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## Industrial restructuring in industrial countries

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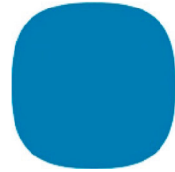
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# Industrial restructuring in industrial countries

Udo E. Simonis

## Introduction

Until recently, the role of economic or industrial change as a driving force for environmental change has not been widely explored.<sup>1</sup> This may be due in part to the difficulty of collecting suitable data and indicators with which to describe the impacts of an economic structure on the environment. In part it may be due to the fact that the level of economic development or the growth rate of the economy was thought to be more important for explaining the changes occurring in the natural environment.<sup>2</sup>

The present chapter approaches the links between the various sectors (or industries) of the economy and the overall economic performance and addresses the possible delinking of polluting sectors (or industries) from the gross domestic product (GDP); it thus views restructuring as one way towards a more efficient industrial metabolism.

Such an examination could take place on the level of the individual sector (or industry) or the aggregate level of all sectors (or industries), but also at the regional level. It should at least be undertaken for those sectors (or industries) whose environmental effects are rather certain (structural environmental impacts). This would imply a mesoeconomic, not a micro-economic, approach to understanding environmental change. Such an examination may make it possible to

assess current structural changes in economies and, on the basis of their environmental implications, may suggest future directions for environmentally benign structural policies.

The expression “structural change” or “restructuring” is generally used to characterize the decline or increase over time in certain sectors, groups of industries, or regions (and, sometimes, technologies) as regards gross national/domestic product.<sup>3</sup> One may also think of structural change in terms of a transformation in the mix of goods and services produced; or one may refer to a broader set of changes in the economy, not only in its products and employment, but also in the social relations of production (e.g. unionization, part-time *v.* full-time jobs), the means of production (handicrafts, robotics), and the forces of production (market demand, profits).

Clearly, not all possible classifications and groupings are helpful or of interest for purposes of structural research. One either has to make an explicit choice, or one has implicitly made one in using or referring to a well-known, long-established concept of structural change. In this chapter, we will use one of several concepts of structure in economics, namely the sectoral production structure – i.e. the share of sectors in the economy and their relation to gross domestic/net material product.

*Economic* restructuring thus subsumes *industrial* restructuring, though the terms are often used interchangeably. Any restructuring of the sectors (or industries) in an economy is, of course, linked to more profound changes in other realms. For our purposes, and within this concept, we will deliberately select sectors whose environmentally destructive potential is beyond question. Thus we will not consider the regional structure, the employment structure, and the investment structure, even though all of these might be quite relevant in explaining the given environmental situation of a country, or its change over time.

Regarding the temporal dimension of structural change, there is, as we will see, a differentiation to be made between *discontinuity* and *gradualism*. There is economic restructuring as a discontinuity, or a break in development, and there is gradualism as an evolutionary or slow transition. Discontinuity may be the outcome of subterranean historical processes, but gradualism is the everyday reality of change. Clearly, the two are not mutually exclusive, but rather two sides of the same coin.

As regards impacts, we use the term “structural environmental impact,” which means the environmental stress (or burden) that results

from a given sectoral production structure, irrespective of pollution-control measures in the form of *end-of-pipe* treatment.

### **Identifying indicators of environmentally relevant structural change**

It is not so long ago that sheer quantity of output was considered to be an indicator of a nation's economic success; in some circles this still seems to be the case. In Eastern Europe the importance attached to this criterion led to "tonnage ideology." In Western societies steel production and railways tonnage were once considered to be central indicators of economic success; currently housing starts, energy consumption, and the number of cars produced play this role. This accounts for the importance of the motor industry in the political arena. For a number of reasons, however, indicators of energy and materials consumption must be understood as indicators of economic failure.

Particularly in times of high or increasing costs for energy and materials, a high consumption of such inputs may turn out to be uneconomic. And countries that have drastically reduced their specific energy and materials use are today at the top of the international list of economic performance; resource use efficiency (or "materials productivity") has a major contribution to make in evolving new strategies towards sustainable development.<sup>4</sup>

No wonder, then, that economists, planners, and engineers are seeking solutions to the problem of how to modify or restructure the existing patterns of energy and materials use, to switch from "high-volume production" to "high-value production."<sup>5</sup> At the same time, this reorientation reflects new and potentially strong environmental priorities. The hope of a "reconciliation between economy and ecology" and the envisaged "industrial metabolism" relies on the premise that a reduction in the energy and material input of production will lead to a reduction in the amount of emissions and waste, and will help to facilitate the potential for recycling and promote the option of intentionally closing cycles in industrial society.<sup>6</sup>

The industrial system as it exists today is *ipso facto* unsustainable (R.U. Ayres). While the natural cycles (of water, carbon, nitrogen, etc.) are closed, the industrial cycles (of energy, steel, chemicals, etc.) are basically still open.<sup>7</sup> In particular, the industrial system starts with high-quality materials (like fossil fuels and metal ores) and returns them to nature in a degraded form.

On the basis of materials cycle analysis, it would appear that industrial society has drastically disturbed, and still is disturbing, the natural system. Ayres proposes two main criteria or measures of an approach towards (or further away from) sustainability, the recycling ratio and materials productivity. In the form of policy suggestions, this means (1) reducing the dissipative losses by near-total recycling of intrinsically toxic or hazardous materials, and/or (2) increasing economic output per unit of material input.

In this chapter, we will use a somewhat different, but comparable, approach in focusing on structural change in the economy and its environmental impact.<sup>8</sup> To assess the empirical dimensions of the harmful or potentially benign environmental effects of structural change, we need suitable information concerning the material side of production. This by itself is not an easy task, especially if we look for cross-national comparisons. Resource conservation, materials productivity, and environmentally significant structural change are not appropriately described by the monetary values used in national accounts, although national accounts and, particularly, input-output tables offer some information.<sup>9</sup> An alternative is to select indicators that act as synonyms for certain characteristics of the production process.

