems. If the purpose of reducing SO_2 emissions is to reduce acid rain, then it must be recognized that SO_2 from the midwest causes more environmental damage than SO_2 from the east coast. In theory, one can devise a system of transfer coefficients to reflect differences in environmental damage caused by different sources. Thus, to increase emissions by one ton in the midwest, a firm may have to buy two permits from an east-coast firm, or only one permit from another midwest firm. This complicates transactions. Alternatively, zones can be created and trading restricted to firms within the same zone. This solution is problematic, since the market for permits then shrinks in size, making it vulnerable to non-competitive behaviour. In practice, the United States opted to allow one-for-one trades throughout one large zone.

Once it is recognized that implementing tax and permit schemes might be complicated and yield uncertain outcomes, it is less obvious that they are preferable to more traditional regulatory schemes. Nevertheless, there are some cases where economic incentive instruments should be feasible.

Deposit-refund systems are already used for beverage containers; these systems have potential in cases where the product can be returned for recycling, or where using the product generates hazardous waste. The incentive to reclaim the deposit can promote the proper disposal of the product. This type of system is attractive because, although it acts like a tax, the deposit is refunded if the potential polluter does not pollute.

Transferable emission permits are desirable when a cap on total emissions is required, and when individual emissions can be monitored. The scope for freely tradable emission permits is probably small, however, since trades for most pollutants can only be permitted within relatively small zones to ensure that local ambient targets are met. Within a small trading area, the potential for developing an efficient market is weak. However, allowing trades that are subject to regulatory approval may be the second-best approach. In some cases, such as with CFCs, carbon emissions, or SO₂ emissions, it may be possible to develop a larger market. In the case of SO₂, however, there are only six large emitters in Canada, which is not enough to create an efficient market. There has been some suggestion of integrating the Canadian and U.S. markets for SO₂ permits, but this would require a more complex system of trading to take into account the effect of location on emissions.

Emission charges also require that emissions be monitored. While these can be unattractive to polluters because of the revenue effect, a two-step charge — a low fee for discharge up to a certain threshold, and a high fee after the threshold is exceeded — could allay concerns. These measures are also unattractive in cases where an emission cap is desirable, since it can be difficult to predict how much emissions will drop in response to a tax.

Product charges are relatively easy to administer, since they can be applied when a good is sold, at the wholesale or retail level. They do not distort trade, since they can be applied equally to imported and locally produced goods. They are especially useful when there are substitute goods available that produce less pollution, since the emphasis is then on changing behaviour, not collecting revenue.

RATIONALE FOR INCREASED USE OF ECONOMIC INSTRUMENTS IN CANADA

AN ECLECTIC APPROACH TO ENVIRONMENTAL REGULATION will always be needed, and the use of regulations will continue to be the basis of environmental policy. Nevertheless, there are several reasons why Canada should expect to see increased use of economic instruments in the next few years, and why it should move forward in experimenting with their use.

Revenue — During the next few years, major investments in infrastructure renewal — sewers, water systems, and highways — will be required. As well, governments are under pressure to downsize and cut costs. However, maintaining environmental quality requires government to spend money. Covering these administrative and infrastructure costs with fees paid by users of environmental services has a number of advantages. Since the government faces considerable pressure not to raise general tax rates, environmentally friendly taxes and user fees may be a more politically palatable way of raising revenue.

Increasing abatement costs — It is difficult to measure accurately the cost of complying with pollution-control regulations. However, there is reason to believe that marginal abatement costs for many types of pollutants will rise during the next decades. First, as the population and the economy grow, there is greater pressure on natural systems, increasing the amount by which each individual must abate to maintain a certain level of environmental quality. This trend is most obvious in large cities, where a continued increase in the use of automobiles has in some cases more than offset the benefits of tougher emission standards for individual vehicles. Second, new abatement efforts will soon be needed for new problems such as carbon emissions. Third, since many of the easier environmental quality problems were solved first, some of the more difficult problems are left for the future. Solutions to more difficult problems may well entail higher compliance costs.

