OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

Asia-Pacific Regional Forum on Industrial Development, Shanghai 2000

Shanghai, China, 4–5 December 2000

Industrial environmental management and accession to the World Trade Organization

by Ralph Luken

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Organized by UNIDO in cooperation with
the Government of China

32 p.
tables

INDUSTRIAL ENVIRONMENTAL MANAGEMENT
AND
ACCESSION TO THE WORLD TRADE ORGANIZATION

November 2000

Prepared by

Ralph A. Luken,
Senior Industrial Development Officer,
Cleaner Production and Environmental Management Branch
Sectoral Support and Environmental Sustainability Division

CONTENTS

Introduction

Accession to the Word Trade Organization (WTO) will result in three major challenges for industrial environmental management in developing countries.[1] First, accession to WTO has the potential to result in significant changes in the scale and composition of industrial production, which could increase the pollution potential of industry. Second, accession to WTO has the potential to result in an expansion of international trade in products and services, which may or may not be constrained by environmental considerations introduced by international buyers in the supply chain. Third, accession to WTO has the potential to widen and deepen international capital flows, which could increase the utilization of environmentally sound technology.

The magnitude of the challenges outlined above needs careful analysis by those concerned with industrial environmental management. In addition, appropriate environmental and industrial policies need to be put in place to respond to them. To encourage such careful analysis and policy response, the present paper will examine one of the challenges: the potential increase in industrial pollution. In particular, it will discuss the most likely objections of industrialists to the requirement that they comply with environmental standards in light of the intensification of competitive pressures resulting from trade liberalization.

The reasons put forward by industry in both developed and developing countries for their opposition to environmental standards are that they are both a significant and unnecessary constraint on industrial growth.[2] Environmental regulations are seen as a “significant” constraint because it is assumed that they can only be implemented at the expense of a competitive economy.[3] They are seen as an “unnecessary” constraint because the social benefits of environmental regulation are perceived to be small in relation to the private costs of compliance.

The present paper reviews recent analytical work on those two issues as a basis for discussion at the regional forum. It first examines the perception that environmental regulation is a “significant” constraint, that is, costs of compliance divert a significant amount of financial and managerial resources away from productive activities. It then examines the perception that environmental regulation is “unnecessary”, that is, the private costs of environmental regulation exceed the social benefits of reductions in pollution damages. From there, the paper reviews alternative forms of industrial environmental management and innovations in industrial policies that can significantly affect the costs of compliance and the ratio of benefits to costs of environmental regulation.

Magnitude of compliance costs

The first perception that needs to be examined is that private costs of complying with environmental regulations are seen to be so high that they will undermine the competitive position of industry. That perception should be questioned because there are several reasons to believe that the costs of compliance are small, thus their impact on competitiveness would be minimal in most circumstances.

First, according to the Organisation for Economic Cooperation and Development (OECD), the costs of environmental compliance for developed countries is believed to be in the range of 1 to 5 per cent of production costs (OECD, 1997a).[4] The word “believed” is used deliberately because only the United States of America, as discussed by Nordström and Vaughan (1999), has systematically collected data on the costs of pollution abatement. As can be seen in table 1, the average cost for all industrial subsectors was 0.6 per cent of the value of shipments and between 1.5 and 2 per cent for the more pollutant-intensive subsectors. Those percentages are relatively modest compared with the other outlays for production inputs.[5]

Table 1: Pollution abatement operating costs by industry in the United States (1993)

SIC[a]	*Industry*	*Pollution abatement operating costs (millions of dollars)*	*Value of shipment (millions of dollars)*	*Abatement cost/ value of shipment (percentage)*
29	Petroleum and coal products	2 793	144 715	1.93
28	Chemicals and allied products	4 802	314 744	1.53
33	Primary metal industries	2 144	142 384	1.51
26	Paper and allied products	1 948	133 486	1.46
32	Stone, clay and glass products	544	65 574	0.83
31	Leather and leather products	52	9 991	0.52
34	Fabricated metal products	742	175 137	0.42
22	Textile mills products	280	73 951	0.38
30	Rubber and miscellaneous products	409	122 776	0.33
20	Food and kindred products	1 368	423 257	0.32
37	Transportation equipment	1 327	414 614	0.32
36	Electronic and other electric equipment	716	233 342	0.31
24	Lumber and wood products	279	94 547	0.30
25	Furniture and fixtures	137	47 349	0.29
38	Instruments and related products	383	136 916	0.28
39	Miscellaneous manufacturing industries	85	42 426	0.20
35	Industry machinery equipment	488	277 957	0.18
27	Printing and publishing	266	172 737	0.15
21	Tobacco products	33	28 384	0.12
Total		18 796	3 054 287	0.62 (average)

Source: U.S. Census Bureau as cited in Nordström and Vaughan (1999).

Note: Pollution abatement operating costs include capital depreciation of the abatement equipment; filters and another material, salaries and wages for operational personnel.
[a] SIC: Standard industrial classification.

Such a modest outlay should not be allowed to mask the difficulties that were encountered by resource and energy intensive industries in the investment phase of complying with environmental regulations. As pointed out by Low (1992), using a more detailed breakdown of the same data from the U.S. Census Bureau, the costs of pollution abatement were as high as 3.2 per cent of the value of shipments. Nor should it mask the fact that some categories of small firms in developed countries, particularly in urban areas, could not comply with the regulations and were forced to close or to consolidate.

It should be noted that the percentage of pollution control costs for industry are probably high because developed countries, in particular the United States, have relied on the uniform application of performance standards and the use of end-of-pipe technology to achieve environmental norms. With hindsight, achieving ambient standards aimed at protecting human health and welfare and a more judicious mix of prevention and abatement measures would have resulted in a lower level of expenditure.

Although there are no aggregate data about the costs of environmental compliance for industry in developing countries as a percentage of production costs, several case studies suggest that the costs would be the same or even less than, say, between 1 and 3 per cent, than those in developed countries. The United Nations Industrial Development Organization (UNIDO) summarized many of those case studies to arrive at such an estimate of the cost of environmental compliance by industry as a percentage of production costs (UNIDO, 1995). The case studies were undertaken by UNIDO, the United Nations Conference on Trade and Development (UNCTAD) and the Economic Commission for Latin America and the Caribbean (ECLAC). The case studies covered six industrial sectors reflecting the experience of different export-oriented industrial sectors, with varying degrees of pollution intensity and firm size, in selected developing countries. (See table 2 and annex I for more information.)

A few of the findings from the UNIDO review should be highlighted. In the Philippines, pollution abatement costs as a percentage of total costs were less than 1 per cent for the sectors studied. The only sectors where those costs exceeded 2 per cent were in the agriculture and energy sectors (UNCTAD, 1995). In Argentina, two large pulp and paper companies were not significantly affected by a pollution control investment of 8 per cent of its capital stock, whereas a smaller firm in the same area was forced to close as a result of environmental regulations. Also in Argentina, only a few of the 35 firms in the leather sector experienced difficulty in complying with environmental norms and two that attempted to comply declared bankruptcy (Chudnovsky, Lugones and Chidiak, 1995).

Despite a diverse picture, some conclusions emerged from that review. One conclusion is that it is possible to mitigate pollution discharge at a reasonable cost, even in the case of smaller units, if timely and appropriate measures are taken to adopt cleaner technologies and waste minimization at the source. A second conclusion is that negative impacts on competitiveness are more likely to occur for small firms that are already established and for industries that are natural resource intensive, which is what occurred in developed countries. A further conclusion is that the timely access to foreign assistance and technology is important in lessening short-term impacts on competitiveness.

The second conclusion mentioned above concerning the existence of any negative impact of environmental compliance (private costs exceeding private benefits) has been challenged. Some commentators (Porter, 1991 and Porter and van der Linde, 1995) have claimed that there are large win-win opportunities available, where pollution can be reduced and productivity improved simultaneously. Supporters of the "Porter hypothesis" have cited examples of plants where environmental performance and productivity improvements have occurred. Most environmental economists remain sceptical of the widespread existence of such win-win opportunities (Jaffe and Palmer, 1997 and Palmer, Oates and Portney, 1995).[6]

The win-win nature of some forms of pollution reduction is supported by most of the factory-level demonstrations undertaken by the joint UNIDO and United Nations Environmental Programme (UNEP) National Cleaner Production Centres Programmes in several developing countries. For example, a cleaner production demonstration at one agro-based pulp and paper mill in India not only reduced pollutant discharge and costs for pollution control, it increased annual output by approximately 20 per cent and improved product quality. (Three case studies on China, India and Viet Nam are summarized in annex II.) Those demonstrations showed the potential for cleaner production to lower the costs of compliance as well as the costs of production. In those three cases and in most others, however, financially attractive process change was not sufficient to reduce pollutant discharge to the extent necessary to comply with the environmental standards. Pollution control measures, which would have a small negative cost impact, would be necessary for compliance.

Lastly, the real cost of pollution control equipment has been falling over time due to technological innovation and economies of scale in equipment manufacture (Anderson, 1999). This is true for both air pollution technologies, such as electrostatic precipitators and bag houses for suspended particulate matter and flue-gas desulphurization for sulphur dioxide, and for water pollution technologies for secondary and tertiary treatment of organics and nutrients. For each pollution category, including greenhouse gases, numerous examples can be cited in which technological progress is continually made with respect to both the amount by which pollution can be abated and the costs of removal.

