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ECOLOGICAL MODERNIZATION OF INDUSTRIAL SOCIETY

Three Strategic Elements

by

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papers

SUMMARY

Ecological Modernization of Industrial Society
Three Strategic Elements

Industrial society is on a course of conflict with the natural environment. Natural resources are being overexploited and the natural ecosystems are overloaded by non-digestable pollutants. Unchanged, industrial society gives no real chance to nature and provides no future for a sustainable development. Therefore, the time has come for "ecological modernization", a methodological and practical concept, focussing on prevention, innovation, and structural change towards ecologically sound industrial development, and relying on clean technology, recycling and renewable resources.

In this paper, some strategic elements of such a concept of "ecological modernization" are being discussed. Its implementation requires a conversion of the economy, a re-orientation of environmental policy, and a replenishment of economic policy. To "raise a loan with the ecology", i.e. to better understand and to make use of ecological principles, that is what matters now: "ecological structural change of the economy", "preventive environmental policy", and "ecological orientation of economic policy" seem to be the three main strategic elements to reconcile the interests of man and nature, and to provide for a better harmony between industrial society and the natural environment.

The author elaborates at some length on these three elements of a necessarily holistic and systemic policy.

CONTENTS

0. INTRODUCTION

In a contribution to a Forum on Industry and Environment, Stephan Paulus gave the following definition of the concept 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."[1]

This is, in fact, a fairly broad definition of a concept, proposed to achieve better harmony among economy, technology and ecology in industrial societies. In this paper I will, therefore, concentrate on only some aspects of such a concept. First, I would like to present some empirical evidence on the relationship between structural change of the economy and environmental impacts. Second, I shall point to some of the deficiencies of environmental policy, particularly the problem of implementing preventive strategies. Third, I shall put forward some ideas on how to integrate environmental considerations into economic policy.

1. STRUCTURAL CHANGE AND ENVIRONMENTAL IMPACTS

It is not so long ago that sheer quantity was considered to be a valid indicator of a nation's economic performance. "Tonnage ideology" and "quantitative growth" dominated in theory and practice, both in the East and the West. For a mature economy, such measures have rather become indicators of economic failure:

- In times of considerable environmental damages, high consumption of raw materials and energy is increasingly uneconomic; countries that have reduced their specific energy and raw materials consumption are today at the top of the international list of economic performance;

- resource efficiency (or "material economy") has become a major focus in the search for new ways to adjust and develop national economies.

In both East and West, planners and engineers are seeking for a solution to the problem of how to modify the traditional patterns of materials consumption. At the same time, environmental priorities play a part in such a conversion of the economy. "Harmonizing ecology and economy" relies on the premise that a reduction in the resource input of production will lead to an ex ante reduction in the amount of emissions and wastes (and also to a reduction in the overall costs of production).

In the following I will present the main results of a recent study, undertaken in collaboration with colleagues from the Free University of Berlin. Using a small set of indicators, some 31 Western and Eastern industrialized countries of both OECD and COMECON were investigated with regards to the relation between economic structure and environmental impacts.[2]

1.1 Identifying Structural Environmental Effects

In order to quantify the relation between economic structure and environmental impacts, one needs suitable information concerning the material side of production, for resource conservation by the national economy - and thus its ecological sustainability - cannot be appropriately described in such terms as income and employment generation, or final consumption. One way out of this methodological dilemma is to select a few indicators adequately describing basic features of the production process.

The international availability of environmental indicators such as emission and immission data relating to "representative" pollutants has grown recently. These indicators concern certain environmental effects of production. Our research interest, however, was for environmentally significant input factors.

In this respect, reliable information exists about the specific energy and water consumtpion or about the use of pesticides in agriculture. Especially, the Annual Reports on the Environment by several advanced industrial nations, by UNEP and the OECD contain useful information on these topics. Less substantial, however, has been the empirical research on the environmental significance of certain input factors in industrial production, or on the question of which indicators provide environmentally relevant information about the structure of national economies. Given the present state of research and statistics, only a few such indicators can be tested in a cross-national comparison of Eastern and Western countries. These are four factors whose direct and indirect environmental significance is self-evident: *energy*, *steel*, *cement*, and *the weight of freight transport* (inland surface transport by rail and road). Regarding their patterns of production and consumption these are "hard" factors, characteristic of a certain structure and stage of the economy.

1.2 Structural Change as Environmental Protection

The main hypothesis of the research was as follows: Positive environmental effects of structural change of the economy are to be expected by actively de-linking economic growth from the consumption of environmentally significant inputs (resources). Such *de-linking*, achieveable in particular via decreasing the input-coefficients in respect of these resources (or via increasing their effectiveness through better use) would

- o result in a decrease of resource consumption;
- o mean ex ante environmental protection, being cheaper than the ex post installation of pollution abatement equipment (*end-of-pipe technology*);
- o be more effective, since end-of-pipe technologies are normally designed to treat single, "outstanding" pollutants, whereas *integrated technologies* touch upon several environmental effects (pollutants) at the same time;
- o open up a full range of options for technological innovation or would itself be the result of it.

For certain types of environmental pollution, the effectiveness of structural change has already been demonstrated empirically. For example, the technical and structural changes in several advanced industrialized nations in respect to energy consumption has had greater positive environmental effects than end-of-pipe protection measures, especially regarding such critical emissions as sulphur dioxide (SO_2) and nitrogen oxide (NO_x). In Japan, for instance, where curative environmental protection measures had already remarkable effects during the 1970s, preventive energy conservation since 1979 (as a result of the second oil price hike) was particularly successful. The same can be said regarding other areas of environmental stress, as for example water pollution.

Aside from having economic advantages, structures and modes of production that reduce the specific energy and raw materials consumption thus seem to be extremely significant for protecting the environment. Examples like these also support the suggestion for introducing *resource taxes* and *effluent charges*, a policy which would accelerate respective technological and structural changes.

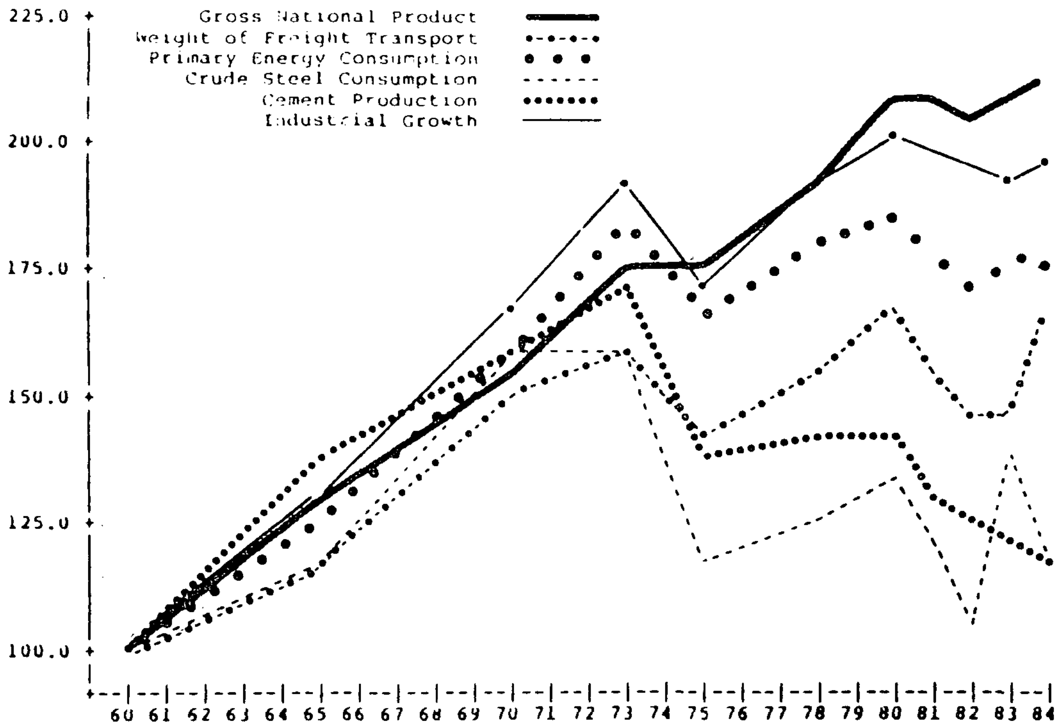
1.3 Structural Change as a Process of De-linking - The Example of the Federal Republic of Germany

Structural change as a shift of input factors to more intelligent uses can be conceived as a process of *successive de-linking*: In the course of time, the contribution of traditional (hard) input factors to the gross national product (GNP) decreases, i.e., they change or lose their function in the development process. Here, we are concerned with the environmentally most significant input factors in this process, focusing on those for which sufficient data are available for a comparative analysis.

Taking the Federal Republic of Germany (FRG) as an example, *Figure 1* illustrates a five-fold de-linking from the growth of the GNP: This de-linking of energy and steel consumption, cement production, weight of freight transport, and industrial production from the GNP became apparent early in the 1970s, and was fully established by the end of the 1970s. In this way, the structural change of the economy generated *environmental gratis effects* of various kinds:

- o The stagnating *consumption of energy* led to a reduction of various emissions (pollutants).