Certain indicators have been in the forefront of the environmental debate since it began, and the availability of data on the emission of various (representative) pollutants has grown considerably.<sup>10</sup> Our present interest, however, is on environmentally relevant input factors.

Given the state of research and data availability, only a few such indicators can be tested in a cross-national comparison of Eastern and Western economies. The results of this test thus cannot give a precise picture of the real world, but can at least offer some patterns of environmentally relevant structural change from which hypotheses could be derived for further research. We use four such factors whose direct and indirect environmental relevance is indisputable: energy, steel, cement, and the weight of freight transport.<sup>11</sup>

Energy consumption in general is accompanied by more or less serious environmental effects, and energy-intensive industries in particular pose environmental threats. Energy consumption thus is probably *the* central ecological dimension of the production pattern of a country. For similar reasons steel consumption is also a general indicator of structural environmental stress, in that it reflects an important part of the material side of industrial society. Cement consumption is in itself a highly polluting process, and cement represents to

some extent the physical reality of the construction industry. (For reasons of data availability, in the following we use the production statistics of cement only.) The weight of freight transport can be understood as a general indicator of the volume aspect of production, as nearly all kinds of transport are accompanied not only by high materials input but also by a high volume of hazardous emissions. (In the following, we use data for road and rail transport only.)

The empirical investigation covers the period from 1970 to 1987 and includes 32 countries from the East and West, i.e., nearly the whole industrialized world. As is well known, certain methodological

**Table 1 Data sources**

Energy consumption	International Energy Agency (IEA), <i>Energy Balances of OECD Countries 1970–1985 and Main Series from 1960</i> ; Department of International Economic and Social Affairs of the United Nations, <i>Energy Statistics Yearbook</i> , <i>Yearbook of World Energy Statistics</i> , and <i>World Energy Supplies</i>
Steel consumption	Statistical Office of the United Nations, <i>Statistical Yearbook</i> ; Statistical Bureau of the United States, <i>Statistical Abstracts of the United States</i>
Cement production	Statistical Office of the United Nations, <i>Statistical Yearbook and Monthly Bulletin of Statistics</i>
Freight transport	Economic Commission for Europe of the United Nations, <i>Annual Bulletin of Transport Statistics for Europe</i> ; International Road Federation (IRF), <i>World Road Statistics</i> ; International Railway Federation (UIC), <i>International Railway Statistics</i>
Population	Organisation for Economic Cooperation and Development (OECD), <i>Labour Force Statistics 1965–1985</i> ; Statistical Office of the United Nations, <i>Demographic Yearbook</i>
Domestic product <sup>a</sup>	United States Statistical Yearbook, <i>Comparative International Statistics</i> ; Statistical Bureau of the United States, <i>Statistical Abstracts of the United States</i> ; Organisation for Economic Cooperation and Development (OECD), <i>Main Economic Indicators and National Accounts of OECD Countries</i>

a. The economic performance of the Eastern European countries is expressed in GNP or GDP terms as published in the *Comparative International Statistics* of the United States Statistical Yearbook. For calculating the GNP in US dollars, the constant GNP values were determined and then adjusted according to the East–West differences in calculation method. The conversion into US dollars is based on the exchange rates published by the World Bank. For the countries of Eastern Europe this method of calculating the GNP or GDP results in a somewhat lower growth rate than that given in their respective national statistics; nevertheless, the method of calculation employed here seems to be fairly realistic.

problems arise when comparing data on the national (domestic) product of Eastern and Western economies.<sup>12</sup> For the purposes of this study, we relied on the data given in the *National Accounts of OECD Countries*, on data from the Statistical Office of the United Nations, and on other well-established data series, as specified in table 1.

### **Structural change as environmental relief**

The harmful as well as the benign environmental effects of structural (or industrial) change and the significance of a structurally oriented environmental policy have been cited in recent literature.<sup>13</sup> According to this insight, environmentally benign effects of structural change are to be expected by actively delinking economic growth from the consumption of ecologically significant resources, like energy and materials. Such delinking, achievable in particular by decreasing the input coefficients of these resources (dematerialization, re-use, recycling) or by increasing their effectiveness (energy and materials productivity) through better use,

- would result in a decrease in resource consumption and probably also in production costs, at least in the long term;
- would mean *ex ante* environmental protection, which is cheaper and more efficient than *ex post* installation of pollution-abatement equipment (end-of-pipe technology);
- would be environmentally more effective, since end-of-pipe technologies normally treat only single, “outstanding” pollutants, whereas integrated technologies touch upon several environmental effects simultaneously; and
- would open up a broad range of options for technological innovation or would itself be the result of such innovation.

For certain types of pollution, the effectiveness of structural change has been verified empirically. For example, structural change with respect to energy consumption had more benign environmental effects than end-of-pipe protection measures, especially as regards such emissions as SO<sub>2</sub> and NO<sub>x</sub>. Several OECD reports on the state of the environment reflect this fact for a number of countries.<sup>14</sup> Changes in the energy structure, for instance, led to greater environmental protection effects than the installation of desulphurization plants. In Japan, energy conservation (and also water conservation) has been particularly successful;<sup>15</sup> conventional environmental protection has been superseded by technological and structural change.

Examples like these may support the rapid introduction of market



instruments, like resource taxes and effluent charges – a policy that would accelerate structural change and lead to economic advantages as well as to environmental relief.