As abatement costs increase, a movement toward more cost-effective policies will be socially efficient and will make implementing tougher environmental standards more politically feasible. On the other hand, new taxes are not likely to be popular when costs are rising. Industry is likely to consider revenue-neutral policies to be more feasible. A limited transferability of pollution permits would allow more flexibility to meet abatement and ambient targets. Schemes that combine environmental taxes with tax credits may also have some merit.

Increasing relative importance of non-point sources of pollution — Much of the success achieved in reducing pollution emissions over the past 25 years has involved targeting stationary-point sources of pollution, such as smokestacks and discharge pipes. Canada has been much less successful in dealing with non-point-sources of pollution, such as the leaching of chemicals from agriculture into waterways, run-off from urban streets into water systems, and urban air pollution from automobiles. Economic instruments may help governments deal with these complex problems involving large numbers of polluters who are difficult to monitor.

Taxes that target inputs highly correlated with pollution, such as fuel and pesticides, may also be useful. As well, new monitoring devices

may be developed that allow direct charges to be applied for using automobiles in pollution-intensive zones. Taxes may also be levied on vehicles that exceed emission standards. Governments could respond to the income-distribution problems by using the revenue to build improved transit systems or to create a pollution tax-credit scheme.

Tax reform and the double dividend — Canada's tax system contains many undesirable disincentives. As I pointed out earlier in the section on distributional effects, revenue raised from environmental taxes may be used to finance reductions in distortionary taxes, such as payroll taxes.

GREEN GDP ACCOUNTING

REGARDLESS OF THE METHODS USED to control access to environmental services, Canada needs reliable, consistent means to evaluate outcomes; that is, it needs good information to make good choices. Raw information, however, is of little use to most decision-makers. Typically, governments use filters to select information, and use index numbers or statistics to summarize data. The gross domestic product (GDP) is a standard summary measure of economic activity. It measures the value of goods and services a country produces in a given year. The GDP rate of change is a standard measure of the rate of economic growth. GDP growth is often viewed as a 'good thing.' Indeed, a casual reading of articles and speeches by economists, business people and politicians would suggest that steady GDP growth is one of the key objectives of government policy.

Of course, GDP is not meant to be an index of general well-being — it does not attempt to quantify non-economic factors that affect our happiness, such as human health, political freedom, quality of life and so on. This is not a flaw. The GDP seeks to measure our income; how we spend it is another matter.

Unfortunately, the GDP does not do a good job of measuring our full income — the full value of goods and services that our society produces. It mainly measures market transactions, but much economic activity takes place outside the market. For example, one of the standard criticisms of GDP is the fact that housework and looking after children does not show up in GDP accounts unless someone outside the home is paid to do the work. This means that measures of per-capita GDP underestimate true income in communities where much of the work takes place through sharing arrangements. Conversely, it can overestimate the increase in the real flow of goods and services when activities that were previously outside the market become market activities — such as when informal baby-sitting networks are displaced by fee-for-service daycare. Some feminists have also argued that GDP has an important demonstration effect — it reinforces a tendency to undervalue the contribution of women to society, since women perform much of the non-market activity that GDP does not measure, such as maintaining a household.

Similar problems arise in accounting for environmental services. Because markets do not do a good job of valuing services that the natural environment provides, it is not surprising that the GDP accounts do not properly reflect the role of the environment in generating our total income. For example, suppose a lake is privately owned and a fee is charged for swimming. If the lake becomes polluted and the swimming business shuts down, GDP will decline. This is as it should be — the flow of services generated by the economy has fallen. On the other hand, suppose the lake is publicly owned and swimming is free. In this case, when the lake becomes polluted and swimming is banned, society suffers the same decline in services, but the change does not show up in the GDP accounts, since swimming is a non-market activity. More generally, if

economic growth is accompanied by pollution, and if pollution leads to a reduction of services provided by the natural environment, then the GDP rate of increase will overestimate the increase in the net flow of services our economy generates. As with housework, there may be a demonstration effect — since we do not measure the flow of environmental services, we may undervalue their importance.

