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INDUSTRIAL
RESTRUCTURING
FOR SUSTAINABLE
DEVELOPMENT:
THREE POINTS
OF DEPARTURE

Udo E. Simonis*

At a forum on industry and the environment held in New Delhi, Stephan Paulus gave the following definition of ecological modernization: "Ecological modernization focuses on prevention, on innovation and structural change towards ecologically sound industrial development . . . It relies on clean technology, recycling, and renewable resources . . . To introduce such a concept into the economy, it is necessary to coordinate various policy areas, such as industrial, fiscal, energy, transport and environmental policies".

This, actually, is a rather broad and demanding definition of a concept proposed to achieve better harmony between economy and ecology. In this article I will, therefore, concentrate on only some aspects of such a concept. First, I am going to present some empirical evidence on the relationship between economic structure and environmental impacts; second, I shall point to some of the deficiencies of environmental policy, and third, I shall put forward some ideas on how to integrate ecological dimensions into economic policy.

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I
E C O L O G I C A L S T R U C T U R A L
C H A N G E O F T H E E C O N O M Y

In both the East and the West, economists, planners and engineers are seeking a solution to the problem of how to change the traditional patterns of resource use. “Perestroika” and “modernization” are two current catchwords in this process, and new environmental priorities play a part in the envisaged conversion of the economy. Harmonizing ecology and economy in a specific sense relies on the premise that a reduction in the resource input of production (ecological structural change) will lead to an *ex ante* reduction of emissions and wastes that have a negative impact on the natural environment (ecological structural change).

In order to clarify the relationship between economic structure, structural change, and environmental impacts, one needs suitable information concerning the material side of production, for environmental protection and resource conservation by the economy—and thus its long-term sustainability—cannot appropriately be described in such terms as income, investments and consumption. One possibility is to select and compare some indicators describing the environmentally relevant features of the production process. The availability of environmental indicators such as emission data relating to “representative” pollutants—for example, sulphur dioxide and nitrogen oxide—has grown recently (see the annual reports on the environment of several industrial nations, and those by the United Nations Environment Programme (UNEP) and the Organization for Economic Cooperation and Development (OECD). These indicators concern certain negative environmental effects of production. Less is known on the environmental relevance of the input factors in industrial production or on the question of which indicators provide environmentally significant information about the structure of the economy. Given the present state of statistics, only a few such indicators can be tested in a cross-national comparison of Eastern and Western countries.

***De-linking economic growth
from environmentally relevant inputs***

Using a set of four indicators (input factors), Jänicke et al. have studied 31 countries of both the Organization for International Economic Cooperation and the Organisation for Economic Cooperation for Development with regard to the relationship between economic structure and environmental impacts. The four factors whose direct and indirect environmental significance is thought to be self-evident were: energy, steel, cement, and freight transport. Regarding their patterns of production and consumption these are environmentally “hard” factors, characteristic of a certain structure of the economy and/or stage of economic development.

The main hypothesis of the research was a simple one and reads thus: positive environmental effects in structural change in the economy are to be expected by actively de-linking economic growth from the use of environmentally relevant inputs (resources). Such active de-linking (or ecological structural policy) would:

- (a) Result in a decrease of resource depletion and/or environmental pollution;
- (b) Mean *ex ante* instead of *ex post* environmental protection;
- (c) Promote those integrated technologies which touch upon several environmental effects (pollutants) at one and the same time.

Structural change as a shift of input factors to more intelligent uses can thus be conceived as a process of successive de-linking. The contribution of traditional (hard) input factors to the national product decreases, that is, they change or lose their function in the development process.