## **Environmentally relevant structural change: Empirical analysis**

### **Environmental benefits of structural change**

Before dealing with the option of accelerating environmentally benign structural change in the economy, it is necessary to consider ways to describe such processes, especially with respect to international and intertemporal comparisons.<sup>16</sup>

Structural change as a continuous shift of labour, capital, and skills to more intelligent uses can also be conceived of as a process of successive delinking: the contribution of traditional factors to the national product decreases whilst the contribution of other factors increases – i.e. they tend to change or lose their function over time. This chapter is concerned with the environmentally relevant factors (sectors) in this process.

Focusing on the four factors described above, figure 1 illustrates such delinking from the growth of the gross domestic product (GDP), taking the Federal Republic of Germany as a first example. The delinking of energy and weight of freight transport from the GDP became apparent by the end of the 1970s, while for cement this process began in the early 1970s; for steel consumption, delinking had already begun in the 1960s.

In the Federal Republic of Germany, structural change generated environmentally benign effects in various ways:

- The growth of the service sector of the economy was environmentally beneficial (if transport activities are excluded from consideration), at least to the extent that it added economic value at relatively little cost in terms of energy and materials.
- The stagnating consumption of primary energy made a reduction in emissions possible, in spite of a comparatively sluggish clean-air policy in this period; the desulphurization and denitrification of the power plants came into full swing only in the second half of the 1980s. The effect of energy saving could have been even more impressive if there had not been a further increase in the consumption of electricity.
- The decrease in steel consumption accounts for a considerable reduction in emissions as far as production and processing are con-

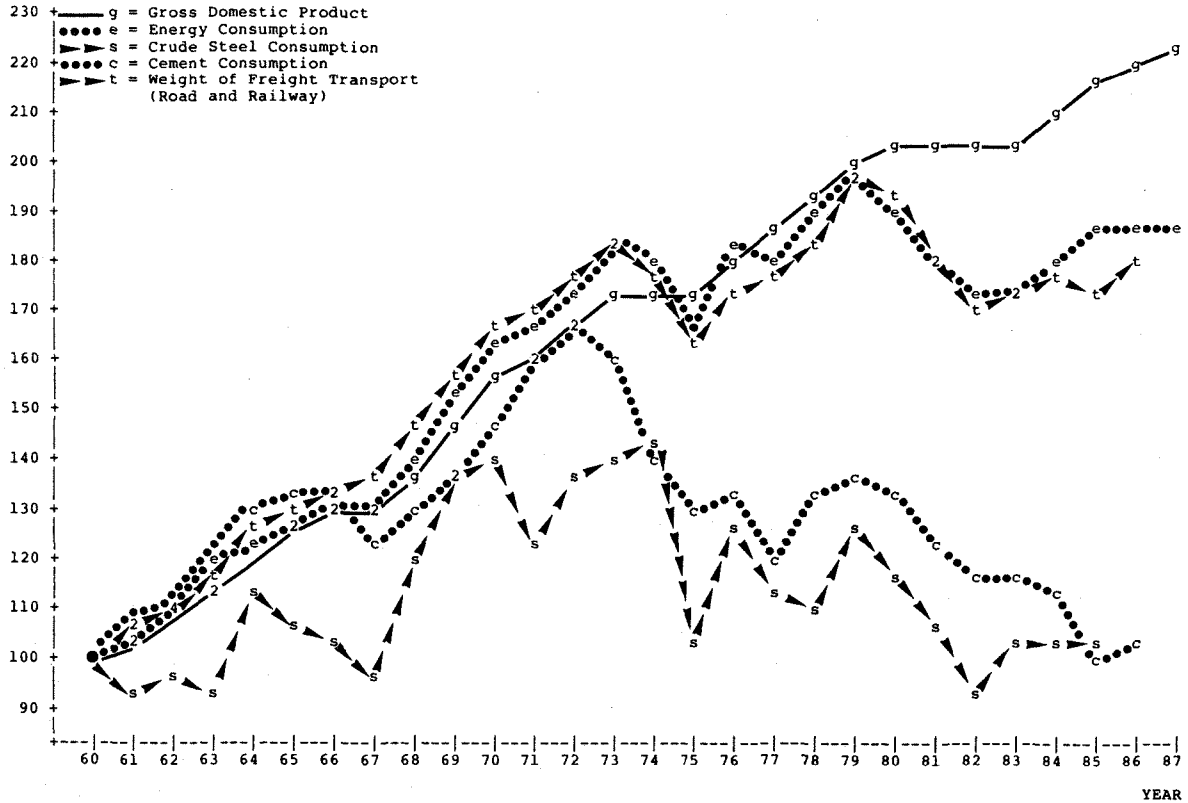


Fig. 1 Structural economic change in the Federal Republic of Germany, 1960–1987 (1960 = 100) (Source: Jänicke et al., note 8)

cerned. The drop is especially noticeable, and is partly due to an increased recycling ratio. However, such benign environmental effects may have to be compared with the harmful effects of an increased use of steel substitutes such as plastics and other materials and their inherent environmental risks.

- The fall in cement production represents a direct environmental gratis effect as far as the emissions from cement factories are concerned. With regard to the environmentally disputed construction industry, this decrease reflects a trend away from new construction towards modernization of the housing stock. (Again this trend may be reversed owing to the large construction programmes launched since the unification of Germany.)
- From the development of the weight of freight transport it can be concluded that in the period under investigation the volume of materials employed declined rather than increased, i.e. materials productivity has risen.<sup>17</sup> (Germany being a transit country, the European Single Market might possibly reverse the trend again and lead to a drastic increase in freight transport.)

Each of the sectors discussed above would of course need to be examined in greater detail, a step that cannot be undertaken here. One of the ensuing methodological questions is whether or not a different set of indicators would offer a more thorough understanding of environmentally relevant structural change in the economy.<sup>18</sup> The international comparison of the energy and materials side of nearly all the industrial countries, as well as the intention to establish a respective typology, however, seems to justify our concentration on the four indicators chosen for this study.