The first problem with the GDP accounts, then, is that they do not properly value the flow of services that the economy generates. The second major problem is that GDP does not take into account changes in the stock of productive assets in the economy. True income is the flow of goods and services generated by our stock of assets. If we also consume some of our assets, then our productive capacity in the future will be diminished — we are consuming more than our current income. Using the standard adjustment, one would subtract the value of depreciation of physical capital to measure the net domestic product (NDP). This amount is reported in the national accounts and is meant to be a measure of net income. If we are concerned about sustainable consumption flows, then clearly the net measure is relevant.

There is no fundamental distinction between natural capital and produced capital, however, and the same logic would suggest that NDP should be adjusted to reflect changes in the stock of natural capital. If a stock of exhaustible resources is being run down, NDP should be reduced. Similarly, if the harvest rate of a forest or a fishery is higher than the regeneration rate, natural capital is being consumed, and NDP should be adjusted downward. But in practice, these adjustments are not made.

While the majority agree that standard GDP accounting practices do not adequately deal with environmental problems, there is disagreement about what should be done.¹² Since markets for most services provided by the natural environment do not exist, values for these services would have to be imputed. Although there are a number of techniques available to estimate the value of such services, they are imprecise and controversial. The adjustments to national income would be affected by the valuation techniques used. Statistics Canada is currently developing satellite environmental accounts as an alternative to integrating environmental and resource depletion issues in the GDP accounts.

There are differing views on what concrete difference this will make to the behaviour of governments and the private sector.

Effects of adjusted measures of NDP — It is unlikely that adjusted measures of aggregate GDP will significantly affect behaviour. The GDP is just one of many indicators that we use to assess performance and develop policy. Other indicators, such as the unemployment rate, the poverty rate, the inflation rate, life expectancy and infant mortality, provide information to the public and policy-makers. Policy in Canada is the out-

come of lobbying, bargaining and compromise among individuals and groups with diverse preferences and interests. One number cannot be expected to give a fully adequate measure of the performance of the country in such a context.

Moreover, a highly aggregated set of accounts is probably not the best tool to use in assessing sustainability in a large country. If forest practices are sustainable in one part of the country but not in another, or if agriculture is sustainable but the fishery is not, then the public and policy-makers should be primarily interested in the sustainability of each separate ecosystem and subeconomy. Pockets of non-sustainability may well be obscured by the use of aggregate measures.

Information and accountability — While an adjusted NDP figure in itself may not yield important changes, the development of environmental accounts involves systematically collecting and processing statistics that relate to resource use and environmental quality. To make progress towards increasing sustainability, governments have to set clear goals and establish a process to make sure that these goals are reached. Maintaining a good set of environmental accounts is crucial to the evaluation process.

Sustainability at the community level — At this stage, aggregate measures of sustainability are probably not that useful for Canada. A systematic exploration of the effects of adjusting income flows to take resource depletion into account may have an impact on communities. Domestic-product accounts that allow communities or regions to assess their sustainability could affect their planning and policy decisions, as well as the behaviour of individual citizens. Important policy decisions hinge on the sustainability of communities. If a community is running down its natural capital without replacing it with other forms of capital tied to the community, then the community's long-run sustainability may be in jeopardy. This has repercussions for determining the appropriate level of infrastructure investment. With good environmental accounting, individuals, firms and governments can adjust their behaviour to make the community sustainable, or spend their resources in other communities that are sustainable.

GLOBALIZATION

IN THE SIXTEENTH CENTURY, the migration of settlers from Europe to Canada had a fundamental influence on land use and environmental quality. The beginnings of the impact of trade on the environment also date from that time, as Canada's early exports were dominated by renewable resources — fur, fish and forest products. Since industrialization set in, bilateral environmental problems between Canada and the United States have been ongoing.

Recently, however, the scope of international environmental problems has widened considerably, and these problems are likely to become increasingly important in the years ahead. This chapter focuses on three issues. First, it briefly reviews Canada's experience with transboundary pollution problems. It then discusses global pollution problems and, finally, looks at linkages between trade and the environment.

TRANSBOUNDARY ISSUES

THROUGHOUT THE PAST 25 YEARS, the three most serious transboundary environmental and resource problems facing Canada were acid rain, Great Lakes water quality and transboundary fisheries.