Examples of successful and deficient de-linking

Taking Germany as an example, Jänicke has demonstrated a fivefold de-linking from the growth of the gross domestic product (GDP). The de-linking of energy and cement consumption and weight of freight

transport from the GDP became apparent during the 1970s; regarding steel, the de-linking process had already begun in the 1960s. In this way, the structural change of the economy generated environmental gratis effects of various kinds:

- (a) The stagnating consumption of primary energy led to a reduction of harmful emissions (pollutants);
- (b) The relative decline in the weight of freight transport indicates that the volume of materials employed was reduced rather than increased;
- (c) The fall in the use of cement represents a direct gratis effect as far as the emissions from cement factories are concerned; this decrease coincided with the trend towards the labour-intensive renovation of the housing stock, as compared to new construction;
- (d) The decrease in steel consumption accounts for a considerable reduction in harmful emissions as far as processing is concerned; this drop was strongly marked and partly due to increased recycling activities.

Environmental gratis effects occur when the rate of usage of the input factors (resources) having a (strong) negative impact on the environment remains below the growth rate of the GDP. Comparing the rates of usage of the four selected input factors with the growth rate of the GDP, Jänicke et al. discovered three different development patterns:

- (a) The factors having impacts on the environment decline absolutely; i.e., absolute structural improvements are induced, corresponding to absolute environmental gratis effects;
- (b) The factors having impacts on the environment remain constant, or increase, but with a lower growth rate than the GDP; i.e., relative structural improvements, corresponding to relative environmental gratis effects;

- (c) The factors having impacts on the environment increase at a higher growth rate than the GDP; i.e., structural deterioration occurs, corresponding to absolute negative environmental effects of economic growth.

In table 1, 16 out of the 31 countries studied are grouped according to these three development patterns.

TABLE 1
ENVIRONMENTAL IMPACTS DERIVING FROM STRUCTURAL CHANGE, PERCENTAGE CHANGES 1970-1985

Country	Consumption on primary energy	Crude steel	Cement production	Weight of freight transport	GDP ^a
<i>Group 1: Absolute structural improvement</i>					
Belgium	7.1	-24.5	-17.6	-2.2	42.7
Denmark	-2.7	-45.6	-33.2	20.1	40.8
France	30.3	-34.8	-23.4	-14.5	51.6
Germany	13.4	-26.3	-32.8	4.4	38.4
Sweden	26.4	-37.9	-41.2	-21.4	32.7
United Kingdom	-2.3	-43.5	-28.7	-18.2	32.4
<i>Group 2: Relative structural improvement</i>					
Austria	32.1	-33.9	-6.0	21.3	54.3
Finland	39.6	14.8	-11.2	12.2	65.7
Japan	37.3	-2.3	27.4	7.5	90.2
Norway	51.1	-21.6	-40.3	34.7	87.5
<i>Group 3: Structural deterioration</i>					
Bulgaria	74.9	24.9	42.3	77.5	37.3
Czechoslovakia	31.5	22.5	37.3	62.9	33.9
Greece ^b	119.3	67.3	162.9	43.1	69.1
Portugal ^b	89.0	34.2	133.1	27.4	69.0
Soviet Union	76.3	33.4	36.0	70.2	47.7
Turkey	218.8	184.4	173.2	118.6	118.2

^aCalculation of the gross domestic product percentage changes on the basis of constant (1980) United States dollars. Bulgaria, Czechoslovakia and Soviet Union data refer to percentage changes 1970-1983 of the gross national product.

^bTransport data only take railway transport data into account.

Source: Jänicke et al.

Of all the industrialized countries investigated by Jänicke et al., Sweden went through the most rapid structural change. The drastic reduction in cement production (– 41 per cent), the decreasing use of crude steel (– 38 per cent), and the decrease in the weight of freight transport (– 21 per cent) add up to notable environmental gratis effects or “absolute structural improvement”.

In Japan, the de-linking process was partly neutralized by the rapid growth in industrial production and thus resulted only in “relative structural improvement”.

In Czechoslovakia, no significant de-linking of economic growth from the four input factors took place. The development profile of this country, with sluggish structural change, is to some extent representative of the other economies of Eastern Europe.