### Environmental protection through resource economy

Figure 2 shows that some delinking was also taking place in the (former) German Democratic Republic (GDR), though it was different in scope and time.

Unlike the FRG, the GDR long continued to rely on the industrial sector, particularly on polluting heavy industry, as the main source of economic growth, while the development of the service sector was woefully neglected. Regarding energy and steel consumption, a slow process of delinking had begun in the early 1970s, but structural change in terms of a "materials economy" was modest. While, according to political rhetoric, increased energy and materials productivity was considered to be the "most important way of reducing

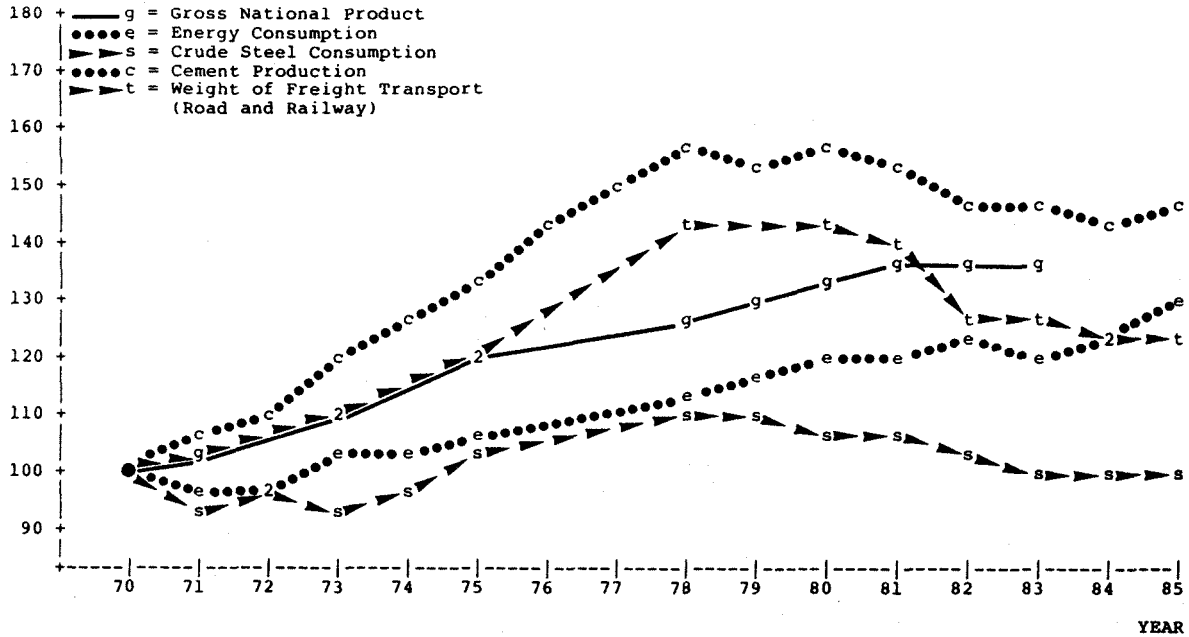


Fig. 2 Structural economic change in the German Democratic Republic, 1970–1985 (1970 = 100) (Source: Jänicke et al., note 8)

the burden on the environment,"<sup>19</sup> practice fell short in implementing this concept.

In addition, the genuine relief of environmental stress can occur only if an *absolute* reduction in the relevant energy and materials inputs is achieved. The reduction in the GDR was not very significant, even in relative terms.

### Changes in structural environmental impacts: East-West comparisons

The differing scales of GDP and of energy and materials consumption within the national economies have not yet been considered in this chapter. This, however, is important since a process of active delinking would generally be achieved more easily where energy and materials consumption were already at a high level. For active delinking, three aspects (or types) of environmental impacts of production and consumption have to be differentiated: (a) absolute environmental impact; (b) impact per capita; and (c) impact per unit of gross domestic product (GDP).

With regard to the absolute impact (a), it is the change over time that is of interest. Without reference to the size of a country, its population and output, however, the absolute impact does not lend itself to international comparisons. Such comparisons only become feasible if one uses the per capita impact (b) and/or the impact per unit of GDP (c).

In a first round, we computed an aggregated environmental impact index, consisting of the per capita impacts of consumption of primary energy and crude steel, freight transport weight and cement production for all the countries under investigation. In computing the index, equal weight was given to the four indicators, marking the deviation from the mean value of all countries for 1970 and 1985. Thus the relative position and the patterns of change of the countries can be observed. The results of the computations are presented in figures 3, 4, and 5. (The abbreviations used are the international signs for motor vehicle licences.)

As figure 3 shows, in 1970 there was a significant relationship between a country's per capita GDP and the structural impacts on its environment regarding the four selected indicators (sectors). The correlation coefficient for the aggregated environmental impact index and the per capita GDP was 0.76 for all the countries considered. This means that around 1970 the national product of the industrial