Roughly half of the sulphur polluting Canada originates in the United States. Over those 25 years, an important objective of Canadian policy — achieving an agreement with the United States to reduce sulphur emissions — proved difficult to attain (Doern and Conway, 1994). It was not until 1991 that the Air Quality Accord, which addresses bilateral air-quality issues, was signed. Bui (1995) argues that there was little compromise made in signing this agreement — the United States simply reduced its sulphur emissions because it was in its own interest to do so, and Canada's benefits essentially followed on the coattails of the U.S. decision. Anticipated future reductions in SO₂ still lag behind the more ambitious European reduction targets, as Table 7 illustrates.

Canada and the United States signed the Great Lakes Water Quality Agreement in 1972, with subsequent amendments made in later years. By most accounts, the agreement has been relatively successful, in that substantial reductions in pollution discharge and improvements in water quality have been achieved. However, as noted earlier, there are still important pollution problems to be addressed in the Great Lakes area.

Numerous other bilateral pollution issues have appeared along the border between Canada and the United States. In some cases, these were dealt with on an *ad hoc* basis, while in other cases, joint institutional arrangements (such as the International Joint Commission) have evolved to help coordinate activity.

Perhaps the most significant transboundary conservation issue Canada faced during this period was the pressure of international harvesting on the fishery. Three approaches to this problem have developed during the past

25 years. The imposition of Canada's 200-mile exclusive fishing zone in 1977 partially solved the problem of open access to the fishery. This extension of Canada's property rights, however, did not solve the problem of migratory stocks, such as salmon on the west coast, which travel through both the Canadian and U.S. exclusive fishing zones, or the problem of straddling stocks, which move in and out of the 200-mile limit. As well, merely imposing exclusive Canadian management was not enough to save the east-coast cod and salmon stocks -- both collapsed in the early 1990s. The second approach was an attempt to negotiate conservation policies with other interested fishing countries. Efforts aimed at achieving bilateral treaties with the United States to deal with the salmon issue met with mixed success. Canada worked within a multilateral organization, the Northwest Atlantic Fisheries Organization, to try to reach accords on managing straddling stocks on the east coast. When this approach proved unsatisfactory, Canada adopted a third strategy of unilaterally attempting to enforce conservation rules outside the 200-mile limit. This led to the brief fish war with Spain.

All of these transboundary issues have their roots in the distant past. The fact that Canada experienced difficulty in dealing with some of them, even in recent years, underscores the difficulties involved in transboundary environmental problems. International conflicts over fish management in particular will likely remain an important problem in the foreseeable future.

RICH AND POOR COUNTRIES AND GLOBAL ENVIRONMENTAL PROBLEMS

SEVERAL GLOBAL ENVIRONMENTAL PROBLEMS, including greenhouse gas emissions, ozone-depleting gas emissions, and threats to biodiversity, have attracted increasing attention during the past decade. Since these problems will all require multilateral coordination, the path to their resolution is strewn with significant obstacles.

Income-distribution issues will be a key aspect of international environmental problems in the coming years. Most of the serious and immediate threats to human health exist in lower income countries. Access to clean drinking water, sewers, and sustainable food and fuel supplies are life-threatening problems in many poor countries. In higher income countries, there is more concern about longer run survivability issues, such as the ozone layer, biodiversity, global warming and wilderness preservation. This raises fundamental questions of equity that Canada has not yet come to grips with, such as how investments in preserving biodiversity should be weighed against the needs of those who are facing starvation or disease. Although Canada is constantly making such implicit trade-offs, it may well be forced to address these issues more explicitly if it wants to see progress on some of the global environmental issues that are of concern to Canadians.

For example, in its foreign aid budget, Canada has to decide whether it should target assistance to alleviate the suffering caused by immediate shortages, or to reduce long-run scarcities. Should government emphasize the impact on the local environment, or the global environment? With limited aid resources already under pressure, these will not be easy choices.

As for global pollution issues, bargaining will have to take place. Agreements will require a mix of rewards and threats. A key issue to consider is how the international burden of reducing pollution will be shared. As an example, Whalley and Wigle (1991) compare four different ways of achieving international reductions of carbon emissions — consumption taxes, production taxes, uniform per-capita emission ceilings, and equal per-capita revenue-sharing arrangements. Poor countries would gain under an equal per-capita revenue-sharing arrangement, but would suffer large losses under a national production tax system. Richer countries would fare better under consumption taxes, and lose the most under a uniform per-capita emission scheme.