Trends towards industrial restructuring

Despite certain analytical limitations of such empirical research (as, for example, the selection of only four input factors), several conclusions can be drawn from this international comparison as regards the trends of industrial restructuring:

- (a) Structural change in the form of de-linking economic growth from environmentally relevant inputs was evident in most, but not all, the countries studied;
- (b) Several countries enjoyed environmental gratis effects as a result of active structural change. In some cases, especially Sweden, these effects were quite considerable;
- (c) In other countries, the possibly beneficial environmental effects of structural change were levelled off by the rapid industrial growth pursued. This was especially true for Japan;
- (d) The strong correlation between the level of production (GDP) and environmental impacts, still evident in the 1970s, had dissolved in the 1980s. The high-income countries featured fairly rapid structural change;

- (e) In the medium-income countries, a distinct pattern emerged in that there were cases of rapid quantitative growth and cases of qualitative growth, i.e., economic growth with constant or decreasing resource input.

All in all, it is therefore not yet possible to speak of one dominant trend towards industrial restructuring. However, the environmental gratis effects of active structural change are highly evident and thus provide one strategic element of the ecological modernization of industrial society.

II PREVENTIVE ENVIRONMENTAL POLICY

Theoretically speaking, environmental policy may be defined as the sum of objectives and measures designed to regulate society's interaction with the environment as a natural system; it comprises aspects of rehabilitation, conservation, and structural adjustment. Practice, however, does not conform to such a broad definition. Only parts of the interaction between society and environment become the subject of policy. So far, environmental policy has been designed mostly as react-and-cure strategies concerning air and water pollution, noise, and waste, with emphasis on the rehabilitation aspect.

For a variety of reasons, this conventional environmental policy was, and still is, meaningful and very necessary. It has, however, a number of deficits, some of which are cited in the following, along with some suggestions for overcoming them through preventive environmental policy, i.e., anticipate-and-prevent strategies.

Environmental expenditures and environmental damages

Since the beginning of the 1970s, when systematic records first began to keep track of the funds allocated for environmental protection, the sum of the respective public and private investments has reached

large proportions in the industrialized countries. Industrial society thus appears to be paying very heavily in the form of back payments for the negative environmental costs of production accumulated in the past.

In Germany, for instance, this sum has risen to about \$140 billion. In a detailed study, Leipert et al., from the International Institute for Environment and Society (IIES), have computed and classified all existing data on investments and expenditures aimed at repairing and protecting the environment.

Table 2 shows the total and sectoral environmental protection investments for the manufacturing sector of the German economy for the years 1975 to 1985.

Table 3 shows the total costs of environmental protection (current expenditures and depreciations) for both industry and government for the years 1975 to 1985.

Figures such as these are, however, ambivalent. On the one hand, they give cause for proud political statements about the successes of environmental protection, according to the motto "the more, the better". On the other hand, they are—presumably—the absolute minimum of what is necessary to secure the very basis for society's sustainability. At the same time, they symbolize a serious structural deficit of industrial society. Environmental protection expenditures are spent when damage to the natural environment has occurred and can no longer be denied. Belated, they are repairs to the process of economic growth, signs of a "post-fact" policy that reacts to damages (and must react to them) but does not, or cannot, prevent them. Therefore, it is necessary to confront the success stories of environmental protection expenditures with figures on the environmental damages themselves.

Again taking Germany as an example, a recent estimation by Lutz Wicke from the Federal Environmental Protection Agency, showed that the annual damage to the natural environment is above 103 billion deutschmarks, or in the order of 6 per cent of GNP, and not 3 per cent, as the OECD had estimated for the industrialized countries some years ago.