Figure 1: Structural Economic Change in the Federal Republic of Germany, 1960 - 1984



o The decline in the *weight of freight transport* indicates that the volume of materials employed was reduced rather than increased, i.e., the respective productivity has risen.

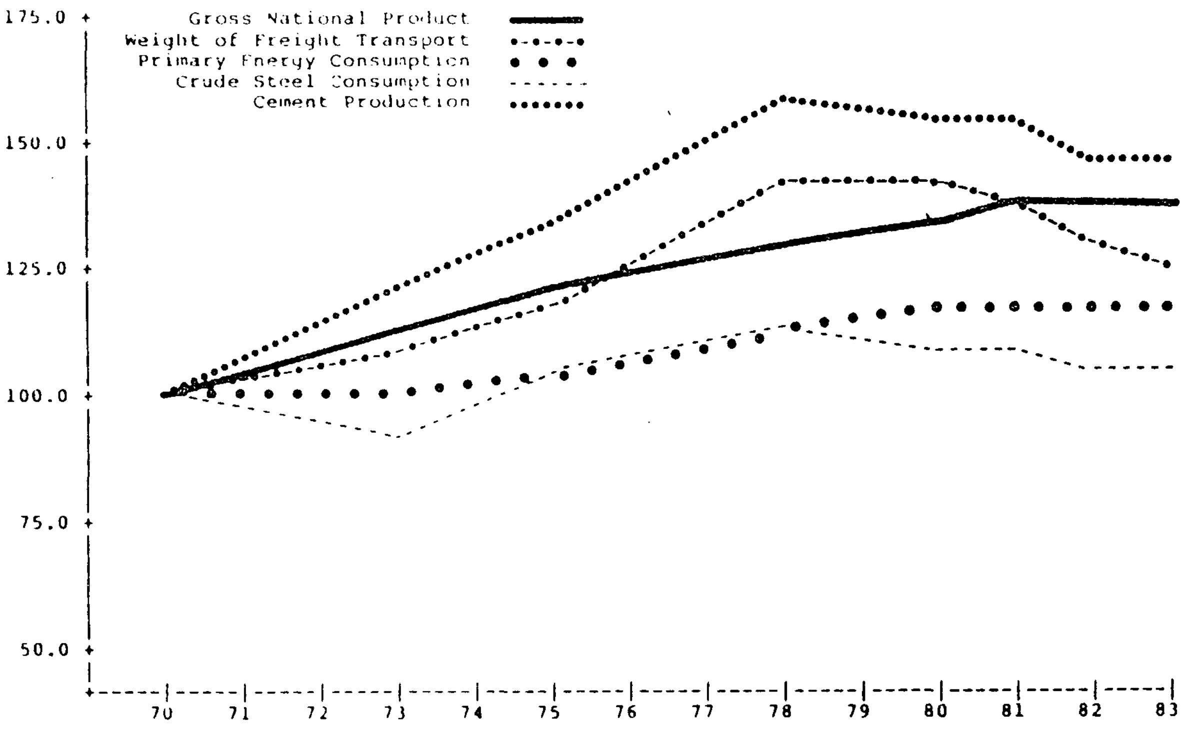
o The fall in *cement production* represents a direct gratis effect as far as the emissions from cement factories are concerned; with regard to the (otherwise environmentally disputed) construction industry, this decrease coincided with the trend towards labor-intensive renovation of the housing stock, as compared to new construction in the 1950s and 1960s.

o The decrease in *steel consumption* accounts for a considerable reduction in various emissions as far as production and processing are concerned; this drop is strongly marked, and is partly due to increased recycling activities.

1.4 Environmental Protection through Resource Economy - The Example of the German Democratic Republic

Figure 2 shows that de-linking is also significant in the case of the German Democratic Republic (GDR). Unlike the FRG, the GDR, however, has continued to rely on the industrial sector as the main source of economic growth. From the environmental point of view, then, structural change is more relevant within the industrial sector than between the industrial and the service sector (i.e., intra-industry *versus* inter-sectoral change).

Figure 2: Structural Economic Change in the German Democratic Republic, 1970 - 1983



The GDR also provides an example of structural change in the sense of "material (or resource) economy". In this country, material economy is officially defined as environmental protection, and is even considered the decisive form of environmental protection. However, a genuine relief for the environment would happen only if an *absolute* reduction of the relevant material and energy inputs occurs. The only *relative* relief for the environment reached in the GDR is, nevertheless, anything but insignificant. Especially in a period of high growth of the GNP, a just small increase in primary energy consumption indicates effective de-linking processes, and can thus be considered a success in environmental protection.

1.5 Changes in Environmental Impacts - Some East-West Comparisons

In considering the environmental impacts of various input factors, one can discern three aspects: (a) *absolute environmental impact*; (b) *impact per capita*, and (c) *impact per unit of the gross national product (GNP)*.

With regard to the absolute environmental impact (a), it is the long-term change that is important. The absolute impact, however, is unsuitable for international comparison without reference to the size of a country, its population and output. Such comparison becomes feasible by using the impact per capita (b), or the impact per unit of GNP (c).

We have tested the level of environmental impacts in 31 industrialized countries of OECD and COMECON between 1973 and 1983. For this purpose, we computed an aggregated *environmental impact index*, consisting of the impacts per capita from the consumption of primary energy and crude steel, freight transport weight, and cement production - giving equal weight to all these four input factors. The aggregation of these four indices (aggregated index) then allows to rank the countries studied.

The results of our computations are presented in *Figure 3* (for the year 1973), *Figure 4* (for the year 1983), and *Table 1* (1973 - 1983).

1.5.1 Environmental Impacts - The Price for Prosperity?

As *Figure 3* shows, there was a significant correlation between a country's per capita GNP in 1973 and the structural impacts on its environment (based on the four selected input factors). The correlation coefficient for the aggregated environmental impact index and the per capita GNP was 0.71 for all the 31 countries. This means that *in 1973* the GNP of these industrial countries primarily relied on "hard" production factors.

Countries with a high GNP per capita and with great structural environmental impacts (see left part of *Table 1*) were the United States, Czechoslovakia, Canada, Sweden, Japan, Switzerland, the FRG and Finland (rank 1 to 8). In the lowest part of the scale were Greece, Hungary, the Netherlands, New Zealand, Ireland, Yugoslavia, Portugal, and Turkey (rank 24 to 31).

During the 1970s this relationship changed to a considerable extent. The correlation coefficient *in 1983* was at only 0.33, significantly below that of 1973. (*Figure 4* shows the diversified picture.) In several industrial countries, the process of structural change drastically pushed back the "hard" production factors in the economy. Accordingly, the ranking of the countries has changed over time (see right part of *Table 1*). Several countries by 1983 had improved their international ranking considerably (see: minus signs). This was especially true of Austria and Switzerland (-10), Japan, and the FRG (-6), but most especially of Sweden (-15).

Figure 3: Scale of Structural Environmental Impacts per capita and GNP per capita, 1973

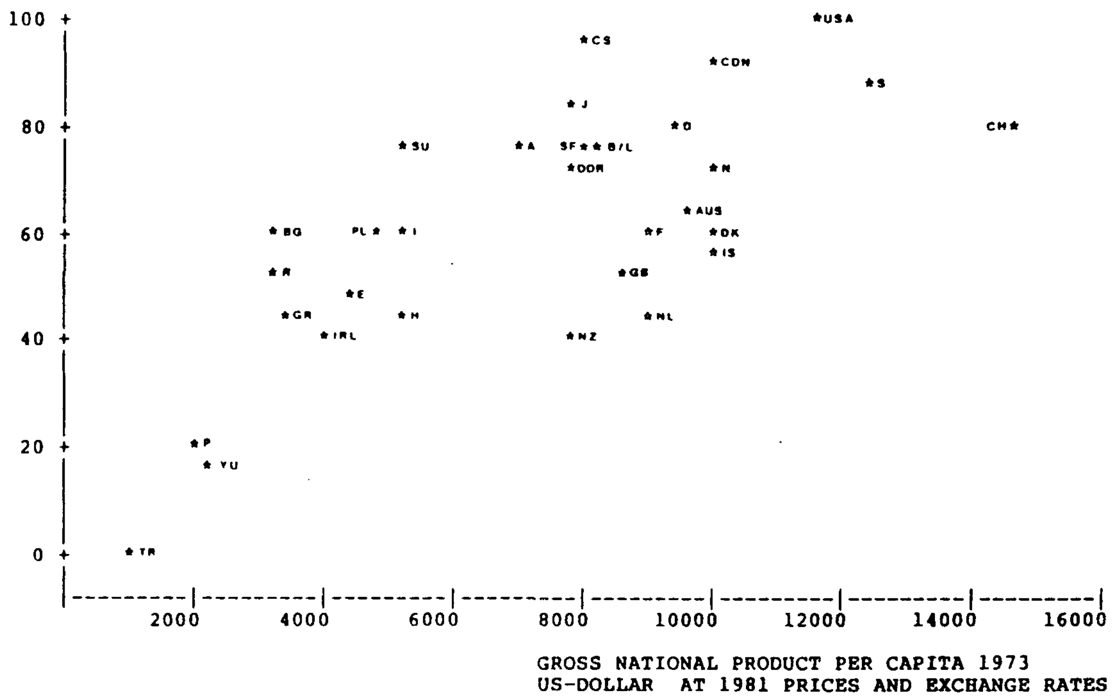


Figure 4: Scale of Structural Environmental Impacts per capita and GNP per capita, 1983