As noted in Copeland and Taylor (1995), the international trade regime affects the bargaining power of countries involved in disputes over pollution abatement. In such negotiations, lower income countries have a strategic advantage in a free-trade regime, since they can credibly commit to increasing their pollution — because of their lower income, they are more willing to accept the cost of reduced environmental quality to achieve a higher level of income. This suggests that the bargaining power of rich countries over these issues may weaken considerably in the future, especially if developing countries are able to export to new, large consumer markets in Asia rather than to OECD markets.

The world community has had some success in reaching agreements on international trade over the past half-century. Although serious income-distribution problems were fundamental to trade protection, it appears that the issue was finessed. The trickle-down theory — that trade will stimulate growth, and growth will help to redress global inequities — has found wide acceptance. There has also been some attempts to promote a trickle-down theory in the area of environmental policy. Unfortunately, despite the optimistic scenarios of Grossman and Krueger (1995) and others, growth is unlikely to solve environmental problems. It is, in fact, the root cause of many of these problems. This finding suggests that there is no easy solution to global environmental problems, and that they will rank among the major foreign-policy challenges in the foreseeable future.

TRADE, CAPITAL MOBILITY AND THE ENVIRONMENT

INTERNATIONAL TRADE AND CAPITAL MOBILITY HELP determine how economic growth affects the environment, and they can have significant impacts on environmental quality. These impacts can be good or bad.

Trade can separate incompatible industries.¹³ For example, since heavy smokestack industries are incompatible with a tourist destination, mutually beneficial trade is possible. Much regional trade is motivated by this factor — heavy industry is separate from housing districts and sensitive ecosystems, garbage dumps are located outside of town, and so on. Trade can also reduce the effective cost of pollution control if pollution-intensive industries leave a country in response to stiffer pollution regulations. However, while environmental quality in one country might improve because of strong regulations, it may worsen where the industry relocates.

Trade can relieve pressure on overexploited resources and give a country time to recover from past mistakes. Denmark provides a classic example of this. It suffered an ecological crisis in the 17th century (see Kjaergaard, 1994). Too many trees were harvested near the ocean shore, which allowed sand dunes to migrate further inland. Up to half of the country was affected. This reduced food production, and the country began a downward ecological spiral. Although further harvesting of trees would only make the problem worse, wood was essential for fuel. The opportunity to import wood from the rest of Europe gave Denmark enough time to put in place measures to stop sand erosion and allow some of the forest stock to recover.

Trade can also harm the environment, since trade allows a country to shift the ecological burden of its consumption onto other countries. Environmentally harmful activities may be moved from a region with strong regulations to one with weak ones. This shift leads to a net increase in environmental damage and, because trade allows large consumers to avoid experiencing directly or immediately the ecological consequences of their consumption, the political resolve to reduce environmental damage may be weakened.

Capital mobility can amplify this process. Theory also suggests that large multinationals have the option of shifting their production to areas with weak environmental policies as a lever to try to prevent the enforcement or implementation of tough environmental policy (see, for example, Markusen, Morey and Olewiler, 1995).

While economic analysis of the effects of trade on the environment is still relatively recent,¹⁴ several generalizations can be made.

Trade takes place in an imperfect environmental policy regime. In principle, as long as environmental costs are internalized, trade should not be a problem. This is the view that many in the trade-policy community advocate. They argue that trade is not the cause of environmental problems — bad environmental policy is the culprit. However, good environmental policy requires a strong institutional apparatus to ensure implementation and enforcement, which many countries do not yet have. Even in countries like Canada that have elaborate environmental policy infrastructures, costs are not fully internalized. As well, exposure to international markets can disrupt traditional practices of controlling access to

common property resources. In this way, trade can interfere with the viability of traditional management systems.

Trade can amplify the mistakes of environmental and conservation policy. If pollution and conservation regulations are too weak, there will be excessive production in pollution-intensive industries, and there will be excessive pressure on ecosystems. Because trade and capital mobility tend to increase supply responses, opening up trade can amplify these effects, as access to international export markets induces yet more entry into industries that exert pressure on the environment. Of course, trade can work the other way — if a country is not competitive in environmentally sensitive industries, trade may induce these industries to leave the country, which will improve the environment.