Table 2: Economic and environmental impact of environmental policies: leather, textile dyeing and printing, pulp and paper, steel, iron foundries and fisheries

Regulatory action	*Industry response*	*Economic impact (including competitiveness)*	*Environmental impact*	*Remarks*
A. Leather				
- European ban on use of PCP and dyes containing formaldehyde and benzi-dine (India) - Domestic regulations requiring installation of treatment plants (India) - Technical norm govern-ing discharge of effluents (Chile)	- Testing centres set up (in the longer run) to determine PCP substitutes obtained (India) - Installation of clean or low waste generating technology and treatment processes e.g. chromium recovery plant, adoption or better hair recovery using less sulphide (Chile)	- Compliance costs range from 1.5 per cent to 3.0 per cent of finished product prices, depending on firm size and concentration of tanning units (India) - Export share of small firms may decline initially, whereas modernized tanneries with labour cost advantages are least affected (India) - High internal rate of return on in-vestment in chromium recovery plant and new hair stripping methods, resulting in overall reduction in production costs (Chile)	- Reduction in effluents (India, Chile) - Industry will be able to eliminate use of PCP by utilizing substitutes (India) - Reduction in effluents, recovery of chromium, less sulphides (Chile)	- Government reduced import duty from 150 to 50 per cent ad valorem to facilitate import of PCP substitutes (India) - Economies of scale are of particular importance—small firms scattered over a large area may suffer adverse effects
B. Textile dyeing and printing				
- European ban on use of benzidine dyes (Brazil, India) - Stringent product standards for blue dyes (Brazil, India)	- Adoption of cost-cutting scientific methods e.g. photo-spectrometers, process controllers, computerized colour matching, dosing apparatus etc. (Brazil) - Adoption of waste minimization measures by dyeing and printing units, project DESIRE, UNIDO (India)	- Reduction in costs of domestic dyestuff by 20 to 30 per cent (Brazil) - Increased costs of imported, modernized dyestuff (Brazil) - Savings in inputs of water, fuel, dye-stuffs and auxiliary materials due to improved technologies which have a minimum payback period of 6 months (Brazil) - For 51 feasible waste minimization options, net annual savings of Rs 7.1 million achieved of Rs. 1.4 million (India)	- Reduced volume and toxicity of effluent as a result of increased repeatability of dyeing process, use of fixating agents and better control of temperature curves - Reduction in use of salt, caustic soda and acids by 40 per cent (Brazil) - Volume of effluent reduced by 30 per cent, COD load by 16 per cent, DESIRE project (India)	- It is feasible and cost-effective for dyeing units to adhere to environmental standards without corroding competitive advantage provided appropriate technical and managerial approaches are adopted

Regulatory action	*Industry response*	*Economic impact (including competitiveness)*	*Environmental impact*	*Remarks*
		C. Pulp and paper		
- External requirements for increased usage of recycled materials (Argentina, India)	- Primary effluent treatment units installed by many firms, however more expensive secondary treatment plants less used (Argentina) - Adoption of waste minimization options by small agro-residue based mills (project DESIRE, UNIDO) (India)	- Greater efficiency in production and reduced costs due to recycling of materials in packaging (Argentina) - Improved efficiency in energy and water use (Argentina) - For 72 feasible waste minimization options, net annual savings of Rs. 28.5 million generated for an initial investment of Rs. 9.5 million and pay back period of 6 months (India)	- Fibre recovery (Argentina) - Reduction in effluent volume by 32 per cent, COD load by 31 per cent, total solids by 40 per cent, DESIRE project (India)	- Small-sized firms using old technologies and equipment have more difficulty in improving environmental performance - Waste minimization options are a feasible solution for small firms
		D. Steel		
- Environmental controls and market reforms manifested in reduced capacity of the steel industry (Poland) - Chilean Supreme Decree No. 4 establishing maximum permissible levels of emissions (Chile)	- Application of environmentally sound industrial technologies and processes (Poland) - Change over from diesel oil to liquid gas in the heat treatment furnace of a medium-sized laminated steel parts unit (Chile)	- Capacity of steel industry reduced, however remaining plants will be more efficient with production costs lower by \$20-\$25 per tonne of steel (UNCTAD) (Poland) - Increase in production efficiency of steel parts unit with a positive net present value and an attractive marginal internal rate of return on investment in technological improvements (Chile)	- Reduction in environmental damages from steel sector by 70 to 80 per cent (UNCTAD figures) as a result of cleaner production processes and reduced capacity (Poland) - Appreciate decrease in particulate emissions from steel parts unit (Chile)	- A positive aspect of strict environmental regulations is the development of a pollution control industry as an important export sector (Poland) - Cleaner production processes can be economically viable for small- and medium-sized enterprises
		E. Iron foundries		
- Chilean Supreme Decree No. 4 establishing maximum permissible levels of emissions (Chile)	- A medium-sized foundry replaced a cupola furnace by an electrical induction furnace, and switched from grey to nodular iron (Chile)	- Improved product quality and a positive net present value with a high internal rate of return on investment in technological improvement (Chile)	- Significant reduction in emission of gaseous and particulate contaminants (Chile)	- Cleaner production processes can be economically viable for small- and medium-sized enterprises

Regulatory action	*Industry response*	*Economic impact (including competitiveness)*	*Environmental impact*	*Remarks*
		F. Fisheries		
- International requirements for better quality and differentiated products (Chile) - Environmental pressures exerted by local communities where processing plants are located (Chile)	- Development of new clean technologies such as primary and secondary centrifugation of the pressing liquid, evaporation of liquid glue, deodorizing of drying gases, optimization of deodorizing equipment through use of linings, application of an integrated steaming, drying and evaporation system etc. (Chile)	- Production of better quality fish meals differentiated in accordance with user needs - Savings of 15-29 per cent in raw material usage - Sale of new technologies and industrial prototypes to Denmark, Japan (Chile), Norway, Peru	- Reduction in solid content of liquid effluents by 7-25 per cent - Minimization of malodorous gas emissions - Energy savings of 25-28 per cent (Chile)	- The technological improvements were made by the Association of Fish Meal Producers in collaboration with a Norwegian enterprise establishing a link between two countries at different development levels (Chile)

Source: Adapted from a background paper for the Global Forum on Industry entitled "Environmental policies and industrial competitiveness", UNIDO (1995). Also based on other material from UNIDO, UNCTAD, ECLAC and other studies (1994-1995).

In addition, the availability and cost of both cleaner technologies and pollution control equipment will fall with the increasing openness of national economies.[7] Research by the World Bank examined the uptake of cleaner technologies in steel (continuous casting and electric arc furnaces) and pulp and paper (thermomechanical pulping) production in 50 countries. The research indicated that open economies led closed economies in the adoption of cleaner technologies by a wide margin (World Bank, 1999). Similarly, a more recent study of the uptake of the electric arc furnace in 30 steel producing countries over 25 years also found that the technology is diffused faster in countries with more open trade policy regimes (Reppelin-Hill, 1999).

At the micro as well as the macro level of analysis, there are some examples of how the openness of the economy can have a beneficial effect on the availability and costs of cleaner technology. One such example is the response of the tannery sector in India to a ban by Germany on the import of leather goods preserved by pentachlorophenol (PCP) and coloured with dyes containing formaldehyde and benzidine (Wiemann and others, 1994). The initial problems of the leather industry occurred mainly due to the lack of testing facilities to determine PCP content and the lack of PCP substitutes. Those problems took a few months to resolve until testing centres were set up and the tanneries in India obtained information on where to purchase substitutes. In order to facilitate the import of substitutes, such as 2-thiocyanatomethylbenzothiazole (TCMTB) and para-chloro-meta-cresol (PCMC), the Government of India reduced the import duty from 150 to 50 per cent ad valorem. In contrast, the leather industry in Argentina did not face the same initial problems as a result of the PCP ban because its liberal trade policies had already made those chemicals more accessible (Chudnovsky, Lugones and Chidiak, 1995).

In summary, there appears to be sufficient evidence to question the perception that compliance with environmental standards by industry in developing countries will have a significant impact on production costs and therefore on competitiveness.[8] The opposite perception, that compliance costs are negligible for the industrial sector as a whole, is probably more reasonable. Even if that perception is an accurate one, however, it should not mask the problems that will be encountered by resource and energy intensive sectors nor the financial difficulties that will be encountered by existing small plants in complying with environmental norms. The difficulties will clearly be severe for some small firms that do not have access to technological information, space for locating pollution control equipment or capital at a reasonable rate of interest.

Environmental benefits and costs

The second perception that needs to be examined is that the private costs of environmental regulations are seen to exceed the social benefits of reducing pollution damage. This perception should also be questioned because there is emerging evidence that the benefits of complying with most environmental standards, both in developed and developing countries, exceed the costs.

As the estimation of environmental benefits (or their opposite, environmental damage reductions) is not well known outside of the environmental management field, this paper briefly outlines the by now well known methodology for benefit estimation pioneered by the United States Environmental Protection Agency (USEPA) in the 1970s and 1980s (Anderson and Kobrin, 1998). The simplest application of the methodology requires only three analytical steps to estimate environmental damages. The first is to measure the level of environmental quality (or degradation). The second is to relate such a level of quality to damages or losses in health, productivity and materials. That depends on knowledge of the "dose-response" function, the relationship that associates the incidence of health problems (or other effects) to different levels of environmental quality. The last step then assigns monetary values to the predicted incidence of health problems (or loss of agricultural production, or damage to materials). In the case of health effects (both morbidity and mortality), the monetization of damages approach requires values based on individual preferences (willingness to pay). As that information is often not available in developing countries, an alternative approach is to base monetary estimates on opportunity costs, that is, hospital treatment costs of illness and the productivity (or human capital) technique for the value of premature loss of life.

Several benefit-cost assessments using that methodology have been undertaken with regard to environmental programmes in the United States (Arnold, 1999). A comprehensive academic review of the aggregate annual benefits of all environmental regulations showed aggregate annual benefits of $162 billion (in 1996) and total annual costs of $144 billion (Office of Management and Budget, 1997). A more comprehensive assessment, limited to air pollution regulations, found that the annual costs of compliance were $523 billion and that the annual benefits ranged from $5.6 trillion to $49.4 trillion (USEPA, 1997).

The World Bank estimated environmental damages for Mexico in the early 1990s using that methodology. Annex III is a summary of the major categories of environmental damages, which is presented to give participants in the forum an impression of how the damages were estimated and the magnitude of the damages by different categories of pollutant discharge.