TABLE 2
ENVIRONMENTAL PROTECTION INVESTMENTS, MANUFACTURING SECTOR,
FEDERAL REPUBLIC OF GERMANY, 1975-1985

Year	Total investments		Waste disposal		Water pollution control		Noise abatement		Air pollution control	
	Current prices	1980 prices	Current prices	1980 prices	Current prices	1980 prices	Current prices	1980 prices	Current prices	1980 prices
	<i>In millions of DM</i>									
1975	2,480	3,090	170	210	900	1,110	200	240	1,210	1,530
1976	2,390	2,830	200	230	820	960	220	260	1,150	1,380
1977	2,250	2,560	200	230	740	850	210	230	1,100	1,250
1978	2,150	2,370	170	180	680	750	200	220	1,100	1,220
1979	2,080	2,190	260	160	760	800	200	210	960	1,020
1980	2,650	2,650	210	210	910	910	240	240	1,290	1,290
1981	2,940	2,810	250	240	950	910	210	200	1,530	1,460
1982	3,560	3,250	390	360	1,130	1,030	230	210	1,810	1,650
1983	3,690	3,270	290	260	1,100	990	230	200	2,070	1,820
1984	3,500	3,100	270	240	1,040	920	230	190	1,960	1,750
1985	5,620	4,940	330	280	1,060	910	260	220	3,970	3,530
	<i>Average annual change in percentage</i>									
1975/84	+ 3.9	- 0.0	+ 5.3	+ 1.5	+ 1.6	- 2.1	+ 1.6	- 2.6	+ 5.5	+ 1.5
1975/79	- 4.3	- 8.2	- 1.5	- 6.6	- 4.1	- 7.9	0.0	- 3.3	- 5.6	- 9.6
1979/84	+ 11.0	+ 7.2	+ 11.0	+ 8.4	+ 6.5	+ 2.8	+ 2.8	- 2.0	+ 15.3	+ 11.4

Source: IIES research project.

TABLE 3
TOTAL COSTS OF ENVIRONMENTAL PROTECTION,
FEDERAL REPUBLIC OF GERMANY, IN MILLIONS OF DM
1975-1985

Year	Industry			Government			Industry and Government		
	Current expenditures	Depreciation	Total costs	Current expenditures	Depreciation	Total costs	Current expenditures	Depreciation	Total costs
<i>At current prices</i>									
1975	3,200	1,520	4,720	3,000	1,920	4,920	6,200	3,440	9,640
1980	5,160	2,250	7,410	4,690	3,390	8,080	9,850	5,640	15,490
1985	7,930	3,160	11,090	6,430	4,340	10,770	14,360	7,500	21,860
<i>At 1980 prices</i>									
1975	4,050	1,870	5,920	3,790	2,570	6,360	7,840	4,440	12,280
1980	5,160	2,250	7,410	4,690	3,390	8,080	9,850	5,640	15,490
1985	6,230	2,640	8,870	5,340	4,030	9,370	11,570	6,670	18,240

Source: IIES research project.

Table 4 is based on different estimation methods, using data on actual damage costs and findings from willingness-to-pay studies. Although the results must be taken with some care, the table illustrates that despite high annual environmental protection expenditures, enormously high environmental damages still occur annually. Of course, this situation may be true not only for Germany but for many other countries as well.

There are more shortcomings of conventional environmental policy. Environmental policy usually identifies the given problem too late, so that the ecosystems affected cannot survive. As it is pursued as a media-specific policy, i.e., separately regulating air and water quality, noise or waste, it also runs the risk of lacking coordination between its specific goals, measures and institutions. And this may then result in shifting a problem from one environmental medium to another, for example, from air to water or soil, or from one place to another, as is the case with long-range, trans-boundary pollution. In addition,

TABLE 4
ENVIRONMENTAL DAMAGE IN
THE FEDERAL REPUBLIC OF GERMANY
("Measurable damage" in billions of DM per year)

Environmental sectors	Environmental damage
<i>Air pollution</i>	ca. 48.0
Health hazards	2.3-5.8
Material damage	2.3+
Degradation of vegetation	1.0+
Forest blight, etc.	5.5-8.8
<i>Water pollution</i>	17.6++
Damage to rivers and lakes	14.3+
Damage to the North Sea and Baltic Sea	0.3++
Contamination of ground water, etc.	3.0+
<i>Soil contamination</i>	5.2++
Cost of Chernobyl disaster	2.4+
Rehabilitation of "yesterday's waste"	1.7
Cost of preserving biotopes and species	1.0+
Other soil contamination, etc.	0.1++
<i>Noise</i>	32.7+
Degradation of residential amenities	29.3+
Productivity losses	3.0+
"Noise rents," etc.	0.4+
Grand total of damage	103.5