Trade can exacerbate global pollution problems, even if good national regulations are in place. Copeland and Taylor (1994, 1995) develop simple models in which countries with different incomes rationally choose different pollution policies — richer countries choose stricter pollution regulations because they can afford them. As a result, pollution-intensive industries are attracted to lower income countries. Moreover, because the pollution intensity of production is higher there, net world pollution rises with the migration of industry. This example illustrates that, even with good regulations, one cannot rule out the possibility that freer trade will lead to increased pollution.

The effects of tightening pollution regulations on trade patterns are unknown. A concern expressed in some business sectors is that tighter pollution regulations may weaken their ability to compete with unregulated foreign firms. This may lead to a decline of domestic industries in sectors that are subject to regulation and to migration of capital. There is, however, very little evidence to support this effect. A recent survey by Jaffee et al. (1993) finds little evidence that policy differences explain investment flows or trade patterns. Olewiler (1994) presents similar findings, but is more cautious in interpreting them.

One encounters three important problems when interpreting this literature. First, it is very hard to get good measures of the stringency of regulations. Since measures of abatement costs for most industries are rather small, they tend to be swamped by other effects in a statistical analysis. Olewiler gives some evidence to support the idea that compliance costs are increasing, which suggests that trade and investment flows may become much more responsive to environmental regulations in the future.

Second, just as trade between labour-abundant and labour-scarce countries should move wages closer together, trade between countries with abundant

and scarce supplies of environmental services should move compliance costs closer. This means that studies using compliance costs as an explanatory variable do not fully measure the impact of environmental policy on trade.

Finally, this literature tends to measure past responses and is not necessarily a good predictor of how firms will respond to a significant tightening of environmental regulations.

TRADE AND THE ENVIRONMENT: IMPLICATIONS FOR THE FUTURE

THE ABOVE GENERALIZATIONS ABOUT THE RELATIONSHIP BETWEEN trade and the environment have several implications.

Coordination of trade and environmental policy. In the future, more attention should be given to the impact of the trade regime on environmental quality. It is not enough to point out that if an ideal environmental policy regime is in place, trade should do no harm to the environment. Rather, the effects of trade and capital flows should be assessed in terms of the realities of the environmental management system.

Therefore, there should be some coordination of trade policy and environmental policy. Changes in trade policy should be assessed to determine their effect on pollution and conservation. This assessment can provide a basis for necessary improvements in environmental management. However, if the political or institutional structure is unable to respond on the environmental side, then the benefits of trade liberalization should be weighed against the environmental consequences. Trade reform should be delayed in cases where it could cause serious environmental problems.

Green countervail. If a trading partner is not properly regulating the use of environmental services, then pollution or resource-intensive industries are receiving an implicit subsidy. Current trade agreements allow retaliation against explicit subsidies. Some have argued that countervail law should be extended to cover implicit environmental subsidies. Canada has opposed this approach because of its unhappy experience with countervail laws in its trade relations with the United States. Countervail laws are widely thought to have been used by U.S. firms to harass successful Canadian exporters, and are essentially treated as a loophole in free-trade agreements. Much of the problem stems from the lack of a clear definition of the term 'subsidy' in trade agreements. Rather, each country has considerable discretion in how to define an unfair subsidy. This problem could be resolved by adding a clearer definition, which would commit countries to providing level playing fields for their firms. The United States has resisted such an approach, since it sees merit in its own, more unilateral, approach.

Canada should continue to push for clear definitions of countervailable subsidies. In the process of narrowing the scope of existing countervail, the possibility of allowing simultaneously for countervail against implicit environmental subsidies should not be ruled out. If clear environmental targets such as ambient environmental quality standards or fish harvest quotas are agreed to, then failing to meet these targets constitutes a subsidy. Provided the scope is narrow and the definition of the target is clear and measurable, as is the case with ambient standards, then the harassment potential of countervail can be minimized. Canada could gain from the commitment effect, both inside and outside its borders. As well, the concern about trading with countries that have weaker environmental standards can be defused, and the internal political support for tough domestic environmental-policy measures can be increased. Although attempts to link the trade regime with environmental concerns would no doubt increase trade frictions, free trade, while not a goal in itself, is one of the tools meant to contribute to a higher quality of life. In an era when trade-offs between income and environmental quality must be made, one cannot ignore the environmental effects of trade liberalization.