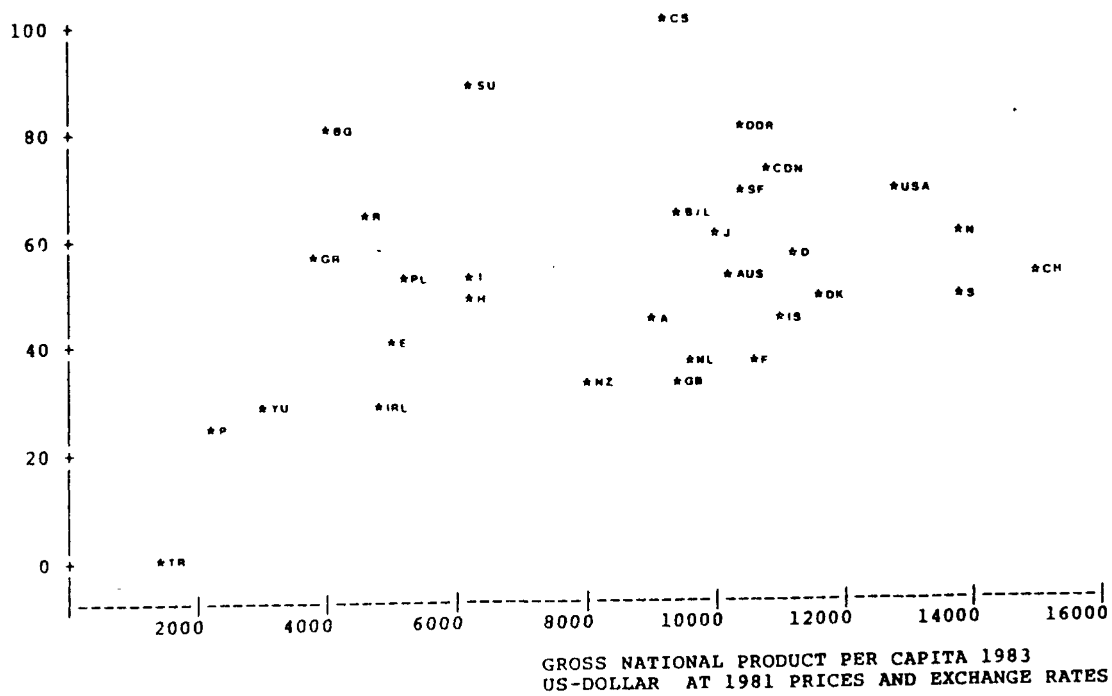


*Table 1: Ranking of Countries according to Structural Impacts per capita, 1973 - 1983**

Average placings for the indicators of cement production, weight of freight transport, crude steel and primary energy consumption

Rank 1973		Rank 1983		Diff. 1973/83
1	United States	1	Czechoslovakia	+ 1
2	Czechoslovakia	2	USSR	+ 7
3	Canada	3	German Dem. Rep.	+ 10
4	Sweden	4	Bulgaria	+ 13
5	Japan	5	Canada	- 2
6	Switzerland	6	United States	- 5
7	FRG	7	Finland	+ 1
8	Finland	8	Romania	+ 14
9	USSR	9	Belgium/Lux.	+ 1
10	Belgium/Lux.	10	Norway	+ 2
11	Austria	11	Japan	- 6
12	Norway	12	Greece	+ 12
13	German Dem. Rep.	13	FRG	- 6
14	Australia	14	Australia	0
15	Denmark	15	Poland	+ 1
16	Poland	16	Switzerland	- 10
17	Bulgaria	17	Italy	+ 1
18	Italy	18	Hungary	+ 7
19	France	19	Sweden	- 15
20	Iceland	20	Denmark	- 5
21	United Kingdom	21	Austria	- 10
22	Romania	22	Iceland	- 2
23	Spain	23	Spain	0
24	Greece	24	Netherlands	+ 2
25	Hungary	25	France	- 6
26	Netherlands	26	New Zealand	+ 1
27	New Zealand	27	United Kingdom	- 6
28	Ireland	28	Yugoslavia	+ 1
29	Yugoslavia	29	Ireland	- 1
30	Portugal	30	Portugal	0
31	Turkey	31	Turkey	0

* Ranking is based on the aggregated environmental impact index. *Plus signs* signifiy a decline in a country's position, while *minus signs* signify a country's improved ranking.

In contrast, the ranking of several East European countries had deteriorated by 1983 (see: plus signs). This was especially true of Romania (+14), Bulgaria (+13), the GDR (+10), Hungary (+7), and the USSR (+7). Thus, Bulgaria, Romania, and the GDR have joined the group of the eight countries (out of the thirty-one in the sample) with the highest structural environmental impacts. Western countries show up in the fifth (Canada), sixth (United States), and seventh (Finland) positions. Japan and the FRG, despite their improvement in their ranking are still in the top half of the scale. The position of Greece has remarkedly deteriorated (+12), while for Norway and the Netherlands there were only minor changes (+2) in their respective ranking.

The fact that *in 1973* advanced Western industrialized nations occupied leading positions regarding environmental impacts per capita is not surprising. At that time Sweden, Japan, and the United States had only begun to recognize the need for sweeping environmental protection measures. The fact that *in 1983* Czechoslovakia was leading the list indicates - by contrast - the problems of that country's economic structure. In the CSSR, energy consumption per unit of GNP is more than 50% higher than in other countries; similarly, the specific steel consumption is nearly twice that of countries with comparable GNP levels.

1.5.2 Environmental Impacts - Lessons on the Way to a Mature Economy?

Above, the (positive) relation between environmental impacts per capita measured according to four selected indicators (energy consumption; steel consumption; cement production; weight of freight transport) and the GNP was investigated; the relation became weaker during the 1970s. This observation now has to be complemented by an examination of the impacts per unit of GNP.

Figure 5: Scale of Structural Environmental Impacts per unit of GNP and GNP per capita, 1983

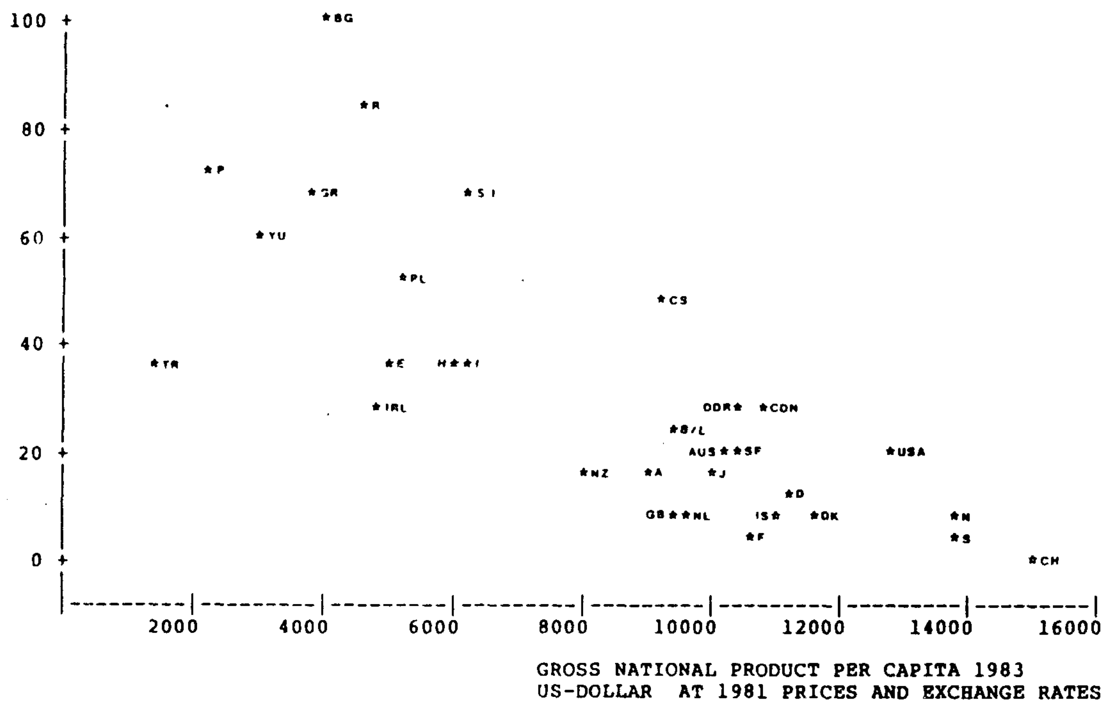


Figure 5 shows that the environmental impacts per unit of GNP are lower the higher the per capita GNP is. This (negative) relation is not surprising. With growing prosperity, the economy becomes based on other ("soft") input factors. This finding may be termed the *"law of decreasing returns from hard production factors"*. In some countries, however, structural change in this sense did not begin to exert its full effect until the beginning of the 1980s, in others it has not yet begun at all. This means that a great variation exists as to the direction of the structural change of the economy.