Source: Wicke.

environmental policy often becomes entangled in a debate on principles. If measures must be taken quickly, the argument gets shifted from the "polluter-pays-principle"—which is advocated in general—to the "taxpayer-pays-principle", thereby switching the burden of environmental protection from the individual polluter to the community, to government or to society at large.

Thus, innovations in planning and implementation are needed. Preventive environmental policy—it seems—can counter the shortcomings of conventional environmental policy. In order to switch to

preventive policy, however, several conceptual as well as practical constraints must be overcome.

One constraint has to do with the particular history of an environmental impact. In cases of yesterday's wastes, when damage has already occurred, a curative strategy is probably the only conceivable option. In cases where no damage has occurred as yet but where damage is expected for the future, the choice between a preventive and a curative strategy is basically open. In such a situation, the anticipatory principle leads to encourage the first option. As practice often is a mixture between the existing and the new, most policies actually will also include a mixture of prevention and cure. Demanding preventive environmental policy will then mean seeking and at last finding a better balance between the anticipatory and the reactive component within the policy action.

Basic conditions for preventive environmental policy

According to Scimemi and Winsemius, one can conceive three factors as concomitant policy-relevant processes in time: the accumulation of environmental damage; the acquisition of technical knowledge; and the rise of public awareness. The time sequence of these processes, especially the relative timing of their critical level, is decisive for the whole issue of preventive environmental policy.

To illustrate the relationship between these three factors, Scimemi has redrawn a diagram suggested by Winsemius, using three separate functions: level of damage; level of technical knowledge; and level of public awareness. The relative position and the shape of these functions depends, of course, on the specific circumstances i.e., country, environmental sector, and historical phase under consideration. The accumulation of damage starts at a given point in history when neither the scientific community nor the general public is yet aware that anything of importance is happening. The process of gathering technical knowledge may not start until some time after damage has begun to accumulate and proceeds gradually. During that phase, the public may still be

unaware of the hazard. It is only some time later that public awareness starts to rise.

Within these concomitant processes, a certain stage becomes important: the technical understanding of the issue reaches a critical level, thus ensuring the first of two conditions required for effective policy action, i.e., technical rationality. Public awareness also reaches a critical level at which the second condition for effective decision-making, i. e., political viability, is fulfilled. It is at this stage that action will be undertaken to avoid the occurrence of further damage.

Recalling past developments in environmental policy at the national or the international level, it is easy to recognize that the processes evolved very much in conformity with Scimemi's theoretical interpretation.

What are now the opportunities to influence these basic conditions of policy action in favour of preventive environmental policy? Three general and two specific options emerge. The general options are: (a) retarding damage accumulation; (b) accelerating technical knowledge; and (c) increasing public awareness. The specific options are: (a) dynamic environmental standard-setting; and (b) dynamic public participation. All these various options make policy decisions possible at a stage when the level of environmental damage is still relatively low.

Environmental impact assessment as part of preventive policy

Acceleration of knowledge and awareness can, of course, be promoted through a variety of approaches and methods and depends a great deal on the specific environmental issue at hand. Environmental impact assessments (EIA) are increasingly being applied, not only for public but also for private investment projects. They entail efforts to learn more about possible environmental impacts and are intended to allow appropriate action to be taken before damage has occurred. In that sense, environmental impact assessments can be classified as part and parcel of preventive environmental policy.