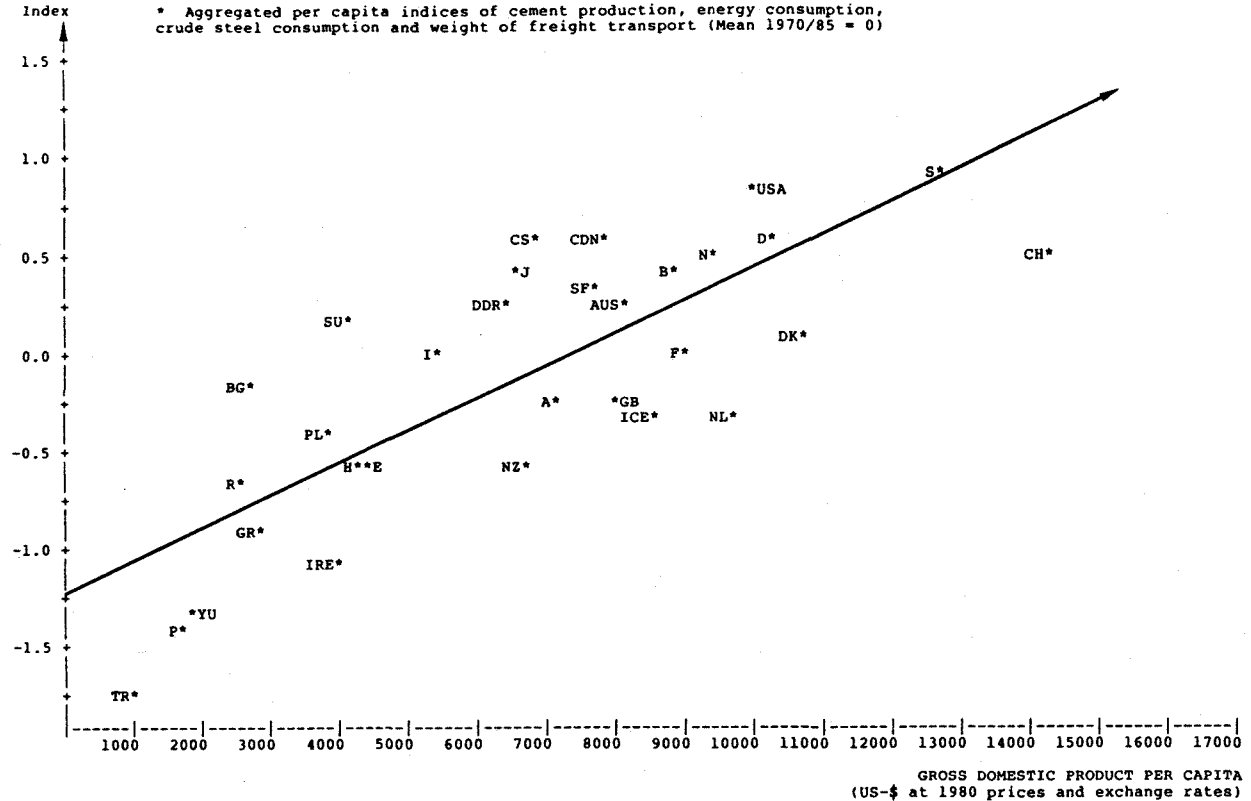


Fig. 3 Index of structural environmental impacts per capita\* and economic performance level (1970 = \*) and regression line ( $Y = 0.000170x - 1.23615/R = 0.756$ ) (Source: Jänicke et al., note 8)

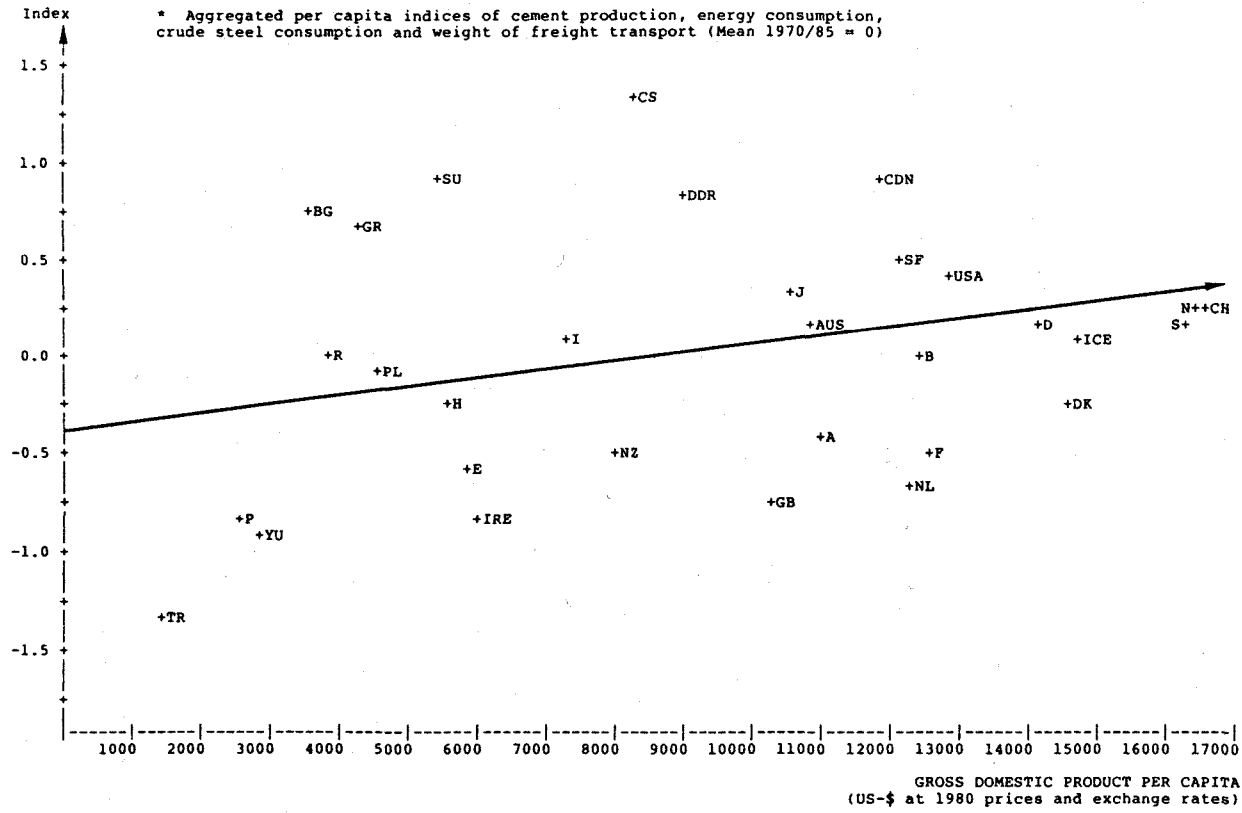


Fig. 4 Index of structural environmental impacts per capita\* and economic performance level (1985 = +) and regression line ( $Y = 0.000046x - 0.39506/R = 0.312$ ) (Source: Jänicke et al., note 8)