Unfortunately, there are few regulation or sector-specific estimates of the benefits and costs for environmental regulations in developing countries similar to those for the United States. At best there are some rough estimates for some nations and some urban areas. The present paper lists a few national and urban damage assessments from all sources of pollution as a percentage of gross domestic product (GDP) or gross national product (GNP). (None of those assessments takes into account global environmental damage due to ozone depletion or global warming.) The data in most of the studies are not sufficiently disaggregated to assign a share of damages to the industrial sector. Summary estimates are presented in table 3. It can be seen that environmental damages with only partial coverage of pollution sources and limited monetization of benefits are a significant percentage of GDP or GNP.

Table 3: Estimates of environmental damage and assumed costs of abatement

Country/region (date of study)	*Pollutants/sources*	*Estimated damages as percentage of GNP/GDP*	*Assumed costs as percentage of GDP*
Brazil	Only health care costs associated with water and air pollution	2.0 of the GDP of Brazil	1.6
China	Mainly industrial sources	4.0 of the GNP of China[a]	1.6
India	Only health impacts of water and air pollution	3.3 of the GDP of India	1.6
Jakarta, Indonesia	Health impacts of air and water pollution	3.5 of the GDP of Jakarta	1.6
Mexico	Estimates of environmental damage costs	2.5 of the GDP of Mexico	1.6
Bangkok, Thailand	Health effects from air pollutants	1.2-5.0 of the GDP of Thailand	1.6

Sources: Brazil: Seroa and Fernandez (1996); China: Guang (1997); India: Brandon and Homman (1995); Indonesia: World Bank (1994); Mexico: Margulis (1992); Thailand: O'Connor (1996).
[a] The estimate prepared by the World Bank is 8 per cent of GNP (World Bank, 1998).

No empirical estimates are available of the national costs for pollution control for developing countries as a percentage of GDP, similar to those for the United States and selected European countries. The best estimate that can be arrived at for developing countries is to assume that their expenditure on pollution control, in the long run, would be similar to that of developed countries (OECD, 1996). The percentage of GDP spent for environmental compliance is, on average, 1.6 per cent of GDP in developed countries. (See annex IV for a summary of the individual country data.) Of that, one quarter is spent on industrial environmental compliance and three quarters on municipal, transport and other sectors.

Comparing the percentage of environmental damage in various developing countries with an expenditure of 1.6 per cent of GDP suggests that in aggregate, the social benefits from reducing environmental damages would exceed the sum of private and public costs of that reduction. In all cases cited, the estimated damages as a percentage of GDP exceed the costs of pollution reduction as a percentage of GDP. In the case of China, the potential environmental gains would appear to be very high compared with the costs.

In addition to those "rough" estimates, more rigorous estimates of the benefits and costs of pollution in Asia are slowly appearing. One such example is the work done by a team of Chinese researchers who estimated the relationship between air pollution and mortality from respiratory disease in Beijing (World Bank, 1999). Their analysis showed that removal of 100 tonnes of sulphur dioxide from Beijing's atmosphere could save one statistical life, which is defined as the probability of one person dying when one million people are exposed to a risk of one in a million. (See box below.) Abating one tonne of sulphur dioxide (SO_2), controlling only 10 per cent of the emissions, would cost a large plant about $3. Thus the costs of abating 100 tonnes would cost about $300. A value of at least $1,000,000 per statistical life saved (the minimum value used by the USEPA) would imply a benefit-cost ratio of 3,000 to 1. Even taking the much lower estimate of the value per statistical life that has been proposed for China, $8,000 per statistical life, would still yield a benefit-cost ratio of 24 to 1.

Controlling air pollution and saving lives in Beijing

Xu and others (1994) have estimated "dose-response" relationships linking atmospheric pollution to respiratory disease in Beijing. Their study shows that atmospheric sulphur dioxide concentration is highly correlated with damage from respiratory disease. Recent scientific evidence provides some insight into the nature of this relationship. Sulphur dioxide and other oxides of sulphur combine with oxygen to form sulphates, and with water vapour to form aerosols of sulphurous and sulphuric acid. Such acid mists can irritate the respiratory systems of humans and animals. Therefore, a high concentration of sulphur dioxide can affect breathing, and may aggravate existing respiratory and cardiovascular diseases. Sensitive populations include children, the elderly, asthmatics and individuals with bronchitis or emphysema.

The second, and probably more significant, effect of sulphur dioxide is traceable to the impact of fine particulates on mortality and morbidity. A review of recent evidence by the USEPA suggests that fine particulates are the source of the worst health damage from air pollution. In the case of China, there is reason to believe that 30 to 40 per cent of fine particulates are in the form of sulphates from sulphur dioxide emissions.

In 1993, Beijing had a population of about 11,120,000; the mortality rate was about 0.611 per cent; total deaths were about 68,000; and total sulphur dioxide emissions were about 366,000 tonnes (of which 204,000 were from industry). From that base, a decrease of 1,000 tonnes in sulphur dioxide emissions decreases total emissions by 1/366 x 100 per cent. An independent econometric analysis of the relationship between emissions and air pollution in the cities of China predicts an associated decrease of 0.51 x 1/366 x 100 per cent in the ambient sulphur dioxide concentration of Beijing. Applying the Beijing "dose-response" result of Xu and others to the new concentration, an estimated saving of 10.4 lives per year is obtained. Dividing both elements by 10 yields a useful round number for policy discussion: 1 life saved per 100 tonnes abated annually.

Source: World Bank (1999) cites Dasgupta, Wang and Wheeler (1997).

In summary, there appears to be evidence that calls into question the perception that the costs of environmental controls would exceed the environmental damages (benefits). Indeed, the evidence is supportive of the opposite perception, that is, that the social benefits of environmental improvement would exceed the private costs of compliance. Having said that, one should also acknowledge that there are some pollutant categories (hazardous air pollutants) and some specific geographic situations (few people or non-unique physical environment) where the costs could exceed the benefits.

Appropriate environmental regulation for developing countries

As stated earlier, accession to WTO will expose domestic firms to more competition from foreign sources. The increased competitive pressure will prevent companies with sunk investments in given technologies from raising their product prices to recapture cost increases from sudden changes in environmental regulations. This means that the adjustment costs to an economy of sudden changes in environmental regulations—or changes in their enforcement—will be larger than in a less open economy. Therefore, accession to WTO means that environmental regulators should put more effort into formulating environmental policies that use flexible and gradual instruments to minimize adjustment costs. The following section provides a discussion of environmental regulation from this perspective.

As there is no accepted international definition of regulation, the present paper uses the definition used by OECD. OECD defines regulation to include the full range of legal instruments by which governing institutions, at all levels of government, impose obligations or constraints on private or public behaviour (OECD, 1997b). In addition, OECD has classified environmental regulation into three categories:

(a) Command and control directly regulate behaviour affecting the environment, typically through licence and authorization procedures;

(b) Economic instruments modify behaviour, using financial incentives and disincentives, such as charges, taxes and fines to improve environmental performance;

(c) Other instruments: this diverse category contains for the most part non-mandatory elements aimed at improving environmental performance. They include planning, environmental impact assessment, voluntary agreements, information disclosure and environmental management systems.

Clearly, the present issue paper cannot review the diversity of environmental regulations that are currently being utilized or considered in developed and developing countries. Rather, the coverage is limited to presenting a few innovative options which have significant potential to reduce the costs of compliance and increase the net benefits of environmental regulations.

Command and control: One option is to assign priority to cleaner production and pollution prevention measures over end-of-pipe measures to achieve compliance with environmental norms. The cost-saving advantage of that approach is well documented in the cleaner production literature. One such example is the impact of a cleaner production assessment for a major manufacturer of fine chemicals in China, specializing in the production of additives for the processing of high-polymer materials. As a result of implementing prevention measures, the plant reduced its capital investment for end-of-pipe equipment by 25 per cent and its operational costs for the equipment by 15 per cent. (See annex II for more information.)

Another option is integrated pollution prevention and control (IPPC) for licensing of industrial sources. The cost-saving advantage of that option is lower overall compliance costs for a facility because it would simultaneously consider pollution reduction measures for air, water and land contaminants. In addition, the IPPC approach reduces administrative and reporting costs (Gouldson and Murphy, 1998).

A third option in this category is to tailor environmental discharge regulations for individual sectors rather than adopt uniform standards proposed by the World Health Organization and the World Bank. Most Asian countries have opted for the uniform standards for all industrial subsectors. For example, Pakistan recently (1997) promulgated 32 water pollution standards (National Environmental Quality Standards) for all industrial sectors and subsectors regardless of the size of the industrial establishments. A more cost-effective approach would have distinguished between plants that discharge wastewater to a municipal sewer and plants that treat and discharge directly to rivers and between new and existing plants (UNIDO, 2000a).

Economic instruments: The two main cost-savings claimed for economic instruments are static efficiency and dynamic efficiency gains. Static efficiency gains are the difference in the costs of compliance incurred between a command and control approach and a charge scheme. The latter would allow plants to abate to different levels so that the marginal abatement costs (charges plus cost of pollution control) are the same for all dischargers. Dynamic efficiency gains are the cost-savings associated with the incentive to innovate beyond compliance with norms stimulated by economic instruments. Unfortunately, most of the estimates of efficiency gains from economic instruments are ex ante appraisals; there are only a few ex post evaluations of the actual efficiency gains from the application of economic instruments in developing countries (O'Connor, 1999 and OECD, 1997c).

One ex ante study evaluated a point/point source trading system for chemical oxygen demand and biochemical oxygen demand discharge for the upper Nanpan River in China (Tao, Yang and Zhou, 1998). The potential benefit, direct reduction cost-savings is the difference between the total cost if each pollution source is required to achieve its permit limits by upgrading its wastewater treatment facilities—without trading and the total cost if trading is allowed to be an alternative for the pollution sources to achieve their permit limits—with trading. The results indicate that the municipal sources must be covered by the trading programme; there would be one case of trading between industrial sources, several cases between the Qujing municipal source and industrial sources and one case between two municipal sources. The end result of trading would result in an annual cost-savings of 2.4 million yuan (8.3 yuan = 1 US dollar) or 18.4 per cent of the total annual cost of meeting the chemical oxygen demand reduction target.