During the last years, some headway has been made to institutionalize and standardize EIA procedures, nationally and, to a minor extent, internationally. As the EIA procedure is used particularly for

specific investment projects, it allows for the “accelerating effort” to be targeted and generally also permits the burden of such efforts to be imposed upon the project initiator himself, thus conforming to a precondition of preventive environmental policy, i.e., the polluter-pays-principle. A big deficit, however, remains in how to implement EIA as a preventive procedure in cases of global change, such as climate warming or ocean pollution.

The required levels regarding technical knowledge and/or public participation in environmental decision-making differ widely from one environmental medium and country to the other. The question of how much knowledge and awareness is enough normally falls upon the political decision-maker i. e., the government, the environmental protection agency, the institution in charge of the problem, even if the scientific community, or parts of it, is ready to say “we know enough” and the public, or parts of it is demanding “something must be done”. Therefore, stalemates in decision-making on environmental issues are quite frequent.

What constitutes enough knowledge or awareness for one country, government or institution, may not be enough for another. The normal outcome of such a situation is a compromise over the emission standards to be implemented. They will be weaker than technically or politically feasible because knowledge and awareness on cause-effect relationships or social priorities is said to be insufficient. Eminent cases in point are the emission standards for sulphur dioxide and nitrogen oxide in air pollution and the nitrate standard in water pollution. Thus, the dilemma of setting stricter emission standards is serious. Meanwhile, the forests may continue to die back, the ozone layer may continue to be affected, and water may continue to become contaminated.

The conclusion, therefore, is that environmental standard-setting must be conceived as a continuous process. With growing knowledge and awareness on actual and probable environmental damage the thresholds for action must be consecutively lowered, i.e., standard-setting must be dynamized so that industrial restructuring can be achieved quickly.

This need to come to terms with the future is not unique to environmental policy, as Scimemi rightly observed. Implementing the prevention principle is especially requested in all other domains of policy where collective interests are at stake. One such major domain we have to address when discussing the possibilities and impediments of ecological modernization is, of course, economic policy.

III ECOLOGY AND ECONOMIC POLICY

Conflicts between economy and ecology

C.F. von Weizsäcker has said that ecology in essence means the necessary and feasible harmony between man and nature, society and environment. In general, however, economy means disharmony with nature. Use is made of nature both directly and indirectly when raw materials are processed into products, and nature is polluted by the emissions and wastes generated by industrial production. These are, then, the two processes in which nature remains the loser: natural raw materials are exchanged for produced waste materials. Besides labour and capital, nature is the truly quiescent and exploited third production factor. How, then, can nature's position in the "economy game" be strengthened?

The use of raw materials and the generation of emissions and wastes are of course, old, not new, issues. Scientific and technological development, however, has made it possible to increase the exploitation of the depletable resources, and has led to an ever-increasing accumulation of harmful emissions and non-decomposable wastes. Nature is no longer able to absorb all of these substances, many of which are not only toxic for flora and fauna but for human beings as well.

Efforts to hide harmful emissions and toxic wastes in land-fill sites, in transfer stations or permanent depositions, to spread them through high smokestacks and incinerators, or to dump them into the water

bodies and abroad have at best been temporarily successful because many emissions and wastes are “mobile poisons” or reappear in different form. These activities lead to what Johan Galtung called the “linearization of ecological cycles,” i. e., the natural diversity is reduced, the robustness of ecosystems declines and ecological symbioses and equilibria break down. As a consequence, environmental degradation increases and the absorption capacity of the natural environment decreases.

Accordingly, the conflict between ecology and economy can be attributed to two basic principles that are actually or possibly incompatible: (a) the ecological principle of stability, as a precondition for the sustainability of ecological systems; and (b) the economic principle of growth as the inherent logic of economic systems—more precisely, the principles of business profitability, national economic growth, and world market expansion.

Given the actual and the pending ecological crisis, the question arises as to whether these economic principles can be changed, reshaped and finally brought into harmony with ecological principles, and at which level, in what way, and at what time. It is, of course, a controversial question both in theory and in practice and presents a specific challenge to the social sciences. The answer depends not only upon the respective individual and societal constellation of interests. It depends particularly upon the ability of and the willingness for social innovations, i. e., on (a) whether the potential of an ecological self-regulation of the economy is used and (b) how the option of an ecological re-orientation of economic policy is implemented.