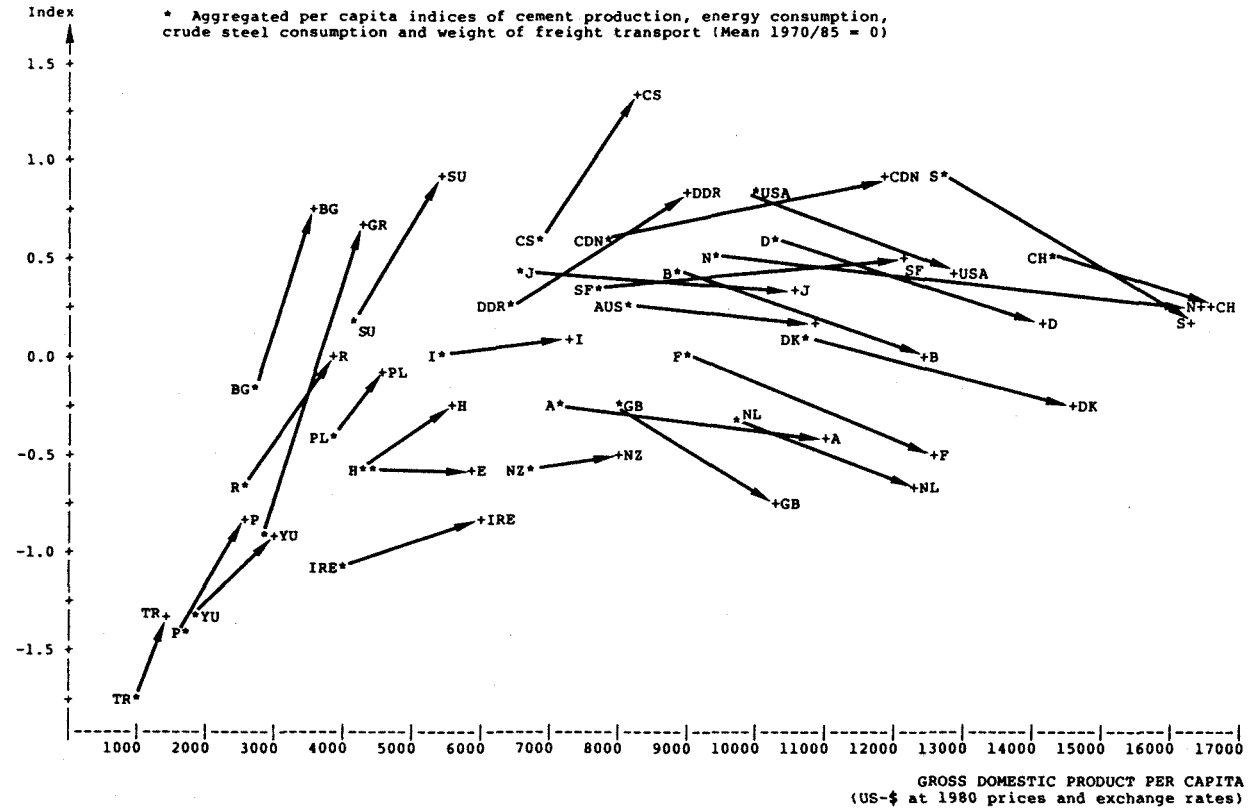


Fig. 5 Index of structural environmental impacts per capita\* and economic performance level (1970 = \*/1985 = +) and change (---->) (Source: Jänicke et al., note 8)



countries was still strongly based on "hard" production factors (high volume production).

Countries with high environmental impacts per capita (see figure 3) were Sweden (S), the United States (USA), the Federal Republic of Germany (D), Czechoslovakia (CS), Canada (CDN), Norway (N), Switzerland (CH), Japan (J), Belgium (B), and even Finland (SF). In the lowest third of the scale were Hungary (H), New Zealand (NZ), Romania (R), Spain (E), Greece (GR), Ireland (IRE), Yugoslavia (YU), Portugal (P), and Turkey (TR).

During the 1970s and the early 1980s, this relationship between economic performance (GDP) and structural impacts changed considerably. The correlation coefficient in 1985 was at only 0.31, significantly below that of 1970; figure 4 shows the new picture. This means that the process of structural change in several countries reduced the importance of the "hard" factors (high volume production) in the economy.<sup>20</sup>

Accordingly, the position of several countries has improved over time. This was especially true of Sweden, but also of the Federal Republic of Germany, France, the United Kingdom, and the United States. In contrast, the placing of several other countries has deteriorated. This was especially true of Greece, but also of Bulgaria, Romania, the USSR, and Czechoslovakia. The group with the highest structural environmental impacts by 1985 was led by member states of the (former) COMECON, namely Czechoslovakia, the USSR, the German Democratic Republic, and Bulgaria; Western industrialized countries showed up in the second (Canada), sixth (Greece), seventh (Finland), and eighth (USA) position, respectively. Japan, despite its improved position, was still in the top half of the scale.