The conclusion of this research then may be read as follows: The cross-national analysis for the year 1983 proves that a high level of environmental impacts per capita of population is no longer strictly connected with a high level of GNP. The advanced industrial nations have for the most part moved into the range of medium environmental impact levels. From a certain point of time onwards, a nation's prosperity can grow primarily from soft production factors - and, as will be shown, from innovative environmental policies. This hypothesis, being known from the theory of "post-industrialism", through our research has been verified from an environmental perspective.

1.6 Typology of Environmentally Significant Structural Change

On the basis of the findings presented above it is possible to formulate a typology of environmentally significant structural change. Regarding the environmental impacts per capita, one can discern the following five groups of countries:

- o Countries with a generally low level of environmental impacts (e.g., Turkey);
- o countries with a high level of environmental impacts and (nearly) no structural change (e.g., Czechoslovakia);
- o countries with a high level of environmental impacts and remarkable structural change (e.g., the German Democratic Republic since 1979);
- o countries with a high level of environmental impacts and rapid structural change, employing predominantly curative (reactive) environmental protection measures (e.g., Sweden);

- o countries with a low level of environmental impacts and rapid structural change, favoring preventive (anticipatory) environmental policy (e.g., the Netherlands).

In the preceding discussion, the environmental gratis effects from structural change of the economy were defined. It may be useful to elaborate a bit further on this element of ecological modernization.

Environmental gratis effects occur, when the rate of usage of the input factors (resources) having an impact on the environment remains below the growth rate of the GNP. When comparing the rates of usage of the four selected input factors (energy consumption, steel consumption, cement production, weight of freight transport) with the growth rate of the GNP, three different patterns emerge:

- o The factors having impacts on the environment decline absolutely; i.e., *absolute structural improvements* are induced, corresponding to absolute environmental gratis effects.

- o The factors having impacts on the environment remain stable, or increase, but with a lower growth rate than the GNP; i.e., *relative structural improvements*, corresponding to relative environmental gratis effects.

- o The factors having impacts on the environment increase at a higher growth rate than the GNP; i.e., *structural deterioration*, corresponding to negative environmental effects of economic growth.

In *Table 2*, 16 out of the 31 countries in the sample are grouped according to these three patterns.

*Table 2: Environmental Effects of Structural Change - Percentage Changes, 1970 - 1983**

Country	Consumption of Primary Energy	Consumption of Crude Steel	Cement Production	Weight of Freight Transport	GNP ***
Group 1: Absolute Structural Improvements					
Denmark	-17.4	5.0	-36.4	- 6.5	32.7
France	7.0	-35.4	-15.5	-14.2	46.3
FRG	8.2	-26.6	-22.8	- 1.9	32.7
United Kingdom	- 3.9	-44.8	-22.0	-16.0	24.3
Sweden	-16.4	-40.7	-45.0	-25.3	20.3
USA **	- 1.9	-25.8	- 6.9	-17.3	39.5
Group 2: Relative Structural Improvements					
Austria **	9.5	-32.0	- 0.2	1.5	49.7
Finland	15.2	14.0	5.6	14.1	50.9
Japan	21.4	-14.7	41.4	7.5	76.7
Netherlands	53.7	-40.0	-18.9	11.4	31.6
Norway	34.8	-10.3	-39.6	27.7	62.5
Group 3: Structural Deterioration					
Bulgaria	56.6	37.9	53.8	76.7	36.9
Czechoslovakia	25.3	25.6	41.9	65.8	33.7
Greece **	120.1	126.5	191.3	16.7	56.2
Portugal **	107.0	101.8	155.1	4.7	49.7
Turkey	110.8	135.8	113.3	116.1	87.6

* Steel consumption data refer to the years 1970-1982 only.
** Transport data only take railway transport into account.
*** GNP data are on the basis of constant (1981) dollars.

Of all the industrial countries under consideration, *Sweden* went through the most rapid structural change (see *Figure* 6). The drastic reduction in cement production (-45%), the decreasing consumption of energy and steel (-16%, and -40%, respectively), and the decrease in the weight of freight transport (-25%) add up to notable environmental gratis effects ("absolute structural improvement").

In *Japan*, the process of de-linking was partly neutralized by the rapid growth in industrial production and thus only resulted in "relative structural improvement" (see *Figure 7*).

Among the Western industrial nations, countries with low levels of GNP are still to be characterized by quantitative (high-volume) growth. This is true for *Turkey* and *Portugal*, still being in an early stage of industrialization, and also for *Greece*.

In *Czechoslovakia*, no significant de-linking of economic growth from the four input factors was discernible; some of them even increased (see *Figure 8*). The development profile of Czechoslovakia, with sluggish structural change, is to a large extent representative of the other countries of Eastern Europe.

The group of countries characterized by "structural deterioration" consists for the most part of industrial late-comers. But with Czechoslovakia, it is a relatively old industrial nation which suffers high environmental impacts.