Ecological self-regulation of the economy

Let us start with a general statement. Most certainly, only a small fraction of the current environmental problems would exist (a) had the economic contexts remained so comprehensible that producers and consumers were personally able to recognize and be liable for the consequences of their own decisions towards depleting resources and polluting nature or (b) if business profitability, national economic growth, and the expansion of world markets could not be increased by external-

izing parts of the ensuing costs. This is the old but still unresolved problem of the external effects of production. Scientific and technological development has been, and still is, coupled with negative external effects, i.e., the shifting of costs to society, future generations, and nature. With respect to the environmental problem, all these cost components are relevant. Let us take, as an example, acid rain and the ensuing damage to the forests.

First, the example of acid rain shows that a part of the costs of industrial production, i.e., the adequate reduction of air pollutants has been shifted to nature, which is resistant only up to a certain level: the forests are dying. Secondly, this example shows the shifting of costs onto succeeding generations, bequeathing a future with less or even no forests in some regions. Thirdly, this example shows the shifting of costs onto third parties (i.e., partial expropriation of the forest owners) and onto society, in the sense that economic and technical decisions of individual polluters (especially emissions from power plants, cars, trans-boundary pollution) impair the well-being and the physical health of the population.

Thus, the economic system evidently makes incorrect calculations with respect to the "ecosystem forest". Both business accounting and national accounting do not provide adequate signals to prevent pollution levels that are not tolerable for the ecological system. Conventional accounting shows favourable balances for the production of energy, for the automobile producers, and for the exporters of pollutants (just to stay with the three sources of pollution mentioned above), although the "ecosystem forest" is definitely being damaged by the emissions from these economic sectors. Losses here, profits there; compensation does not take place nor is liability provided for.

One of the pending tasks both for theory and practice can thus easily be prescribed. We should internalize the external effects of production, shift the costs back to the economic units that cause the environmental problem, and include the ecological perspective into all investment decision-making. Drastically reducing the external effects

of production on society, nature, and future generations seems to be the necessary step towards regaining harmony between economy and ecology. But, how to proceed in practice and where to put priority?

To reorganize the economy towards a materially integrated cycle would, first of all, mean to reduce systematically the use of depletable resources and the generation of polluting emissions and wastes—and this is in contradiction to the prevailing “throughput economy” as seen by K. Boulding. In practice, recycling and clean technology are still at an incipient stage and not systematic economic undertakings. In particular, the step from simply disposing wastes towards avoiding wastes (“low waste economy”) has not been made.

Certainly, this is in part because the recycling of many waste products is impossible or extremely costly. But it is also true because adequate price and cost signals have not been set. The prevention of waste generation and the conservation of depletable resources are still not being sufficiently promoted. This state of affairs, however, has also to do with the above-mentioned structural deficits of the economic accounting procedures, which do not adequately measure the diminishing stocks. Therefore, two contradictory trends can be observed: increasing monetary income and decreasing natural stock.

Proposals for ecological accounting at the factory level and in the national accounts, however, are promising. With ecological accounting, the amount of energy, materials, wastes, land use, etc., are being computed and, by simulating the given shortage, accounting units are determined and then enter the accounts. Thus, a measure is developed which not only may guide private investment decision-making, but at the same time will provide a public information instrument for promoting qualitative economic processes.

In industrial society, another ecological principle is no longer adhered to, that of the sustainability of resource use. Traditionally, forest owners, for instance, have followed the rule: do not cut down more wood than you regrow. This rule is being undermined: externally produced acid rain collides with internal resource conservation and

accumulated external debt leads to the overexploitation of national resources. The goal of sustaining the yield of the forest capital stock is being undermined by indirect expropriation and resource depletion.