Although no ex post evaluations of the actual efficiency gains from the application of economic instruments in Asian countries could be found during the research for the present paper the World Bank did identify several applications in Asian countries (China, Malaysia and the Philippines) that have resulted in significant reductions in pollutants and presumably the associated cost-savings (World Bank, 1999). For example, the Laguna Lake Development Authority of the Philippines implemented a pollution charge (environmental user fee) for a pilot group of 21 plants. After two years of implementation, the Authority reports that organic pollutant discharge from the plants had dropped by 88 per cent.

Other instruments: One option is the proper use of locational policies for the siting of industry. Plants that are located near each other or within industrial estates can take advantage of the cost-savings associated with using a common wastewater treatment facility and with collective management of solid and hazardous wastes (UNEP, 1997).[9] For example, a proposal for one central treatment plant rather than for four separate treatment plants for industrial and human wastes in Dong Nai Province, Viet Nam, would result in 40 per cent in annual costs of pollution control (Luken, 1999).

Another option is targeting major sources of pollutant discharge for compliance with environmental norms. In many situations, only a few sources account for most of the pollutant discharge and those sources, usually being larger plants, have lower per unit costs of pollution reduction than smaller plants. For example, an area-wide environmental management plan for Dong Nai Province, Viet Nam, estimated that controlling water pollution at 3 out of 55 plants would reduce the organic pollutant load discharged by 90 per cent (UNDP/UNIDO, 1998). A more compelling example comes from the experience of Brazilian regulatory agencies, which rank factories according to size and risk, and target the largest or most risk-creating factories almost exclusively. In the case of Rio de Janeiro, the regulatory agency ranked several thousand factories based on their pollution discharge and health and welfare risks. After ranking several thousand factories, they found that 60 per cent of the State's serious industrial pollution could be reduced by targeting only 50 large factories in the highest risk category. In addition, they found that targeting 150 plants in the medium-risk category could reduce an additional 20 per cent of the serious pollution and that by targeting 300 plants out of several thousand in the smallest-risk category, an additional 10 per cent could be reduced (World Bank, 1999).

Supportive industrial policies

In addition to the creative application of environmental management instruments, there are also numerous opportunities to improve the cost-effectiveness and benefits and costs by integrating environmental considerations into the formulation and implementation of industrial policy. In the broadest sense, industrial policy encompasses all deliberate interventions by the public sector to influence the nature and direction of industrialization in line with specific objectives (UNIDO, 1999). Governments can alter the course of industrial development in various ways, that can be grouped into three generic categories:

(a) They can provide goods (such as steel or electricity produced by state-owned enterprises and public utilities) and services (such as those rendered by a public export promotion network);

(b) They have the possibility of modifying the price system through taxes, tariffs or subsidies;

(c) They are responsible for fixing and enforcing the set of rules that regulate economic exchanges.

As in the case of environmental policies, this paper cannot review the diversity of industrial policies that are currently being utilized or considered by developed and developing countries. Rather, the coverage is limited to presenting a few innovative options, which have significant potential to reduce compliance costs and to increase the net benefits of environmental regulations.

Provide services (or alternatively, no longer provide services that are best delivered by private firms): One opportunity in this category is to change factory ownership, which usually has an effect on environmental compliance. The case most often described is privatization, which shifts ownership from the public to the private sector. According to the World Bank (1999), "state-owned plants worldwide have compiled an unenviable record of wasteful resource use and financial distress, which in turn means higher abatement costs, less investment in pollution control and higher pollution intensity". The World Bank report then offers several studies in the Asian region to support that statement, a study in Indonesia, a study in China and a four-country study of pulp mills in Bangladesh, India, Indonesia and Thailand.

A second opportunity in this category is a set of policies and services that would encourage the uptake of more advanced management techniques and process technologies, which tend to encourage cleaner production (pollution prevention). A most-needed public service would be to integrate and rationalize policies across sectors, especially environmental protection versus industrial development, energy development and investment promotion. There is a compelling need to move beyond the programmes of the 50 international organizations that are currently supporting cleaner production demonstrations, training and information dissemination to integration and rationalization at the sectoral level if there is to be any significant uptake of environmentally sound technology in the on-going modernization of the industrial sector in the region (Stevenson and Evans, 2000).

Modify the price system: One such opportunity, already described, was reduction of import duties on cleaner production chemicals and technologies, and pollution control equipment. A related opportunity would be to equalize depreciation taxes on cleaner production technologies and pollution control equipment.

Fix the rules: The regulatory mechanism will influence sectoral composition of industrial growth; by promoting domestic competition, it may result in a structural shift towards light industries. Clearly, policies that encourage light industry, such as garments and electronics, would not increase the pollution potential as much as those that encourage heavy industry, such as chemicals and steel making. To some extent, countries in the region have pursued different sets of policies in that regard, as evident in table 4, which characterizes the sectoral composition at three points in time.

During the 20-year period in question, the sectoral composition in some countries, such as Indonesia, Sri Lanka and Thailand, shifted towards less polluting industries, whereas in others, such as India and Pakistan, it shifted towards more polluting industries.

Table 4: Sectoral composition by pollution intensity for selected Asian countries, 1975-1995

Country[a]	*Share (as a percentage)*		
	1975	*1985*	*1995*
Bangladesh			
More polluting industries	13.8	16.2	13.2
Somewhat polluting industries	67.2	66.2	46.2
Less polluting industries	19.0	17.6	40.6
Total	***100***	***100***	***100***
India			
More polluting industries	27.7	31.9	34.1
Somewhat polluting industries	51.5	49.7	49.9
Less polluting industries	20.8	18.4	16.0
Total	***100***	***100***	***100***
Indonesia			
More polluting industries	42.4	44.4	39.8
Somewhat polluting industries	37.5	30.3	37.1
Less polluting industries	20.1	25.3	23.1
Total	***100***	***100***	***100***
Nepal			
More polluting industries	19.1	21.6	16.2
Somewhat polluting industries	72.3	65.6	54.7
Less polluting industries	8.6	12.8	29.1
Total	***100***	***100***	***100***
Philippines			
More polluting industries	24.6	30.4	26.0
Somewhat polluting industries	58.9	51.9	57.4
Less polluting industries	16.5	17.7	16.6
Total	***100***	***100***	***100***
Singapore			
More polluting industries	33.5	39.6	20.1
Somewhat polluting industries	38.6	41.6	45.1
Less polluting industries	27.9	18.8	34.8
Total	***100***	***100***	***100***
Sri Lanka			
More polluting industries	16.0	18.3	14.5
Somewhat polluting industries	48.0	47.9	46.4
Less polluting industries	35.9	33.7	39.1
Total	***100***	***100***	***100***

Country[a]	Share (as a percentage)		
	1975	*1985*	*1995*
Thailand			
More polluting industries	25.3	20.7	20.6
Somewhat polluting industries	62.1	62.0	54.2
Less polluting industries	12.6	17.3	25.2
Total	***100***	***100***	***100***

Source: UNIDO Industrial Statistics Database (2000b).

[a]Sectors in the more polluting category are paper and products (341), industrial chemicals (351), petroleum refining (353), other non-metallic minerals (369), iron and steel (371) and non-ferrous metals (372). Sectors in the somewhat polluting category are food (311), beverages (313), textiles (321), leather products (323), printing and publishing (342), other chemicals (352), fabricated metals (381), machinery, electrical (383), and transport equipment (384). Sectors in the less polluting category are tobacco products (314), wearing apparel (322), footwear (324), wood products (331), furniture (332), miscellaneous petroleum and coal (354), rubber products (355), plastic products (356), pottery (361), glass (362), machinery, except electrical (382), professional and scientific equipment (385) and other (390).

Conclusions

The present paper has presented evidence that calls into question the perceptions that environmental regulations are both unnecessary and a significant constraint on industrial growth in developing countries. Unfortunately, such perceptions have intensified in recent times with the increasing competitive pressure resulting from the opening of economies; they have led to a phenomenon called the "regulatory chill", that is a reluctance on the part of environmental regulators to act because of those perceptions (Nordström and Vaughan, 1999). However, available evidence from developing and developed countries suggests that environmental regulations are a necessary constraint (a positive social good) because the benefits of pollution reduction in the aggregate appear to exceed the private costs of pollution reduction. Available evidence also suggests that the costs of compliance are negligible and thus would have only a minor impact on the competitive position of domestic industry in relation to foreign competition.

Even if the delegates find such positions acceptable, those positions should not mask many specific issues that have been mentioned. One issue is that not all environmental regulations applicable to industry would result in social benefits exceeding private costs of compliance; in fact, just the opposite is sometimes the case. The second issue is that energy- and resource-intensive industries and small plants, in urban areas in particular, will encounter financial problems in complying with environmental norms and some will become uncompetitive and will be forced to close.

Given such a perspective on industrial environmental issues and the competitiveness-driven "regulatory chill", industry ministers might want to consider establishing, in cooperation with their colleagues in environment ministries, economic analysis units to examine subsector-specific costs of compliance, based on the use of environmentally sound technologies. Those units would prepare economic impact assessments of proposed effluent and emission for specific subsector regulations, examine benefits and costs of specific standards, and advocate the use of regulatory innovations. The methodologies for economic impact assessments and regulatory impact analyses are well established and regulatory reform is an ongoing process in many developed countries. The same should be the case in all developing countries. International organizations, such as UNIDO, given the global importance of complying with environmental norms, should be called upon to support the enhancement of analytical capacity in ministries of industry to generate a better basis for decision-making on industrial environmental management.[10]

According to a recent report from the Asian Development Bank, there is a need for a new production revolution in the region that will balance economic, social and environmental concerns (Smith and Jalal, 2000). The conditions are ripe for the revolution, given the large additions to its capital stock that will be needed in the next 20 years. The question is whether the countries of the region will take advantage of the opportunity or be frozen in place by the "regulatory chill".