Figure 6: Structural Economic Change in Sweden, 1970 - 1983

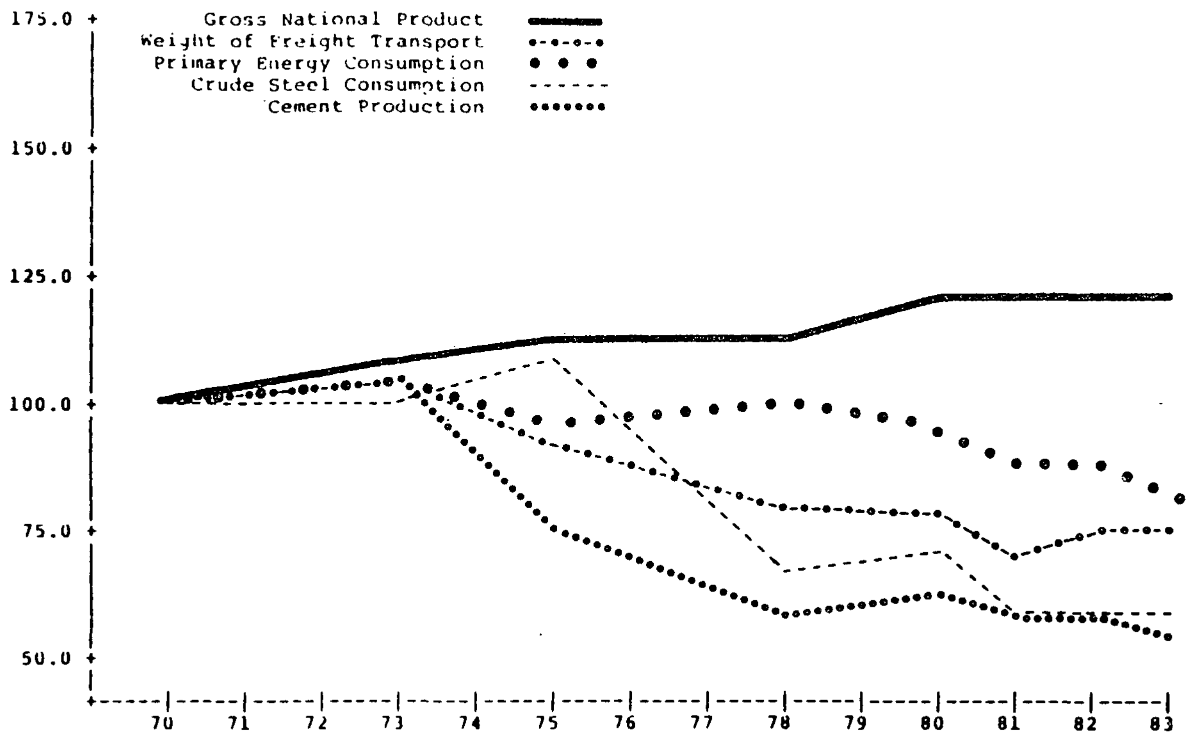


Figure 7: Structural Economic Change in Japan, 1970 - 1983

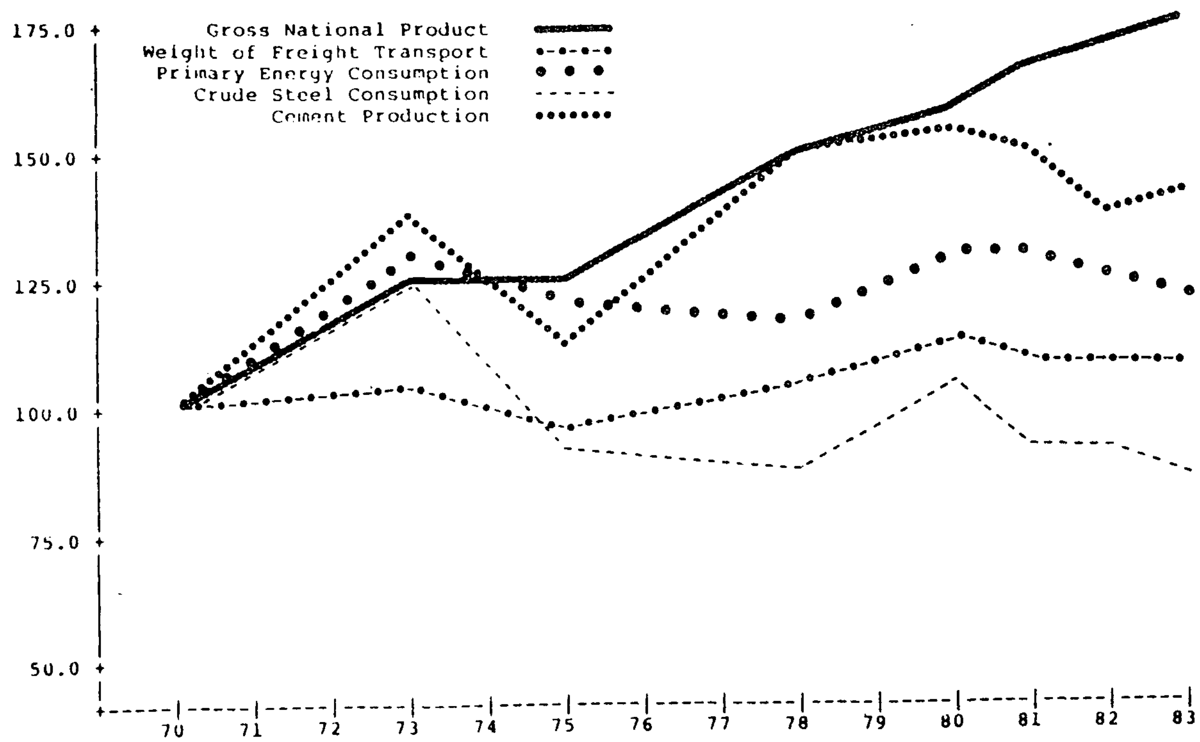
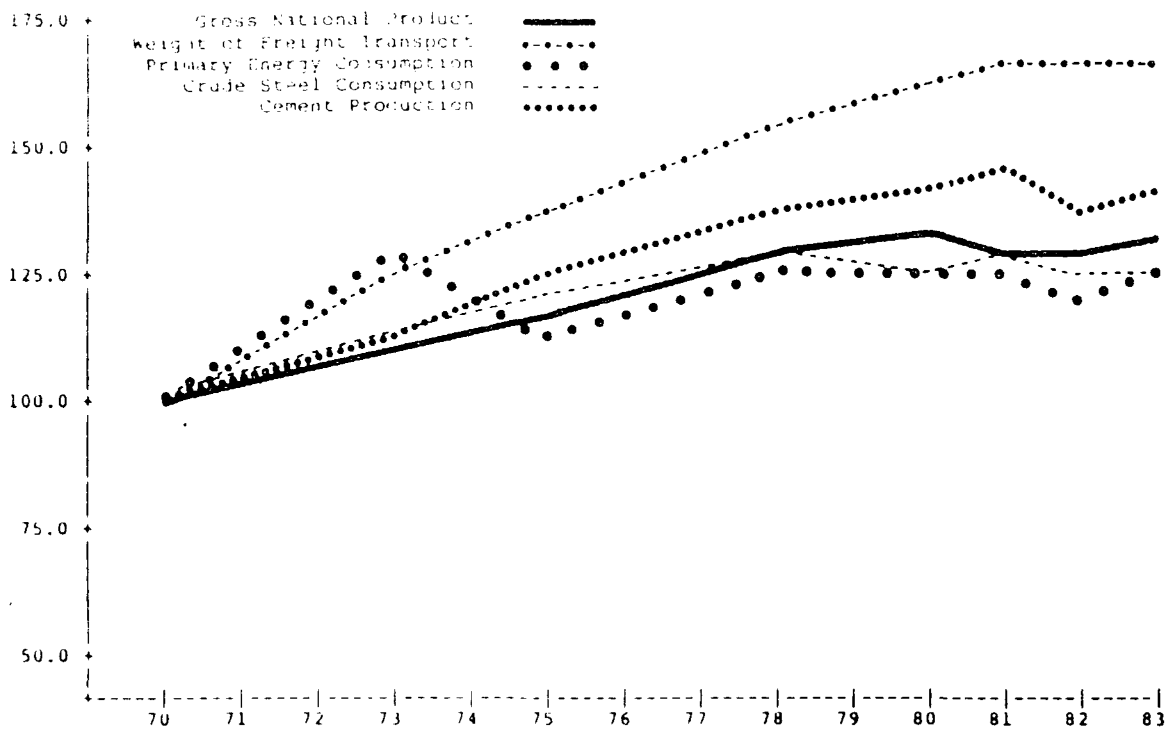


Figure 8: Structural Economic Change in the CSSR, 1970 - 1983



1.7 Conclusions

Despite certain analytical limitations of the empirical analysis (as e.g., the rather arbitrary selection of only four input factors), several conclusions can be drawn from an international comparison of the relationship between economic structure and environmental impacts:

- o Structural change in the form of de-linking material inputs and economic growth was evident in most but not all of the 31 industrialized countries studied. Fewer than half of these countries still clung to the traditional modes of quantitative growth.

- o Several countries enjoyed environmental gratis effects as a result of active structural change. In some cases, especially for Sweden, these effects were quite considerable.

- o In other countries, the possible positive environmental effects of structural change were levelled off by the rapid industrial growth pursued. This was especially true in the case of Japan.

- o The strong correlation between the GNP level and environmental impacts, still evident in 1973, had dissolved in the 1980s. The high income countries featured fairly rapid structural change.

- o In the medium-income countries, a distinct pattern emerged in that there were cases of rapid quantitative growth and cases of qualitative growth.

All in all, it is, therefore, not (yet) possible to speak of one dominant trend towards ecological modernization among the industrialized countries.

2. PREVENTIVE ENVIRONMENTAL POLICY

Theoretically speaking, environmental policy can 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 restoration, conservation, and structural adjustment".[3] Practice, however, does not conform to such a broad definition. Only selected parts of the interaction between society and environment become the subject of policy. So far, environmental policy has mostly been designed as react-and-cure strategies concerning the control of air and water quality, noise, and waste disposal, with emphasis on the restoration and conservation aspect.

For a variety of reasons, this conventional environmental policy was, and is still, meaningful and very much necessary. It has a number of deficits, however, 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.

2.1 Environmental Damage - Environmental Expenditures

Since the beginning of the 1970s, when systematic records first began to keep track of the funds allocated for environmental protection, in the industrialized countries the sum of the respective public and private investments has reached large proportions. In the Federal Republic of Germany (FRG), for instance, this sum has come to the handsome total of over 200 billion Deutschmarks (or about 125 billion US-dollars). The industrial society thus appears to be paying through the nose - backpayments for the negative environmental costs of production accumulated in the past.[4]

In a detailed study on the FRG, we have computed and classified all existing data on investments and expenditures aimed at repairing and protecting the environment. *Table 3* shows the total and sectoral environmental protection *investments* for the manufacturing sector of the German economy for the years 1975 to 1984, in current and constant (1980) prices, and also the respective growth rates for three time periods.

Table 4 shows the total environmental protection *expenditures* (investments and current expenditures) for both the manufacturing sector and the state, again in current and constant prices.

Table 3: Environmental Protection Investments in four Environmental Media, Manufacturing Sector, FRG, 1975 - 1984

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
	In Millions of DM									
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	160	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
	Average Annual Change in %									
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: Current IIES research project.

Table 4: Environmental Protection Expenditures, FRG 1975 - 1984

Year	Industry		Government		Industry and Government	
	Current prices	1980 prices	Current prices	1980 prices	Current prices	1980 prices
	In Millions of DM					
1975	5,680	7,140	7,740	10,200	13,420	17,340
1976	6,000	7,190	8,850	10,940	14,550	18,130
1977	6,180	7,180	8,410	10,340	14,590	17,520
1978	6,390	7,200	9,780	11,470	16,170	18,670
1979	6,740	7,190	11,350	12,380	18,090	19,570
1980	7,810	7,810	12,750	12,750	20,560	20,560
1981	8,860	8,160	12,510	11,940	21,370	20,100
1982	10,110	8,820	11,890	11,130	22,060	19,950
1983	10,620	9,070	11,640	10,720	22,260	19,790
1984	10,890	9,090	11,830	10,630	22,720	19,720
	Average Annual Change in %					
1975/84	+7.5	+2.7	+4.8	+0.5	+6.0	+1.4
1975/80	+6.6	+1.8	+10.5	+4.6	+8.9	+3.5
1980/84	+8.7	+3.9	-1.9	-4.4	+2.5	-1.0

SOURCE: Current IIES research project.