The dynamics and the international pattern of structural change from 1970 to 1985 are indicated in figure 5, which is derived from figures 3 and 4. The main message here is the variation in the direction of change. In the group of low- and medium-income countries (among the industrial countries), two different patterns emerged: increasing environmental impacts, on the one hand, and stabilizing or decreasing environmental impacts on the other (see figure 5).

The fact that economically advanced Western industrial countries occupied leading positions as regards per capita environmental impacts in 1970 may not be so surprising as it seems at first glance. At that time, Sweden, the USA, and Japan, being confronted with high pollution loads and partly with environmental crisis, had to recognize

the need for sweeping environmental protection measures. The fact (by contrast) that Czechoslovakia was "leading" in 1985 indicates the problématique of that country's economic structure. At that time, Czechoslovakia's energy consumption per unit of GDP was more than 50 per cent higher than in most other countries, and specific steel consumption was actually twice that of countries with comparable levels of GDP.

### **Typology of environmentally relevant structural change**

As was explained above, the shifts in the international position of countries listed in figures 3 to 5 relate to structural per capita impacts only – i.e. no account is being taken of the individual country's economic growth rate. For example, the shift in Norway's position coincided with a high rate of economic growth (see table 2) so that the environmentally benign effects of structural change were partly neutralized. To be sure, the absolute (per capita) environmental impacts are of the utmost importance for the environmental policy debate. However, structural change in relation to the growth of the economy is also relevant for the environmental situation of a country. There may be no structural improvement in absolute (per capita) terms because high growth rates neutralize the otherwise positive effects of structural change.

To differentiate the patterns of change, the following typology may be useful:

1. Absolute structural improvement, i.e. an absolute (per capita) decline in production factors (sectors) causing high environmental impacts.
2. Relative structural improvement, i.e. a relative decline in production factors (sectors) causing high environmental impacts compared to the growth of the economy.
3. Absolute structural deterioration (which includes relative deterioration), i.e. a disproportional increase in production factors (sectors) causing high environmental impacts compared to the growth of the economy.

Environmental gratis effects may be defined as those effects that occur when (*ceteris paribus*) the rate of usage of those factors (sectors) having an impact on the environment remains (considerably) below the growth rate of the GDP (type 1 and 2).

In table 2 16 countries out of the whole sample of industrial countries investigated are grouped according to these three different de-

**Table 2 Environmentally relevant structural change: percentage changes 1970/1985**

Country	Consumption of		Cement pro- duction	Weight of freight transport	GDP <sup>a</sup>
	Primary energy	Crude steel			
<i>Group 1: Absolute structural improvement</i>					
Belgium	7.1	-24.5	-17.6	-2.2	42.7
Denmark	-2.7	-15.6	-33.2	20.1	40.8
France	30.3	-34.8	-23.4	-14.5	51.6
FRG	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 <sup>b</sup>	119.3	67.3	162.9	43.1	69.1
Portugal <sup>b</sup>	89.0	34.2	133.1	27.4	69.0
Soviet Union	76.3	33.4	35.9	70.2	47.7
Turkey	218.8	184.4	173.2	118.6	118.2

Source: Jänicke et al. (note 8).

a. Calculation of the Gross Domestic Product percentage changes on the basis of constant (1980) US dollars. Bulgaria, Czechoslovakia, and Soviet Union data refer to percentage changes between 1970 and 1983 in the Gross National Product.

b. Transport data only take railway transport data into account.

velopment patterns. Again, we use here the above indicators of an energy- and materials-intensive mode of production, i.e. consumption of primary energy and crude steel, weight of freight transport, and cement production.

Of all the industrial countries studied, Sweden (see figure 6) is the environmentally most positive case. Although the growth rate of industrial production was very low after 1973, Sweden increased its GDP quite considerably, primarily through an expansion of the service sector. The drastic reduction in cement production (-41.2 per cent), the decreasing consumption of crude steel (-37.9 per cent), and the decrease in the weight of freight transport (-21.4 per cent) add up to notable overall environmental gratis effects.

Also in the United Kingdom, the four structural impact factors de-

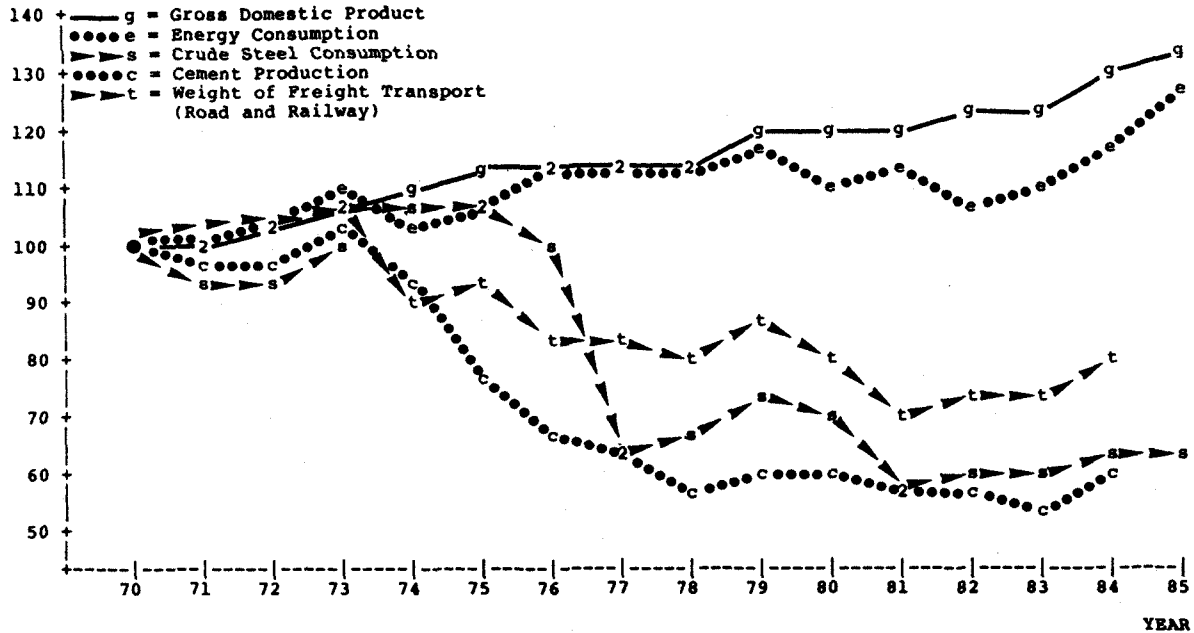


Fig. 6 Structural economic change in Sweden, 1970–1985 (1970 = 100) (Source: Jänicke et al., note 8)