ANNEX I: DESCRIPTION OF CASE STUDIES: IMPACT OF ENVIRONMENTAL REGULATIONS ON INDUSTRIAL COMPETITIVENESS[a]

A. Leather

Various studies[b] have analysed the impact of environmental regulations on the leather industry. The most critical regulations that impact on costs of compliance are effluent and emission standards for water. In general, standards are comparable among industrialized countries but tend to be less stringent in developing countries. Firms comply to those standards either through changes in the composition of inputs and materials used or through technological improvements and treatment technologies. An assessment of compliance costs by Ballance and others indicates that, in general, capital costs will rise as a result of environmental compliance but the effect on overall costs (including operating costs) is less certain. Operating costs may increase on account of special chemicals required to treat pollutants as well as extra personnel costs and electricity costs; however, more efficient new technologies may act as a neutralizing factor. Rough estimates indicate that about half of the pollution load from leather industries can be eliminated with relatively marginal investments. According to case studies, leather tanneries processing 100 tons of raw bovine hides per week can provide conventional effluent treatment for 200 ppm BOD and 30 ppm of suspended solids at a cost that is 3.2 per cent of the sales value for full chrome side-upper leather.[c] In the case of a sheepskin tannery processing 3,000 pickled pelts per week, the costs of treatment were 2.1 per cent of leather sales value.

India

The export-oriented leather industry in India is faced with a ban throughout Europe on the use of pentachlorophenol (PCP) for the conservation of leather and the use of dyes containing formaldehyde and benzidine. It is possible that packaging and labelling requirements would also come into effect fairly soon. Domestic regulations also require tanneries to install individual or common waste treatment plants. Estimated cost impacts of such measures range from 1.5 to 3 per cent of finished product prices; however, those vary for different units depending mainly on the size of the tannery. Smaller units with backward technologies, located in urban areas, are the worst affected since they are unable to import equipment and processing chemicals that reduce effluents and maintain a quality product. Those units are unable to capture a larger share of the market. More modernized tanneries with access to imported leather and a labour cost advantage are the least affected by regulations in external markets (mainly the European Union and Germany).

A study conducted by the German Development Institute in India has assessed that the leather industry in India will be able to adjust to the PCP ban and cope with new product-related ecological standards despite problems encountered in the initial stages of the ban. The initial problems occurred mainly due to a lack of testing facilities to determine PCP content and the lack of PCP substitutes. Those problems took a few months to resolve until testing centres were set up and tanneries in India obtained information on where to get substitutes. In order to facilitate the import of substitutes (such as TCMTB and PCMC), the Government of India reduced the import duty from 150 to 50 per cent ad valorem.[d] The same study has found that the support system for India's leather sector, in the public and private sector, is able to render services for export promotion, research and training. The main drawback lies in monitoring and enforcement functions.

---

[a] Adapted from a background paper for the Global Forum on Industry entitled "Environmental policies and industrial competitiveness", UNIDO (1995).

[b] See Balance R. and others (1993) "The world's leather and leather products industry" (UNIDO).

[c] UNEP (1991) "Tanneries and the environment", Technical Report Series No. 4, UNEP Industry and Environment Office (Paris: UNEP).

[d] Note that Argentina's leather industry did not face the initial problems as a result of the PCP ban to the same extent as the industry in India because of the liberal trade policies already in place in Argentina which made imports more accessible.

Chile

The Government of Chile has sought to reduce liquid wastes from soaking, tanning and finishing of leather products in response to a technical norm governing the discharge of waste products. That norm controls discharges into wastewater collection systems and surface and underground watercourses and water bodies and has been in force provisionally since February 1993. Industry executives in the leather industry have responded to those measures by seeking viable and economically feasible solutions that have not affected adversely their competitive position.

The removal of potentially contaminating elements from the residues is done by using clean or low-waste-generating technologies and treatment technologies. An optimal solution resides in combining the two options, since even clean technologies cannot reduce contamination within the limits required by law, and further treatment of process sewage becomes necessary.

A study conducted by ECLAC and GTZ[e] assessed the use of clean technologies in the soaking stage (specifically, hair stripping operations) and the tanning stage, using available information based on quotations and estimates provided by some tanneries. Those stages generate much of the heavily polluted wastewater, using sulphides (for hair stripping) and chromium (for tanning).

An economic assessment was made of three project alternatives for a model tannery. The first of these was to implement a chromium recovery plant. That assessment resulted in a high internal rate of return of 28.97 per cent. The second alternative was to consider the implementation of a chromium recovery plant and the adoption of a different hair stripping method using less sulphides and involving recovery of the hair. That resulted in an even higher internal rate of return. In the third alternative, consideration was given to investment and the costs of implementing a sewage treatment plant. The results demonstrate the economic and environmental superiority of clean technology as opposed to treatment of waste generated.

The crucial point is that new and environmentally sound technologies can result in an overall reduction in production costs. The opportunities for leather firms to meet environmental standards, domestic or foreign, depend on the use of clean technologies that do not need end-of-pipe treatment (Ballance and others, 1993). Another factor of particular significance in the leather sector is economies of scale. The impact of economic policies on competitiveness will depend on the size of the firm and the degree of firm concentration. The probability of competitiveness loss is greater for small- and medium-scale units. However if tanning units are concentrated in a particular geographical area they will be better able to retain their competitive position despite comparatively stringent environmental regulations.

B. Pulp and paper

An UNCTAD study[f] has found that due to trade liberalization in Argentina a number of medium-sized paper mills have been able to achieve improvements in environmental performance as a consequence of greater production efficiencies, manifested in fibre recovery.

In this context, project DESIRE, undertaken by UNIDO and the National Productivity Council (NPC), increased efficiency in the use of energy and water. An increasing use of recycled materials in the packaging industry (in response to foreign requirements) has resulted in reduced costs. Whereas primary effluent treatment units were installed by many firms, the same cannot be said for the more expensive secondary effluent treatment units. The same study has shown that smaller-sized firms that generally use old equipment and out-dated technologies find it more difficult to improve their environmental performance due to limited space and financial resources. Whereas the latter may be

---

[e] Patricia Ilabaca, "Anilisis economico de alternativas no contaminantes de curtiembres en Chile". Documento CEPAL, LC/R.1356, 22 de noviembre de 1993.

[f] See "Environmental policies, trade and competitiveness: conceptual and empirical issues", a report by the UNCTAD Secretariat (1995); A. Markandya (1995) "Reconciliation of Environmental and Trade Policies: Synthesis of Country Case Studies".

true in the case of adopting new technologies, the scenario could be quite different if firms respond to stricter regulations by adopting waste minimization options in India.[g] It has been demonstrated that in the case of small-scale agro residue-based pulp and paper mills, savings from adopting waste minimization options are almost double that of the initial investments required. For 72 feasible options, net annual savings of $672,000 were generated in response to an initial investment of $349,000. That implies an overall payback time of 6 months on the investments. It becomes apparent from that exercise that even in the case of small-scale industries, there is a possibility of improving environmental performance in response to stricter regulation while at the same time remaining a competitive enterprise.

C. Textile dyeing and printing

Textiles have also been affected by external regulations similar to those for the leather sector. Environmental impacts of the textile sector, including cotton cultivation, dyeing and printing are substantial and the possibility that stricter ecological standards in the north will come into effect is very likely. In this section, the impacts that this might have on compliance costs in the dyeing and printing industry are discussed.

Coloured wastewater discharges from dyeing and printing options are the most visible form of pollution from this industry. Other environmental concerns relate to the use of toxic substances, high water and energy intensity of production, and air emissions of volatile organic compounds. See UNIDO (1995). Results of the UNCTAD study in India have indicated that bans on the use of benzidine dyes will most likely double the cost of dyes, affecting the competitiveness of the dyestuff industry and the textile industry. This could be true if the substitutes are more modern dyes. In the case of traditional dyes, the additional costs of replacement will not be very high. The UNCTAD study also estimates that adhering to stringent product standards for a single blue dye would increase investment costs by $13 million for some firms on account of upgraded technology, secondary treatment plants and automation control equipment to monitor the air-to-fuel ratios and carbon dioxide emissions. However, those costs will not be as high as those estimated by the above-mentioned study, when techniques that lead to savings in inputs such as water, fuel, dyestuffs and auxiliary materials are applied. If that can be accomplished by optimizing key stages in the production process, it would automatically result in reduced volume and toxicity of the effluent, that is, cleaner production. That in turn will manifest itself in reduced costs of effluent treatment and lessen the impact on competitiveness. UNDO has been implementing such clean production programmes in the private textile industry to overcome industrialists' initial resistance to environmentally friendly production.

Brazil

UNIDO activities in Brazil have demonstrated considerable cost-savings in the dyeing industry. In order to explain how those savings can be effected, a brief description of the technical processes is warranted. Wet processing contains mainly chemical processes like desizing, scouring, bleaching, mercerizing, dyeing, printing and resin finishing. Those are supplemented by physical processes such as washing, drying, heat setting, shearing, brushing and raising. The multitude of processes and their sensitivity to parameters, such as time, temperature and pH-value, had made the dyeing industry heavily dependent on the experience and advice of dyestuff manufacturers and managers resulting in the application of recipes containing unnecessary and expensive amounts of dyestuffs and auxiliaries.