Trade sanctions in environmental treaties. One of the problems with many environmental agreements is the fact that the ratio of words to action is high. The Montreal Protocol on Ozone-Depleting Substances departed from this tradition by including trade sanctions against those who refused to participate, and by creating a fund to help less developed countries adjust to the terms of the treaty.

Effective treaties need enforcement devices. Trade agreements include a threat of retaliation if the trading partners do not meet the terms. Since environmental treaties are no less crucial to the future quality of life, they also need enforcement mechanisms. Combinations of penalties and incentives, such as transfers of cash, technology or goods, are needed. Short of war, sanctions directed at international trade and investment are the main instruments available as enforcement devices. There will likely be increasing pressure to link trade sanctions to participation in environmental treaties, particularly at the multilateral level. Such a development should be positive, as long as the use of sanctions arises from multilateral agreements, and is not imposed unilaterally.

CONCLUSION

CANADA IS IN AN EXTREMELY FORTUNATE POSITION IN THE WORLD. It has large amounts of life-sustaining resources, such as water, clean air, agricultural land and forests. It has great expanses of wilderness that support a rich diversity of wildlife. Although each Canadian resident in a city has a large 'environmental footprint,' Canada is a big country. Canada is a net exporter of natural-resource services.

However, there are many local non-sustainability problems in various parts of the country. The fishing industries cannot continue to support current employment levels — current harvest rates for some stocks may have to be reduced, and other stocks may collapse. The emission levels of some pollutants are too high, and water quality is threatened in many areas. Some cities are placing great strains on their local environment. Although Canada does have vast areas of wilderness, much of it is far from the centres of population. Each year, the 'edge of the wilderness' tends to creep northward, farther away from population centres. As well, there are significant uncertainties regarding the relationship between ecosystems and human intervention, and unexpected disruptions may occur. These factors all call for a more cautionary approach to the stewardship of environmental resources than Canada has maintained in the past.

The sustainability of Canada's quality of life cannot be assessed without referring to the sustainability of the rest of the world. Some life-threatening pollutants, such as CFCs, have global effects, and Canada is still vulnerable even if it eliminates their use. As well, Canada's flow of consumption depends on international trade. A crisis in the rest of the world could disrupt Canada's flow of consumption, regardless of whether its internal policies are cautious.

There are two crises looming in the near future. First, some poor countries may be unable to sustain current consumption of their own environmental services, and are unlikely to be able to generate enough income from activities such as manufacturing to import environmental services, especially food, from other countries. Fifteen years from now, the population of sub-Saharan Africa is expected to be twice the 1989 level.

It is unclear how the potential non-sustainability of consumption in poor countries will affect Canada. It will be confronted with a serious ethical dilemma about how to reconcile its wealth with significant human suffering elsewhere. Paradoxically, although Canada is a wealthy country, many Canadians do not feel wealthy. Continued high unemployment and a possible future widening of the earnings gap between high- and low-income workers in Canada may not leave Canadians feeling generous. If the leveling off and possible decline in income continues, foreign-aid budgets will face severe pressure.

Some writers, such as Homer-Dixon (1991), argue that looming environmental crises in poor countries will contribute to more violent conflicts. As well, there will be increased threats to human health. Diseases that were once thought to be in decline are resurfacing, and new strains of viruses and bacteria

are appearing. Large populations with poor nutrition, combined with possible climate changes leading to flooding and other natural disasters, may exacerbate the situation. Since globalization has increased the opportunities for disease to move around the world, Canada will not be immune from these problems.