Figures like these, however, are 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 long-term existence. At the same time, they symbolize a serious structural deficit of industrial society: Environmental protection expenditures are made when damage to the natural environment is unmistakeable 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 seems to be in order to confront this "success story" with an estimation on the actual yearly environmental damage in the FRG. This means not to look at the current environmental protection *expenditures* but at the probable actual *damage* to the environment. According to such a recent estimation by an economist from the Federal Protection Agency, the *annual damage* to the natural environment in the FRG is in the order of 6% of the GNP, and not 3% as the OECD had estimated for the industrial countries a few years ago (see *Table* 5).

The figures in *Table 5* are based on different estimation methods, using data on actual damage costs and findings from willingness-to-pay studies.[5] Though the results must be taken with some care, the table gives an idea that despite high annual environmental protection expenditures still enormously high annual environmental damages occur. That is, the actual annual damage to the environment is much higher than the increased private and government expenditures for environmental protection may make believe. And this situation may not only be true for Germany but for many other industrial countries as well.

Table 5: Annual Environmental Damage in the FRG, Estimation, billion Deutschmarks

Damages	Damage Costs
Air Pollution	approx. 48.0
- health damages - material damages - damages to outdoor vegetation - forest damages	- over 2.3 - 5.8 - over 2.3 - over 1.0 - over 5.5 - 8.8
Water Pollution	much over 17.6
- damages to rivers and lakes - damages to the North and Baltic Sees - damages to groundwater	- over 14.3 - over 0.3 - over 3.0
Soil Pollution	over 5.2
-Chernobyl accident costs - hazardous waste disposal - expenditures for preservation of biotops and species	- over 2.4 - over 1.7 - over 1.0
Noise	over 32.7
- decline in property value - decline in productivity - "noise compensation"	- over 29.3 - over 3.0 - over 0.4

Source: L. Wicke et al.: Die ökologischen Milliarden. München 1986.

There are more shortcomings of conventional environmental policy. To name a few: conventional environmental policy usually identifies the given problem very late; the measures it employs occasionally take place so late that the ecosystems affected can no longer be saved. As it is pursued as a *media-specific* policy, i.e., regulating air, water and soil quality, noise and waste, it also runs the risk of lacking coordination between its specific goals, measures and institutions. And this then may result in shifting a problem from one environmental medium to another, e.g., from air to water or soil, or from one place to another, as is the case with long-range, trans-boundary pollution.

In addition, environmental policy often becomes entangled in a debate on principles. If immediate measures simply must be taken, in the process of political bargaining the argument gets shifted from the *"polluter-pays-principle"* - which is advocated in general - to the *"taxpayer-pays-principle"*, thus switching the distribution of 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. With the concept of *preventive environmental policy* - it seems - one can counter some of the shortcomings of conventional environmental policy. But in order to reach a better balance between react-and-cure strategies and anticipate-and-prevent strategies, or even a full switch to preventive policy, several conceptual as well as practical constraints have to be overcome.[6]

A first constraint has to do with the particular history of an environmental impact, with the state of affairs existing when the question of choosing the best strategy arises. In cases of yesterday's wastes (in German: *Altlasten*), where damage has already occurred (e.g., when a polluting industrial plant has closed down), 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 (e.g., an investment project affecting an environmentally sensitive area), the choice between a preventive or a curative strategy is basically open. In such a situation, the anticipatory principle is clearly intended to encourage the first option.

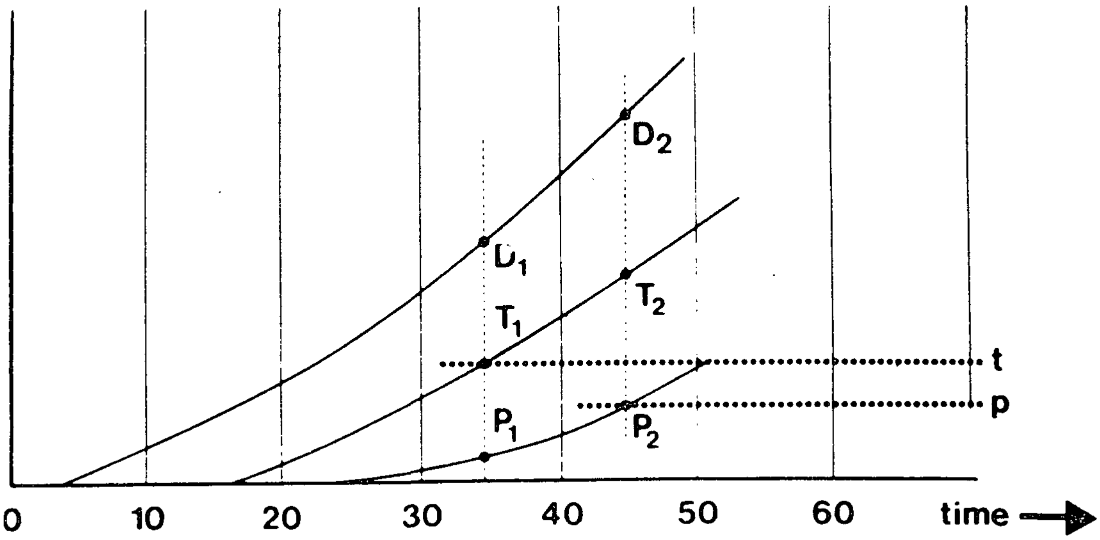
As practice is always a mixture between the existing and the new (plants, projects etc.), most policies actually will include a mixture of prevention and cure. The focus of the argument in favor of preventive environmental policy will then turn towards seeking *a better balance* between the anticipatory and the reactive component within each policy action. The direction of policy formulation and implementation could then be shifted from the reactive model towards the anticipatory one. But how to accelerate such policy shift?

2.2 Basic Conditions for Preventive Environmental Policy

According to Scimemi and Winsemius one can look at 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*, has a decisive effect on 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*, *Level of Public Awareness*.[7] The relative position and the shape of these functions depends, of course, on the specific circumstances (country, environmental sector, historical phase) under consideration. A common case (the common case?) is illustrated in *Figure 9*.

Line D_1 - D_2 indicates the *accumulation of environmental damage* over time. The accumulation of damage, be it natural or manmade, starts at a given point in history, in the diagram somewhere between time 0 and time 10. At that point, neither the scientific community nor the general public is yet aware that anything of importance is happening. Line $T_1 - T_2$ indicates the process of *gathering technical knowledge*. This process may not start until some time after damage has begun to accumulate (in the diagram somewhere between time 10 and 20), and proceeds gradually. During that phase the public is still unaware of the hazard. Somewhere between time 20 and 30, while technical knowledge increases further, *public awareness* starts to rise, as indicated by the line $P_1 - P_2$.

Figure 9: Factors of the Environmental Policy Life Cycle: Damage, Technical Knowledge, Public Awareness



Within these concomitant processes, one stage becomes important (critical level). Somewhere between time 30 and 40, as illustrated, the technical understanding of the issue reaches a critical level, *t*, thus ensuring the first of the two conditions required for effective policy action, *technical rationality*. Later on, between time 40 and 50, public awareness also reaches a critical level, *p*; at that time the second condition for effective decision-making, *political viability*, is fulfilled. It is only at this stage that action will be undertaken to avoid the occurrence of further damage.

Anyone familiar with recent developments in environmental policy at the national or the international level, will be able to recall a number of instances where the process evolved very much in conformity with Scimemi's theoretical interpretation. In this sense, the diagram may thus be considered to be a true representation of real events.

What are now the opportunities to influence the basic conditions of policy action in favor of preventive environmental policy? A look at *Figure 9* helps one to formulate five basic options:

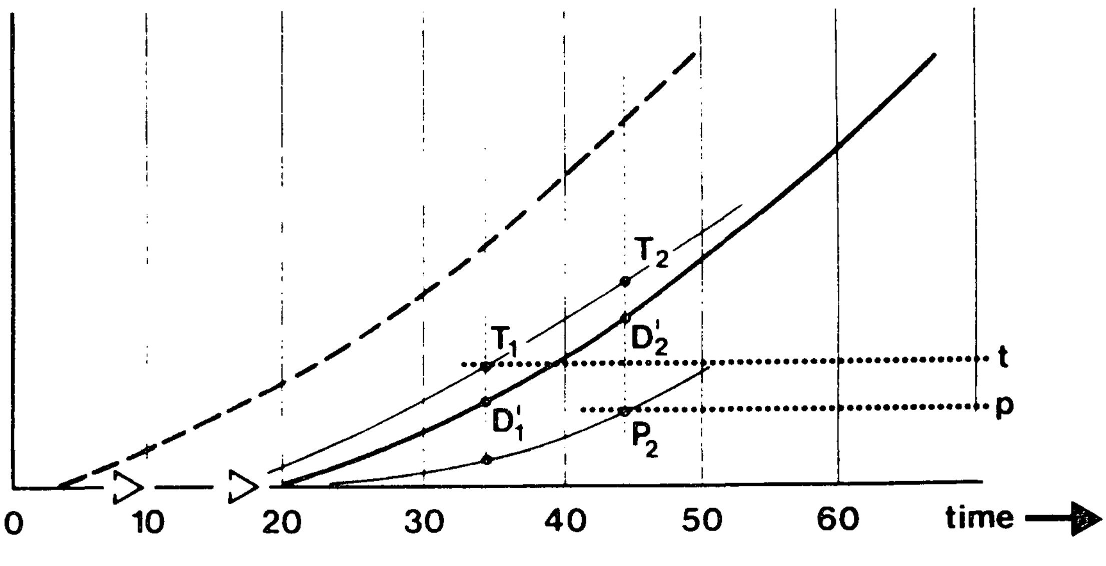
- o Delaying damage accumulation (i.e., sliding the D_1 - D_2 curve towards the right);
- o accelerating technical knowledge (i.e., sliding the T_1 - T_2 curve towards the left and/or raising its slope);
- o increasing public awareness (i.e., sliding the P_1 - P_2 curve towards the left and/or raising its slope);
- o reducing the minimum requirements in terms of technical knowledge and expertise (i.e., lowering the level of threshold t);
- o reducing the minimum requirements in terms of public awareness and participation (i.e., lowering the level of threshold p).