Since the 1960s however, with the introduction of computers, photospectrometers and process controllers, the development of the dyeing industry has become more scientifically based. Optimized recipes developed through computerized colour matching have not only increased the repeatability of the dyeing process and reduced the consumption of dyestuff, energy and water, but have also reduced the costs of dyestuff by 20 to 30 per cent. Computerized process controllers and dosing apparatuses can reduce the consumption of salts, caustic soda and acids used for neutralization up to 40 per cent. Better control of temperature curves and fixating agents (together with modern dyestuff) are able to

[g] UNIDO (1998).

reduce the polluting effects of textile effluents. Alkali recovery plants can reduce the consumption of caustic soda by up to 90 per cent and therefore decrease the toxicity of effluents from textile dyeing and finishing processes. Results from one company have shown that in the year 1994, the use of redyeing was brought down from 7.4 per cent to 0.7 per cent and colour stripping and redyeing did not occur any more. The payback period on investments in those processes is estimated as being 6 months at a minimum.

Apart from the application of clean production processes, waste minimization options can also be adopted to reduce the costs of complying with more stringent environmental regulations. The DESIRE project undertaken by UNDO in India has demonstrated in four small-scale dyeing units that made an initial investment of Rs. 1.4 million in waste minimization measures yielded monetary savings of Rs. 7.1 million, and a reduction of 30 per cent in volume of effluent and 16 per cent in COD load.

The above examples demonstrate that it is feasible and cost-effective for dyeing units to adhere to environmental standards without necessarily corroding their competitive position, provided the right kind of technical and managerial approaches are adopted.

D. Energy

Perhaps the strongest evidence for export losses due to stringent environmental policies, both domestic and foreign, is to be found in the energy sector of some of the former centrally planned economies of Eastern Europe. A survey in Poland[f/] has shown that whereas market reforms and stricter environmental regulations have impacted positively on the environment, they have resulted in loss of international competitiveness because the prices of raw materials and energy have risen sharply in Poland. A large proportion of exports from Poland, for example, electricity to the Czech Republic and Germany, are raw material- and energy-intensive. In large part, the competitive advantage of Polish electricity exports is because it does not have to capture sulphur emissions. When desulphurization of flue gas is introduced, the export of electricity may well become uncompetitive due to higher costs of generation (estimated by UNCTAD at 40 per cent). That in turn will affect the export of other energy-intensive goods such as plastics, fertilizers, organic chemicals and building materials. Similar considerations apply in other sectors such as coal mining where it is estimated that production costs will increase by 10 to 15 per cent due to stricter environmental regulations on saline water discharges and exports in 2000 will fall from 25 million tons to 10 million tons. At the same time, it should be noted that the introduction of environmentally sound technologies in response to stricter environmental standards will increase efficiency. That was found to be the case in Poland, for example, in the steel sector.

E. Steel

Industrial restructuring and market reforms may reduce capacity in the Polish steel industry but at the same time it will also reduce environmental damage by 70 to 80 per cent. Remaining plants will be more efficient with production costs lower by $20 to $25 per ton (UNCTAD).

A similar experience is recounted in response to Chilean Supreme Decree No. 4 establishing maximum permissible levels of emissions. In periods of extreme environmental emergency and at the insistence of competent government authorities, when an industry exceeds the permitted levels it must suspend operations. In the case of a heat-treated laminated steel parts unit, the effects of a technological change in the fuel used in a heat-treatment furnace, from diesel oil to liquid gas were analysed. That change was made by a medium-scale metallurgical enterprise (35 employees) in the Santiago, Chile, metropolitan area, with the aim of achieving productive efficiency, as well as reducing contaminant environmental emissions and complying with the regulation established in Supreme Decree No. 4.

An ECLAC study[h] found that an appreciable decrease in particulate emissions could be observed, and that meant that the enterprise was complying with all the regulations in force and did not run any risk of being affected by restrictions on its activity. Moreover, a beneficial economic result was seen, with a positive marginal net present value and a highly attractive marginal internal rate of return (118 per cent).

F. Iron

The same study has assessed the effects of a technological change that replaced a smelting process carried out in a cupola furnace by one performed in an electrical induction furnace, in a medium-scale iron foundry (35 employees) located in the Santiago, Chile, metropolitan area. That enterprise was forced to implement a technological change, motivated by the challenge of increasing the added value of its products and, at the same time, reducing the pollution levels, which exceeded the limits permitted by the legislation in force.

The change envisaged was designed to comply with the environmental regulation and to improve the competitiveness of the enterprise by enabling it to increase the value added to its primary product. It did that by switching from grey iron to nodular iron. The technological change reduced the emissions of gaseous and particulate contaminants owing to the characteristics of the smelting process when performed in an induction furnace. The decision to introduce the technological change had two interesting results: it significantly reduced the emissions generated by the industrial processes, so that the enterprise remained below the emission standard, and it improved the quality of the product obtained.

An economic assessment of the change, carried out by ECLAC and GTZ, shows it to be a profitable investment, as revealed by a positive marginal net present value and a very attractive marginal internal rate of return (69.1 per cent).[h]

Chile

The same study also made an assessment of a medium-scale foundry (38 employees) located in Santiago, Chile, which introduced a technological change in order to reduce the pollution generated, as well as to achieve a more efficient operation. The enterprise-smelted iron using a cupola furnace to obtain the metal yields the product which is grey iron with a carbon content of 3-3.5 per cent.

Foundries, especially those that use a cupola furnace, are industries which have a high pollution index because of gas releases and particulate emissions into the atmosphere. The enterprise in question was subjected to the suspension measures provided for in the new legislation (Supreme Decree No. 4), as its emissions greatly exceeded the permitted limits.

Owing to that situation, the enterprise management opted for technological changes which, in addition to substantially reducing contaminant emissions, increased the efficiency of the process of smelting raw materials in the cupola furnace. Once the changes had been made, the enterprise was able to substantially reduce particulate emissions, reaching levels much lower than the limits permitted by the environmental sanitation agency. That ensured its smooth and uninterrupted functioning throughout the year. The economic benefits obtained by the enterprise were also significant: its production capacity increased and the costs of the process of smelting raw materials and obtaining cast iron decreased. Those results were reflected in a highly positive marginal net present value for the project, coupled with an exceptionally high marginal internal rate of return of 93.16 per cent.[h]

---

[h] Bustos, L., "Transformación productive ambientalmente sustentable en pequeñas empresas: el caso de dos fundiciones y una planta de tratamiento térmico en la Región Metropolitana (Chile)". Documento CEPAL, LC/R.1250, 5 de febrero de 1993.

G. Fisheries

Even before national environment norms were established, Chilean fisheries in the late 1970s faced environmental challenges from new demands of a more specialized market, requiring better-quality and more differentiated products, and from environmental pressures exerted by local communities where the processing plants were located.

Chile

In response to those challenges, a group of fishery enterprises from Chile belonging to the Association of Fish Meal Producers (CORPESCA) whose products are fish meal and fish oils had, in conjunction with a Norwegian enterprise (Hetland Process), developed a number of clean technologies that had met both environmental goals and goals of greater efficiency and profitability. In addition, the processes developed had enabled those companies to adapt better to market demands and obtain better prices and, at the same time, to produce better-quality fish meals (specialty or "prime" fish meals) differentiated in accordance with the needs of their users (fish farming, poultry breeding, cattle finishing, food preparation, etc.). Previously, the final product (fish meal) had been sold in bulk to large-scale buyers or traders.

Among the environmental benefits obtained from the new technologies are lower levels of particulate emissions in liquid effluents, fewer or no emissions of malodorous gases, energy savings and optimal use of raw materials.

Among the technical, economic and environmental achievements of the new technologies, mention can be made of the following:

- Primary and secondary centrifugation of the pressing liquid, so that fish solids and oil are obtained and the solid content of the effluent (liquid glue) is lowered by 7-25 per cent;
- Decanting and filtering of discharge water, so that fish solids are obtained and the solid content of the effluent is lowered by less than 0.04-2 per cent;
- Evaporation of liquid glue, so that soluble protein concentrates are obtained which are added to the fish meal, and the solid content of the effluent is eliminated;
- Deodorizing of drying gases; in an initial stage, the water vapour level was lowered and cleaning them with seawater reduced the volume and temperature of the gases;
- Gas emissions into the atmosphere were totally eliminated through a complete technological overhaul of industrial steaming, drying and evaporation equipment and the use of additional equipment;
- Sanitation and health programmes in the plants, blocking the development of germs that accelerate the decomposition of raw material and increase the emission of odours in the process;
- Computer control of operating speeds so as to optimize drying, reducing the emission of odorous gases;
- Optimization of deodorizing equipment through the use of linings that improve gas exchange and lower emissions;
- Application of an integrated steaming, drying and evaporation system that uses residual drying vapours as a heating method, and use of a computer-controlled thermodynamic chain for evaporation and steaming.

In addition to the other results mentioned, the following was achieved:

- An energy saving of 25-28 per cent;
- Production of a more digestible fish meal with a higher percentage of protein and lysine;
- An increase of 15-29 per cent in utilization of raw materials.

The obvious advantages of the new technologies and industrial prototypes have enabled them to be sold to such countries as Denmark, Japan, Norway and Peru. In addition, a kind of technological dependency has been overcome, since previously all equipment was purchased in the developed countries. Moreover, a promising technological link has been established between two countries at very different levels of development (Chile and Norway).[i]

H. Food processing

In contrast to the positive experience cited above in the case of fisheries in Chile, is the case of meat processing in Zimbabwe. The UNCTAD study cites examples where it is felt that foreign standards are having an adverse effect on exports of ostrich products and beef to Australia and the European Union. Quarantine regulations and costly blood tests would make exports of live birds and meat less competitive. Phytosanitary standards for the export of beef to Europe require importers in Europe to inspect all produce before it leaves the exporting country. Exporters in Zimbabwe feel that that will raise their costs substantially and dissuade them from finding export markets.

---

[i] Ezquerra, E. R. (1994) *Empresas lideres en desarrollo, aplicación y difusión de tecnologías ambientalmente racionales en América Latina: el caso de Maestranza Iquique S.A.-Hetland Process ye empresas pesqueras asociadas a Corpesca, Chile* (Documento CEPAL, LC/R.1152/Rev.3, 18 de marzo).