The second looming crisis arises from countries with relatively large populations that are currently undergoing rapid rates of economic growth, which will affect Canada much more directly. The net international demand for the use of Canada's environmental services will likely increase, as the demand for food, minerals, and forest products rises with income and population, and as the resource base of some countries becomes depleted. This should eventually lead to price increases, although the timing is uncertain because of large supplies of resources in competing resource-rich countries. An increase in the demand for Canada's environmental services should lead to a terms-of-trade improvement which would benefit Canada. However, the benefits will only be forthcoming if resource stocks and environmental services are properly managed. Many environmental services are based on common-property resources, such as air and water. Canada has only partially succeeded in controlling access to these resources. Increases in international trade can harm an economy that exports the services of open-access resources. Therefore, Canada must coordinate its trade policy with its conservation policy. More liberal trade requires increased conservation efforts to ensure sustainability. If Canada is unable to ensure that proper conservation measures are in place, it should not commit to open foreign access to its resources.

As consumption levels increase in the rapidly growing economies of Asia, severe pressures will be exerted on the global environment. Carbon emissions will increase, biodiversity will be threatened, the health of the oceans will be placed in jeopardy, and there will be further pressure on the ozone layer. Although Canada's consumption of environmental services may well be sustainable if the consumption of the rest of the world stays low, it is extremely unlikely that the earth could sustain the spread of North American levels of consumption to a significant fraction of the world's population.¹⁵ Therein lies the dilemma. Global sustainability will require some coordination among countries to reduce the emissions of key pollutants.

The distribution of the right to pollute among countries will be one of the key international policy issues in the next few years. The equitable approach to this problem involves equal per-capita access to environmental resources across the globe. Barring unexpected major improvements in technology, if such a principle is adopted, richer countries would have to significantly reduce their consumption of environmental services so that increased consumption by poorer countries would not put excessive pressures on the global environment.

A more likely scenario would see power and wealth continue to determine access to environmental services. This could exacerbate global problems, since the incentive for countries to increase their wealth and power to stake a claim on global environmental services would add to the strains on the earth's

life-supporting resources. Even in a power-driven scenario, however, it would be in the interest of richer countries to help poorer countries reduce and control environmental damage.

Canada should continue to play an active role towards developing a multilateral approach to deal with global pollution problems. At the same time, it should take defensive measures at home. It should exploit the use of commitment devices to ensure that long-run environmental goals are achieved. It should set clear goals for ambient environmental quality, and put a review process in place to ensure that these targets are met. It should also diversify its environmental risks. In a world increasingly committed to free trade, Canada should adopt a conservative and cautious approach to allowing access to common property resources.

NOTES

- 1 There is much literature on sustainable development. As an introduction, see Goldin and Winters (1994) for an economic approach, and Dale and Robinson (1996) for an alternative approach.
- 2 See Baumol and Oates (1988) for a classic treatment of the subject.
- 3 Bank of Canada (1996).
- 4 See Statistics Canada (1994) and OECD (1995a) for a more complete review.
- 5 See OECD (1995a).
- 6 The simple conceptual framework outlined here has been used in the empirical work of Grossman and Krueger (1993) and others, and in the theoretical work of Copeland and Taylor (1994). Elsewhere, I have given a more detailed and slightly more analytical expository account of this literature (Copeland, 1996).
- 7 The sustainable-development literature has emphasized the high rate of resource use by high-income countries. For an example, see Wackernagel and Rees (1996). Chichilnisky (1994) and Brander and Taylor (1995) show how standard economic analysis predicts that trade liberalization in an economy based on open-access resources can lead to reduced long-run consumption in that country, because trade leads to excessive harvesting of the resource.
- 8 In the past, the use of a gold standard has sometimes acted as a commitment device.
- 9 This is not the place to debate the merits of free trade (see chapter 8 entitled « Globalization » for a discussion of the environmental effects of trade liberalization). There are some who think that trade is not yet free enough, and others who think the government has conceded too much sovereignty. The point here is simply that commitment effects have played a crucial role in supporting the current trade regime.
- 10 See Hahn (1989).
- 11 See Cropper and Oates (1993) for a useful discussion of this issue.
- 12 See Lutz (1993) and Repetto et al. (1992) for some views on this issue.
- 13 See Copeland and Taylor (1995b).
- 14 See Beghin et al. (1995) for a survey.
- 15 See Wackernagel and Rees (1996).

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