These various options all have the effect of making policy decisions possible at a stage when the level of environmental damage is still relatively low or damage is even non-existent. (For an illustration see *Figures 10, 11*, and *12*). In the following, I will briefly discuss these options and indicate some of the particular impediments associated with each of them.

2.2.1 Retarding Damage Accumulation

This option is illustrated in *Figure 10* (where the original D_1 - D_2 line is moved to position D_1' - D_2'). It presupposes the ability to deliberately delay damage to accumulate while counting on research and technical knowledge, or public awareness (or both) to advance at a significant pace (based on laboratory work, education, teaching, mass-media effects, etc.).

Figure 10: Retarding Damage Accumulation

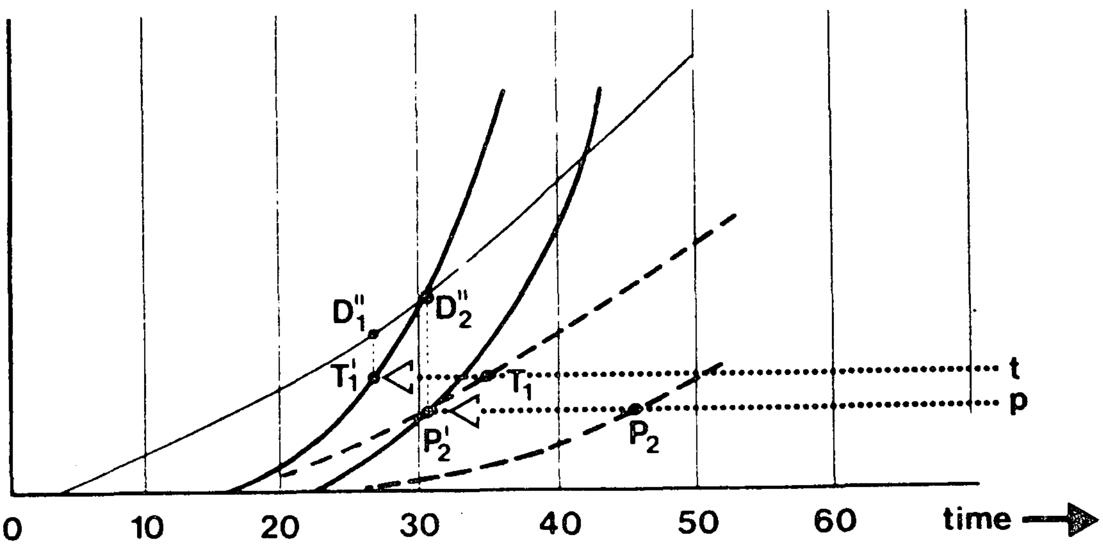


How realistic is this option? Although it is sometimes possible to postpone the commencement of a polluting activity, it will generally be much harder to interrupt such activity after it has started. Also, to retard damage accumulation normally will entail costs or the loss of economic advantages. Furthermore, it may underestimate the positive links that exist between environmental damage, technical knowledge, and public awareness; damage felt or suffered may drastically speed up the process of accelerating knowledge and awareness.

2.2.2 Accelerating Technical Knowledge and/or Public Awareness

These two options are illustrated in *Figure 11* (where both the T_1 - T_2 and the P_1 - P_2 lines have been bent upwards).

Figure 11: Accelerating the Generation of Technical Knowledge and/or the Development of Public Awareness



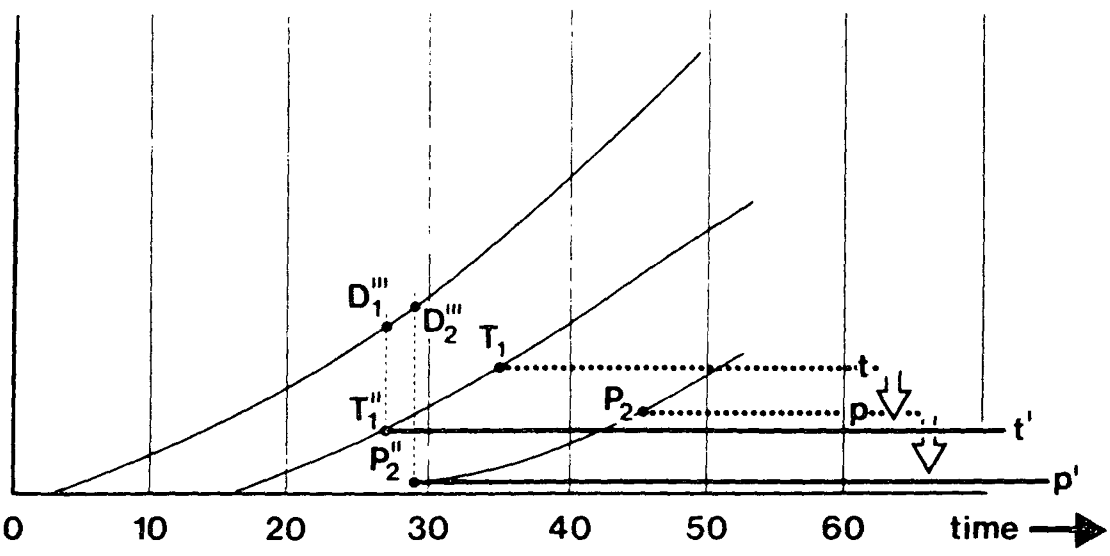
Acceleration of knowledge and awareness can be promoted through a variety of approaches and methods and depends a great deal on the specific environmental issue at hand. *Environmental Impact Assessments* (EIA) are increasingly being applied, not only for public but also for private investment projects. 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 typically anticipatory instruments or part and parcel of preventive environmental policy.[8]

During the last years, some headway has been made to institutionalize and standardize EIA procedures, nationally and to some extent also internationally. As the EIA procedure is particularly fitting for specific investment projects it allows for the "accelerating effort" to be targeted, and 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*.

2.2.3 Lowering the Thresholds for Technical Knowledge and/or Public Awareness

These two options are illustrated in *Figure 12* (where threshold lines *t* and *p* have been lowered to levels *t'* and *p'*, respectively).

Figure 12: Lowering the Thresholds for Technical Knowledge and/or Public Awareness



The required levels (thresholds) regarding technical knowledge and/or public participation in environmental decision-making differ widely from one environmental medium and country to the other. The decision, on *how much knowledge/awareness is enough* normally falls upon the political decision-maker (the European Commission, the government, the environmental protection agency), even if the scientific community (or parts of it) is ready to say "we know enough". Therefore, stalmates in decision-making on certain environmental issues are quite frequent. Eventually, this situation can be exploited by opposing agencies, parties, or nations. The dispute between the FRG and the UK on the acid rain problem is a case in point. The positions of these two countries are reversed when asbestos rather than sulphur is at issue.

What is "enough knowledge" for one country (agency, party) may not be enough for the other. The normal outcome of such a situation is a compromise over the *emission standards* to be implemented. They will be weaker than technically feasible because knowledge on cause-effect-relationships is said to be insufficient. Cases in point are the emission standards for SO_2 and NO_x in the air pollution field, or the nitrate standard in the water pollution field. The dilemma of setting uniform and stricter emission standards (i.e., to agree on lowering threshold *t* in *Figure 12*), therefore is serious. Meanwhile the forests may continue to die back, and the water may continue to get contaminated.

The conclusion therefore is, that environmental standard setting must be conceived as a continuous process. With growing knowledge on environmental damages the thresholds for action must be consecutively lowered, i.e., standard setting must be dynamized.

(The methodological problem of determining thresholds for public awareness/participation could be described very much along the same lines.)

2.3 Conclusions

A constructive approach towards promoting preventive environmental policy and/or reaching a better balance between reactive and curative strategies is not to ignore existing constraints. One such constraint is to prove that preventive decisions are indeed timely. A second constraint is linked with the very advantage of preventive decisions: their implementation before damage occurs, i.e., before the painful educational experience of suffering environmental pollution. A third constraint stems from the fact that prevention depends on a certain forecasting capability. However, the advantages of prevention in terms of resource savings, sparing of efforts, and avoiding definite damage to the environment should be greater than the disadvantages of marginal forecasting failures.