ANNEX II: CASE STUDIES OF CLEANER PRODUCTION IN ASIA

A. China: fine chemicals

A cleaner production project in China funded by the World Bank and implemented by the Industry and Environment Office of the United Nations Environment Programme (UNEP) and the Environmental Research Institute (IVAM) of Amsterdam University, looked at the potential for cleaner production at 7 companies (Berkel, 1996). One of the plants is a major manufacturer of fine chemicals in China, specializing in the production of additives for the processing of high-polymer materials. As a result of implementing preventive measures, the mill achieved the following:

(a) Reduced its capital investment cost for end-of-pipe equipment by 25 per cent and annualized costs by 15 per cent;

(b) Reduced water use by 80 per cent and chemical oxygen demand by 95 per cent;

(c) Increased output by 25 per cent;

(d) Increased the expenditure for labour by 40 per cent.

To achieve those results, the plant has implemented 9 low-cost options and it is now considering 4 high-cost options. The investment needed for implementing the first batch of 9 cleaner production options was less than $1,200. The annual savings due to increased efficiency and decreased materials and water consumption was $30,000, giving a payback period of less than two weeks. The investment needed for the 4 high-cost options would be $520,000. The annual savings will be $750,000, giving a payback period for the capital investment of less than 9 months.

B. India: agro-based pulp and paper

A joint study by the National Productivity Council of India and UNIDO investigated the potential for waste minimization in three sectors: agro-based pulp and paper, pesticide formulation and textile dyeing and finishing (UNIDO, 1998). Before the investigation, one of the agro-based pulp and paper mills (which produces 30 tonnes per day) had prepared an estimate of the cost of meeting discharge standards based on end-of-pipe technology. As a result of implementing preventive measures, the mill achieved the following:

(a) Reduced its capital investment cost end-of-pipe equipment by 25 per cent and its annualized operating and maintenance costs by 35 per cent;

(b) Reduced the discharge of various pollutants by 20 per cent to 40 per cent;

(c) Increased annual output by 22 per cent, improved the quality of the paper produced (specks were reduced) and made a new product (secondary fuel for brick kilns from the primary clarifier);

(d) Hired 9 more employees to cope with increased production capacity;

(e) Reduced off-site secondary pollution by reducing the consumption of sodium hydroxide and of energy (less suspended particulate matter and sulphur dioxide).

To achieve those results, the mill implemented 28 preventive measures at a capital cost of $100,000 and an operating cost of $40,000. The total savings from those measures were $400,000, giving a payback period on capital investment of less than four months.

C. Viet Nam: food

UNIDO, with the support of the Government of Sweden, undertook in 1997-1998 a cleaner production demonstration and training project with the Department of Science, Technology and the Environment in Ho Chi Minh City (Department of Science, Technology and Environment, Ho Chi Minh City/United Nations Industrial Development Organization/Swedish International Development Co-operation Agency, 1999). One of the six plants involved in the project was a noodle factory. Because its production process consisted of several different production lines, the company cleaner production team decided to focus its efforts on the production of instant noodles. As a result of implementing preventive measures, the factory achieved the following:

(a) Reduced wastewater volume by approximately 70 per cent;

(b) Reduced organic pollution by between 30 and 35 per cent;

(c) Reduced significantly in gaseous emissions;

(d) Installed a monitoring system to check consumption of 27 key process inputs;

(e) Established a reward system for workers who improve resource efficiency;

(f) Improved shelf life of products;

(g) Decreased percentage of broken noodles from 9 to 3 per cent;

(h) Increased production capacity by approximately 25 per cent.

To achieve these results, the plant has implemented 24 no- and low-cost cleaner production options. The plant invested approximately $62,000 to implement these options and as a result realized annual direct cost-savings of $630,000, giving a payback period of less than one year.

ANNEX III: SUMMARY OF MAJOR ENVIRONMENTAL COSTS IN MEXICO

Table 5: Summary of major environmental costs in Mexico

Problems	*Potential effects production/health*	*Method/formula*	*Annual costs (US$ billions)*	*Built-in assumptions*
Soil erosion	Loss of agricultural output	Average productivity loss x output (soybeans, maize, sorghum, and wheat) + increased fertilizers	1.20	Application of projected tendency losses in US to perpetuity + 20% for fertilizers
Health effects from air pollution (Mexico City only)	Particulates: morbidity (respiratory restricted activity days—RRAD)	RRAD = 0.0114 x baseline RRAD x (conc. fine particulates – legislation standard)	0.36	Day lost = $32 Conc. FP = 119 Tg/m^3 FP Standard = 50 Tg/m^3 Baseline RRAD = 3
	Particulates: mortality (MR)	MR = 1.69/million x concentration suspended particles	0.48	Conc. SP = 298 Tg/m^3 1 statistical life = $75,000
	Ozone: morbidity	RRAD = baseline x adult population x exp [(6.88 x Δ ozone)-1]	0.10	50% productivity loss Other assumptions as above
	Lead: children's treatment for high blood lead levels (BLL)	Population affected x average estimated treatment costs	0.06	Screening if >25 Tg/dl EDTA test if >35 Tg/dl 1% require chelation Hospital cost = 1/15 of US cost
	Lead: children's compensatory education	Population affected x education costs	0.02	20% of those >40 Tg/dl Average education expenditure per child
	Lead: hypertension in adults	Population affected x average estimated treatment costs	0.01	-1 Tg/m^3 lead in air = -3 Tg/dl in blood -1% BLL = -0.8% prob. of hypertension Lead con. Air = 1.4 Tg/m^3 Average BLL 15 Tg/dl
	Lead: myocardial infarctions	As above	0.04	60% occur in hypertense Cost = ½ as in US
Excess use of underground waters due to poor pricing (not social costs)	Subsidies to supply water to Mexico City	(Mag. cost-charge) x consumption	1.00	Average price P$2,900 Marginal cost P$4,500 Average consumption = 1.8 billion m^3
	Subsidies to irrigation	As above	0.16	Implicit subsidy of $82/ha/year to 2 million ha
Diarrhoeal diseases from waste and solid waste pollution; lack of sanitation and foodstuff poisoning	Morbidity	Incidence x average treatment costs	0.03	Children and elderly require treatment, 50% ORT, 20% lab analysis Adults require treatment and 20% ORT
	Mortality: scenario 1–current situation	No. of lives x life expectancy x value	3.60	1 statistical life = $75,000
	Mortality: scenario 2–with oral rehydration therapy (ORT)	Incidence x average treatment costs	0.00 ($450,000)	Treatment = US$ 3, ORT = $1 + 12 administration

Source: Margulis (1996).

Note: In all cases, the rate of discount is 5 per cent.

ANNEX IV: POLLUTION ABATEMENT COSTS EXPENDITURE AS A PERCENTAGE OF GDP OF SELECTED DEVELOPED COUNTRIES

Table 6: Summary of pollution abatement costs expenditure as a percentage of GDP[a, b]

Public and private sectors	*1985*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*
Australia	..	..	..	..	0.6	0.7	..
Austria	..	1.8	1.7	..	2.0	2.1	..
Canada	..	..	..	0.9	..	..	..
Finland	..	..	..	..	..	..	1.4
France	0.9	1.0	1.2	1.2	1.2	1.2	1.2
Germany	1.5	1.6	1.6	1.6	1.6	1.6	1.5
Italy	..	..	..	0.9	..	..	..
Japan	1.0	1.1	1.1	1.1	1.1	..	..
Netherlands	1.4	1.5	..	1.4	1.7	1.8	1.9
Norway	..	..	..	..	1.2	..	..
Portugal	..	..	0.5	0.5	0.8	0.7	..
Sweden	0.2	..	0.4	..	..	1.2	..
Switzerland	..	..	..	..	..	..	2.1
United Kingdom	1.3	..	..	..	1.4	..	..
United States	1.4	1.4	1.4	1.4	1.5	1.5	1.6

Source: OECD (1996).

[a] All significant changes in PAC expenditure shares must be reviewed with care, as PAC expenditure may also increase because of improved sectoral coverage and data availability.

[b] Based on the abater principle (expenditure 1). This includes for some countries receipts from by-products.

Notes

[1] For the purposes of the present paper, countries in transition and developing countries are grouped under the heading of developing countries.

[2] For information about the perceptions of industrialists in developing countries, see Luken (1997), which surveyed organizations and entrepreneurs about their perceptions of environmental management standards; for information about the perceptions of industrialists in developed countries, see Nordström and Vaughan (1999), which summarized articles on "regulatory chill".

[3] A related objection, which is not examined in the present paper, is that environmental regulation adversely affects employment as well as plant-level expenditures. A number of modelling and other empirical studies undertaken by developed countries contradict that perception (Sprenger, 1997). "The small employment effects of environmental policies appear to be small, relative to total employment levels, and tend to be swamped by other, more influential changes taking place in the economy and, if anything, environmental policies have had a small net beneficial effect on employment, at least in the short and medium term."

[4] As pointed out by Nordström and Vaughan (1999), the OECD compares pollution abatement costs as a percentage of production costs, whereas the U.S. Census Bureau compares pollution abatement costs as a percentage of the value of shipments. The two concepts are closely related because market prices (the value of shipments) in the long run tend to be reduced to the unit production costs, including a "normal" return to capital.

[5] To take the example put forward by Nordström and Vaughan (1999), the production costs of steel in the United States of America are estimated at $513 per ton, of which $15 can be attributed to pollution abatement. The cost of producing steel in Mexico is estimated at $415 per ton. Thus even if all environmental regulations were removed in the United States, the production costs would still exceed the level in Mexico by $83. That is, whatever the roots of the competitiveness problems of the steel industry in the United States, only a tiny fraction can be blamed on environmental regulations (OECD, 1997a).

[6] One of the most recent investigations of the "Porter hypothesis", a study of the pulp and paper industry in the United States, shows mixed results (Boyd and McClelland, 1999). The study found win-win potential for inputs and pollution to be simultaneously reduced by 2 to 8 per cent without reducing production. It also found that environmental constraints reduced production by 9 per cent, a quarter of which resulted from pollution abatement capital constraints.