One basic principle to be re-established in the economy is that of responsibility or liability. With respect to environmental problems, the legal system and economic behaviour in most countries is marked by the strict proof of causality. Only when the injured party can prove who caused the damage is the polluter held liable for compensation. Instead, statistical probability is in some countries and in some cases sufficient to obligate industry to compensate for damages as a kind of collective liability. Once this principle was established by the courts and through legislation, it quickly helped to improve environmental quality through ecological self-regulation of business activities.

In general, the liability principle would strengthen the anticipate-and-prevent strategy in environmental policy, and shift the technical solutions for environmental problems from *ex post* to *ex ante* approaches, i.e., from controlling or end-of-pipe technology towards low emission or integrated technology. To implement the principle in practice, small steps or big leaps could be taken: from continuous reporting on wastes or automatic monitoring of emissions to collective funds and strict environmental liability.

Ecological reorientation of economic policy

Confronted with serious environmental damage, conventional economic policy is increasingly being challenged. Its guiding principles, goals, instruments, and institutions are being questioned, and a new concept is emerging: ecological economic policy.

Conventional economic policy is based on the guiding principle of maximizing flows: volume of production, income, profits, turnover—the throughput economy referred to above. Ecological economy, however, is based on a different guiding principle, i.e., increasing efficiency and maintaining substance. Aspects such as environmental compatibility and resource conservation become important; structural adjustment

of products and technologies according to ecological considerations becomes the task.

Regarding goals, it seems necessary to redefine and supplement the conventional economic policy goals, especially to reassess the growth target and to include environmental stability into the catalogue of economic policy goals. The conventional policy goal indicators were developed at a time when environmental pollution was already a problem but not yet a public issue; they have not really been readjusted since. Economic growth is still being measured in terms of goods and income categories only (gross national product) while their effects on the stock and the quality of the resources (natural capital) are not adequately considered. In the conventional concept of economic growth, all monetary transactions are summed up independently of their specific function; also increasing expenditures are included that are spent solely for the necessary compensation for damage originally caused by the production process; in other words, compensatory or defensive expenditures.

Qualified goal indicators for economic policy can be defined in various ways: computations of compensatory expenditures, i.e., assessment of an environmentally related net product ("eco-national product"); combined growth and distribution indices (redistribution with growth); an integrated system of economic and environmental indicators, or an attached "satellite system".

Regarding instruments, conventional economic policy relies mainly on two instruments: variations of interest rates and variations of tax rates. From an ecological point of view, new taxes and charges are required which, to some extent, should replace traditional taxes. In a situation of structural unemployment and environmental pollution, the introduction of resource taxes such as an energy tax, emission charges on, for example, sulphur dioxide, nitrogen oxide and carbon dioxide emissions, and a definite decrease of wage taxes is called for. Such a structural tax reform would change the existing incentives in the economy towards the acceleration of resource efficiency and the increase of employment opportunities.

Economic policy manifests itself in and works through particular institutions. Therefore, an ecological orientation of economic policy also requires the creation of new institutions and the abolition or redefinition of old ones. The current debate on the negative environmental effects of decisions by the World Bank and the IMF are just a case in point. The actual and the pending environmental crisis require structural institutional reforms by which economic institutions would have to incorporate the ecological perspective. Environmental institutions would have to improve their competence and integrate assessments of environmental impact into all major economic decision-making.

Conclusion

According to these deliberations, industrial restructuring for sustainable development or “ecological modernization” is obviously a demanding concept, both methodologically and practically. Its implementation requires a far-reaching conversion of the economy, a reorientation of environmental policy, and a replenishment of economic policy. The three main strategic elements or points of departure seem to be ecological structural change of the economy; preventive environmental policy; and ecological orientation of economic policy. They reconcile the interests of man and nature, society and environment. The social sciences—economics, sociology, jurisprudence, political science, psychology—must develop further the methodological foundations and improve the institutional arrangements for a successful practical implementation of such a concept.