This need to come to terms with the future is not unique to environmental policy, as Scimemi rightly observes. 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 the concept of *ecological modernization* is, of course, economic policy.

3. ECOLOGY AND ECONOMIC POLICY

3.1 Interrelations and Conflicts between Economy and Ecology

"Ecology in essence means the necessary and feasible harmony between man and nature, society and environment." (C.F. von Weizsäcker). Economy, however, in general means disharmony with nature. Use is made of nature both directly and in-directly when raw materials are processed into products, and nature is polluted by the emissions and wastes generated by production. These are, then, the two processes in which nature remains the loser. She exchanges natural raw materials for produced waste materials. Besides labor and capital, nature is truly a quiescent exploited third production factor. How can nature's position in the "economy game" be strengthened, her rights guaranteed and her protection provided?[9]

The use of raw materials and the generation of emissions and wastes are, of course, old issues. Scientific and technological development, however, has made it possible to increasingly exploit the depletable resources, and has lead to an 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 nature but for human beings as well.

Efforts to hide harmful emissions and toxic wastes - in dumping sites, in intermediate or permanent storage places, to spread them - through high smokestacks, or to dump them - into the water, have at best been temporarily successful because many emissions and wastes are "mobile poisons". One result of this process is what Johan Galtung called the *"linearization of ecological cycles"*, i.e., the natural diversity is reduced, the robustness of ecosystems declines, ecological symbioses and equilibria break down. As a consequence, environmental pollution increases and the absorption capacity of the natural environment decreases.

Accordingly, the conflict between ecology and economy can be attributed to two (actually or possibly) incompatible basic principles: The ecological principle of *"stability"*, as a precondition for the sustainability of ecological systems, and the economic principle of *"growth"*, as the inherent logic of the 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 on whether these economic principles can be changed, reshaped and finally brought into harmony with ecological principles, on which level, in what way, and at what time, is, of course, a controversial question in both theory and practice. The answer depends, first, upon the respective individual and societal constellation of interests. The answer also depends upon the ability of and the willingness for social innovations, i.e., on (a) whether the possibilities for an ecological self-regulation of the economy are used, and (b) how the possibilities for an ecological re-orientation of economic policy are implemented.

3.2 Ecological Self-Regulation of the Economy?

To start with a general statement: Most certainly only a small fraction of the current environmental problems would exist if the economic contexts would have remained so comprehensible, that producers and consumers would personally be able and liable to recognize and perceive the consequences of their own decisions towards depleting resources and polluting nature. Or, if business profitability, economic growth, and the expansion on world markets could not be increased by externalizing parts of the ensuing costs. This is the old but still relevant - because 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 components of external effects are relevant.

Let us take the pollution of the *"ecosystem forest"* as an example of strong public debate in Europe:

- o First, this example shows the shifting of a part of the costs of production, i.e., not sufficiently reduced air pollutants, onto nature, which is resistant only up to certain levels: the forests are dying.

- o Second, this example shows the shifting of costs onto the succeeding generations, i.e., a future with less forests, and limited reproduction capacity of the soil.

- o Third, 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.

The economic system thus evidently makes incorrect calculations with respect to the "ecosystem forest". Both business accounting and national accounting do not provide sufficient and adequate signals which may prevent pollution levels that are not tolerable for the ecological system. Conventional accounting shows favorable balances for the production of energy, for the automobile producers, and for the pollutant exporters (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. Loss here - profit there, compensation does not take place nor is it planned.

One of the pending tasks thus can easily be described: "Internalize the external effects of production!" That means shifting the costs back to the economic units that cause the environmental problems, and including the "ecological component" into all investment decision-making. Undoubtedly, decreasing the external effects of production on society, nature, and future generations would be an important step towards regaining harmony between economy and ecology. But, how to proceed in practice?

To organize the economy as an *integrated cycle*, as recycling in the broadest sense, would mean to reduce systematically the use of depletable resources and the generation of polluting emissions and wastes - and this is in contradiction to an economy being organized for quick throughput. In practice, recycling is still at an incipient stage (with glass and paper wastes, used tires and batteries) and not a systematic economic undertaking. The step from simply disposing waste towards an integrated waste management has not yet been made.

Certainly, this is in part because many waste products cannot be recycled or only at high cost. But it is also true because the right price and cost signals have not been set. Preventing waste generation and conserving resources are not sufficiently being promoted. And lastly, it has also to do with the structural deficits of the economic accounting procedures which do not adequately measure the diminishing stocks. The outcome may consist of contradictory trends: *increasing monetary income - decreasing natural stock.*

Approaches towards *ecological accounting* at the factory level and integration of environmental aspects into the *national accounts* are promising and have been sufficiently tested. With ecological accounting the amount of energy, materials, wastes, and land use are computed and, by simulating the given shortage, accounting units are determined which then enter the accounts. Thus a measure is developed which not only may guide private investment decision-making, but at the same time provide a public information instrument for determining and promoting qualitative economic processes.

A second ecological principle is no longer valid in modern industrial society, that of the *sustainability of resource use*. Traditionally, forest owners have followed the rule "Do not cut down more wood than can be regrown". This rule is now being undermined: externally produced "acid rain" collides with internal resource conservation. Sustaining the yield of the forest capital is being replaced by indirect expropriation. Nature fights back by dying. How should society respond?

One basic principle to be re-established for the various sectors and units of the economy is that of *responsibility and liability*. With respect to environmental problems, the legal system, and also economic behavior, in most countries is marked by the strict proof of causality. Only when the injured (damaged party) can prove who caused the damage (polluting party) then the polluter is held liable for compensation. Instead, in some countries - for example in Japan - statistical probability is sufficient for obligating industry to compensate for damages (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 addition, it strengthened the anticipate-and-prevent strategy in environmental policy, and shifted the technical solutions for environmental problems from ex-post to ex-ante solutions, i.e., from *controlling or end-of-pipe technology* towards *low emission or integrated technology*.

To implement the principle of responsibility (and liability) 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.

3.3 Ecological Re-Orientation 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. Kenneth Boulding fifteen years ago called this the "throughput economy". Instead, he demanded the "spaceship economy". Writing today, he probably would speak of the "ecological economy". This paradigm is based on a different guiding principle: "Increasing efficiency and maintaining substance!" Aspects such as environmental compatibility and resource conservation become important, and structural change of products and technologies according to ecological considerations becomes the task.

With respect to the *goals*, it seems necessary to redefine and supplement the conventional economic policy goals, especially to re-assess the growth target and to include "environmental stability" into the catalogue of economic policy goals.[10] The conventional policy goal indicators were developed at a time when environmental pollution was already a problem but not yet a public issue, and since then they have not really been readjusted. Economic growth is still being measured in terms of goods and income categories only (GNP - Gross National Product), while the effects of this on the stock and the quality of the resources (natural capital) are not or not adequately considered. In the conventional concept of economic growth, all monetary transactions are summed up independent of their specific function, despite the fact that increasingly more expenditures are included which are solely being spent for the necessary compensation for damage previously caused by the production process ("compensatory or defensive expenditures").

Better qualified goal indicators for economic policy can be established in various ways: through computations of the compensatory expenditures, i.e., assessment of an environmentally related net product (ENP - Eco National Product); through combined growth, employment and distribution indices; through an integrated system of economic and environmental indicators.

Regarding the *instruments*, conventional economic policy relies strongly on two main instruments, variations of interest rates and of tax rates. From an ecological point of view, new taxes and charges are required which, to some extent, may replace the traditional taxes. Highly relevant in a situation of unemployment and environmental pollution would be the systematic introduction of *resource taxes* (as e.g., an energy tax) and *emission charges* (as e.g., a charge on sulphur dioxide emissions) and a definite decrease of wage taxes. Such a structural tax reform could help to change the existing incentive structure in the economy towards accelerating resource efficiency *and* increasing employment opportunities.

Economic policy manifests itself in and works through particular *institutions*. Therefore, the ecological orientation of economic policy also requires creating new institutions and abolishing or redefining old ones. As a rule, environmental problems are not confined to the parameters of private ownership nor do they remain within given state borderlines, and environmental protection falls within the realm of competence of people, of local, national, as well as supranational institutions. Thus neither the existing civil law, nor the national governmental jurisdiction can provide adequate answers to the actual and the pending environmental crisis. A structural institutional reform is required by which economic institutions would have to incorporate ecological perspectives, and environmental institutions would have to improve their competence, and by which environmental impact assessments would become integrated into all economic decision-making.

4. CONCLUSIONS

According to what was said in the preceeding chapters, *"ecological modernization"* obviously is a demanding concept, both methodologically and practically. Its implementation requires a conversion of the economy, a re-orientation of environmental policy, and a replenishment of economic policy. To "raise a loan with the ecology", i.e., to rely on ecological principles, that is what matters: "Ecological structural change of the economy", "preventive environmental policy", and "ecological orientation of economic policy" seem to be the three strategic elements to reconcile the interests of man and nature, society and environment.

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