[7] OECD (1999) reviews the full range of win-win benefits that can accrue to developing countries that open their domestic markets to foreign providers of environmental services, such as pollution control. The report describes several case studies from developing countries.

[8] The present report made no effort to review the limited literature that directly addresses the impact of environmental regulations on international trade patterns. It would appear that even in the most polluting sectors which spend comparatively larger amounts to comply with environmental regulations, such as pulp and paper, petroleum products, organic and inorganic chemicals, coal mining, cement, and ferrous and non-ferrous metals, there is no discernible impact according to a World Bank study (Piritti, 1994). The same study found that, contrary to common perceptions, higher environmental standards have not tended to lower their international competitiveness. There has been little systematic relationship between higher environmental standards and competitiveness in environmentally sensitive goods (those that include the highest pollution abatement and control costs).

[9] An additional advantage would accrue to the provincial environmental protection agency, which would find its job of monitoring environmental compliance less resource intensive.

[10] UNIDO has undertaken technical cooperation projects to upgrade the capacity of ministries of industry in Madagascar, Morocco and Nepal to be informed and pro-active participants in industrial environmental management.

BIBLIOGRAPHY

Anderson, D. (1999) Technical progress and pollution abatement: an economic review of selected technologies and practices, draft report, Centre for Energy Policy and Technology, Imperial College of Science Technology and Medicine (London).

Anderson R. and P. Kobrin (1998) "Introduction to environmental economics research at EPA", report prepared for the United States Environmental Protection Agency (Washington, D.C.: USEPA).

Anderson, R. and P. Kobrin (2000) "Regulatory analysis at EPA", report prepared for the United States Environmental Protection Agency (Washington, D.C.: USEPA).

Berkel, R. van, Cleaner production in practice: Methodology development for environmental improvement of industrial production and evolution of practical experiences, doctoral thesis, University of Amsterdam, Amsterdam, 1996.

Boyd, G. and J. McClelland (1998) "The Impact of Environmental Constraints on Productivity Improvement in Integrated Paper Plants", *Journal of Environmental Economics and Management*, vol. 38, No. 2, September 1999, pp. 121-142.

Brandon, C. and K. Hommen (1995) *The Cost of Inaction: Valuing the Economy-wide Cost of Environmental Degradation in India*, Asia Environment Division (Washington, D.C.: World Bank).

Chudnovsky, D., G. Lugones and M. Chidiak (1995) "Comercio Internacional y Medio Ambiente El Case Argentino", Estudio preparado a solicitud de UNCTAD (Buenos Aires: CENIT).

Garcia, D. (1994) *Reconciliation of Trade and Environmental Policies: The Case of Colombia*, UNCTAD Case Studies (Geneva, Switzerland: UNCTAD).

Gouldson, A. and Murphy, J. (1998) *Regulatory Realities: The Implementation and Impact of Industrial Environmental Regulation* (London, UK: Earthscan Publications Limited).

Guang, X. (1997) "An estimate of the economic consequences of environmental pollution in China", Policy Research Center of the State Environmental Protection Agency (Beijing: State Environmental Protection Agency).

Jaffe, A. and K. Palmer (1997) "Environmental regulations and innovations: a panel data study", *The Review of Economics and Statistics*, November, pp. 610-619.

Low, P. (1992) "Trade measures and environmental quality: the implications of Mexico's exports", in P. Low (ed.), *International Trade and the Environment*, World Bank Discussion Paper 159 (Washington, D.C.: World Bank).

Luken, R. (1997) "Trade implications of international standards for environmental management systems", *Green Productivity: In Pursuit of Better Quality of Life* (Tokyo: Asian Productivity Organization), pp. 215-224.

Luken, R. (1999) "Industrial pollution reduction in Dong Nai, Republic of Vietnam", *Sustainable Development International* (London: IcG Publishing Ltd).

Margulis, S. (1996) "Back-of-the-envelope estimates of environmental damage cost in Mexico", in P. H. May and R. Seroa da Motta (eds.), *Pricing the Planet: Economic Analysis for Sustainable Development* (New York: Columbia University Press).

Nordström, H. and S. Vaughan (1999) *Trade and Environment*, Special Studies 4 (Geneva, Switzerland: Word Trade Organization).

O'Connor, D. (1996) "Grow now/clean later, or pursuit of sustainable development", Technical Paper No. 111 (Paris: OECD).

O'Connor, D. (1999) "Applying economic instruments in developing countries: from theory to implementation", *Environment and Development Economics*, vol. 4, No. 1, pp. 91-110.

Organisation for Economic Cooperation and Development (1996) "Pollution abatement and control expenditure in OECD countries", OCDE/GD (96) 50 (Paris: OECD).

Organisation for Economic Cooperation and Development (1997a) "The effects of government environmental policy on costs and competitiveness: iron and steel sector", DSTI/SI/SC (97) 46 (Paris: OECD).

Organisation for Economic Cooperation and Development (1997b) *Reforming Environmental Regulation in OECD Countries* (Paris: OECD).

Organisation for Economic Cooperation and Development (1997c) *Evaluating Economic Instruments for Environmental Policy* (Paris: OECD).

Organisation for Economic Cooperation and Development (1999) "The 'win-win' role of trade liberalization in promoting environmental protection and economic development", Environmental services (Paris: OECD).

Office of Management and Budget (1997) *Report to Congress on the Costs and Benefits of Federal Regulations*, 30 September 1997.

Palmer, K., W. Oates and P. Portney (1995) "Tightening environmental standards: the benefit-cost or the no-cost paradigm?", *Journal of Economic Perspectives*, vol. 9, No. 4, pp. 119-132.

Piritti, Sorsa (1994) "Competitiveness and environmental standards", World Bank Policy Research Working Paper number 1249 (Washington, D.C.: World Bank).

Porter, M. (1991) "America's Green Strategy", *Scientific American*, April, p. 68.

Porter, M. and C. van der Linde (1995) "Toward a new conception of the environment-competitiveness relationship", *Journal of Economic Perspectives*, vol. 9, No. 4, pp. 97-118.

Reppelin-Hill, V. (1999) "Trade and environment: an empirical analysis of technology effect in the steel industry", *Journal of Environmental Economics and Management*, vol. 38, pp. 283-301.

Seroa, R. and A. Fernandez (1996) "Health costs associated with air pollution in Brazil", in P. H. May and R. Seroa da Motta (eds.), *Pricing the Planet: Economic Analysis for Sustainable Development* (New York: Columbia University Press).

Smith, D. and K. Jalal (2000) Sustainable Development in Asia (Manila: Asian Development Bank).

Sprenger, R. U. (1997) "Environmental policies and employment" (Paris: OECD).

Stevenson, R. and J. Evans, Industry and the environment, forthcoming article, *Asian Environmental Outlook 2001* (Manila: Asian Development Bank).

Department of Science, Technology and Environment, Ho Chi Minh City/United Nations Industrial Development Organization/Swedish International Development Co-operation Agency (1999) *Cleaner Production Case Studies: Food Processing, Pulp & Paper and Textile Processing Sectors,* Reduction of Industrial Pollution in Ho Chi Minh City, project TF/VIE/97/001, September 1999 (Ho Chi Minh City, Viet Nam: UNIDO).

Tao, W., W. Yang and B. Zhou (1998) "Tradable discharge permits system for water pollution of the Upper Nanpan River, China", Yunnan Institute of Environmental Sciences/Yunnan Environmental Protection Bureau, Economy and Environment Program for Southeast Asia.

United Nations Conference on Trade and Development (1995) "Effects of environmental policies, standards and regulations on market access and competitiveness, with special reference to developing countries, including with least developed among them and in light of UNCTAD empirical studies", report by the UNCTAD Secretariat, Trade and Development Board, Ad Hoc Working Group on Trade, Environment and Development (Geneva, Switzerland: UNCTAD).

United Nations Development Programme/United Nations Industrial Development Organization (1998) "Industrial Pollution Reduction in Dong Nai", Final project report, DG/VIE/95/053 (Hanoi: UNDP).

United Nations Economic and Social Commission for Asia and the Pacific (2000) "State of the Environment 2000" (Bangkok: UNESCAP).

United Nations Environment Programme (1997) "The Environmental Management of Industrial Estates", UNEP IE Technical report No. 39 (Paris: UNEP).

United Nations Industrial Development Organization (1995) "Environmental policies and industrial competitiveness: Are they compatible?", background paper for "Global Forum on Industry: Perspectives for 2000 and beyond", Panel IV Environmental policies and industrial competitiveness, New Delhi, India, 16-18 October 1995.

United Nations Industrial Development Organization (1998) "From waste to profits: the Indian experience", Final report: "DESIRE" (DEmonstration in Small Industries for Reducing WastE).

United Nations Industrial Development Organization (1999) "Industry in development: why it matters, wherefore it suffers, what it needs", discussion paper, Statistics and Information Networks Branch and Industrial Policies and Research Branch, September 1999.

United Nations Industrial Development Organization (2000a) "Industrial policy and the environment in Pakistan", Final report, project NC/PAK/97/018.

United Nations Industrial Development Organization (2000b) Industrial Statistics Database.

Wiemann, J. and others (1994) "Ecological product standards and requirements as a new challenge for developing countries' industries and exports: the case of India's leather, textile and refrigeration industries" (Berlin: German Development Institute).

World Bank (1994) *Indonesia: Environment and Development, A World Bank Country Study* (Washington, D.C.: World Bank).

World Bank (1998) *Clear Water, Blue Skies, China's Environment in the New Century* (Washington, D.C.: World Bank).

World Bank (1999) *Greening Industry: New Roles of Communities, Markets, and Governments* (New York: Oxford University Press).

Printed in Austria
00-58219–November 2000–100

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, A-1400 Vienna, Austria
Telephone: (+43 1) 26026-4789 or 5521, Fax: (+43 1) 26026-6821, E-mail: cchua@unido.org