creased by between 2.3 per cent and 43.5 per cent but, in contrast to Sweden, these reductions were connected with, or induced by, high mass unemployment.

In Denmark, too, structural change in the economy decreased the importance of the energy- and materials-intensive sectors quite considerably. Between 1970 and 1985, the GDP grew by some 40.8 per cent, while three of the four impact factors decreased by between 2.7 per cent and 33.2 per cent.

In Japan (see figure 7), the process of delinking was partly neutralized by the rapid growth in overall industrial production and thus only resulted in relative structural improvement (see group 2 in table 2). The conclusion can be drawn that a forced rate of industrial growth interferes with the environmental relief of structural change. Countries with high growth rates must therefore undertake stringent remedial environmental protection measures in order to achieve a net relief for the environment.

In Czechoslovakia (see figure 8), no real delinking of economic growth from the four impact factors took place; some of them even increased. After the oil price hike of 1979 the economy entered a crisis. The development profile of Czechoslovakia, which had undertaken no structural change at the time under investigation, was representative of the economies of Eastern Europe. Group 3 of the countries (see table 2) consists for the most part of industrial late-comers, then in an early stage of industrialization. But Czechoslovakia was a relatively old industrial economy that (in 1985) ranked at the top among the countries suffering from high structural environmental impacts per capita.

This leads at least to two specific questions: (1) do all late-comers have to go through stages of increasing environmental impacts; and (2) what prevents old industrial countries from taking an environmentally friendly development path? A third, more general, question is, of course: What is to be learned from past experience, and under what conditions can economic restructuring become a strategic variable, or point of departure, for sustainable development?

### **Specific conclusions**

First of all, the method used in this study leaves room for refinement.<sup>21</sup> Certain problems remain as regards data, particularly the differences in computing the national (domestic) product in East

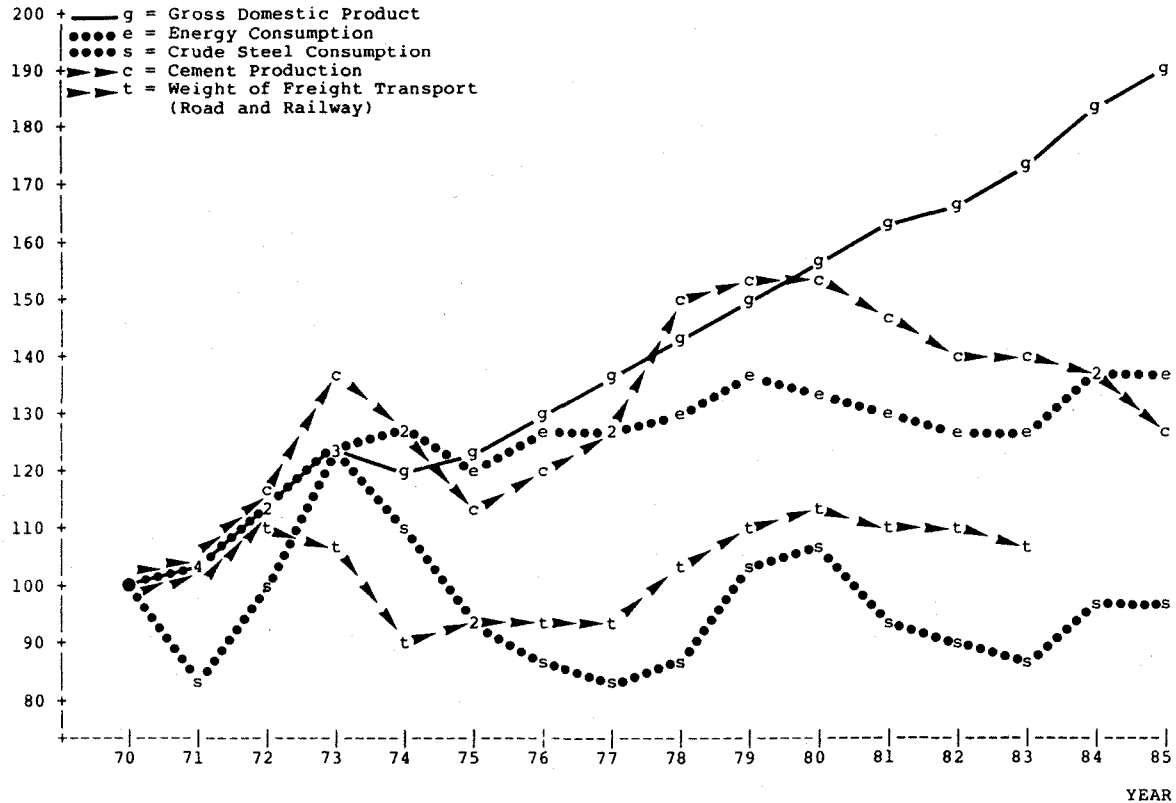


Fig. 7 Structural economic change in Japan, 1970–1985 (1970 = 100) (Source: Jänicke et al., note 8)

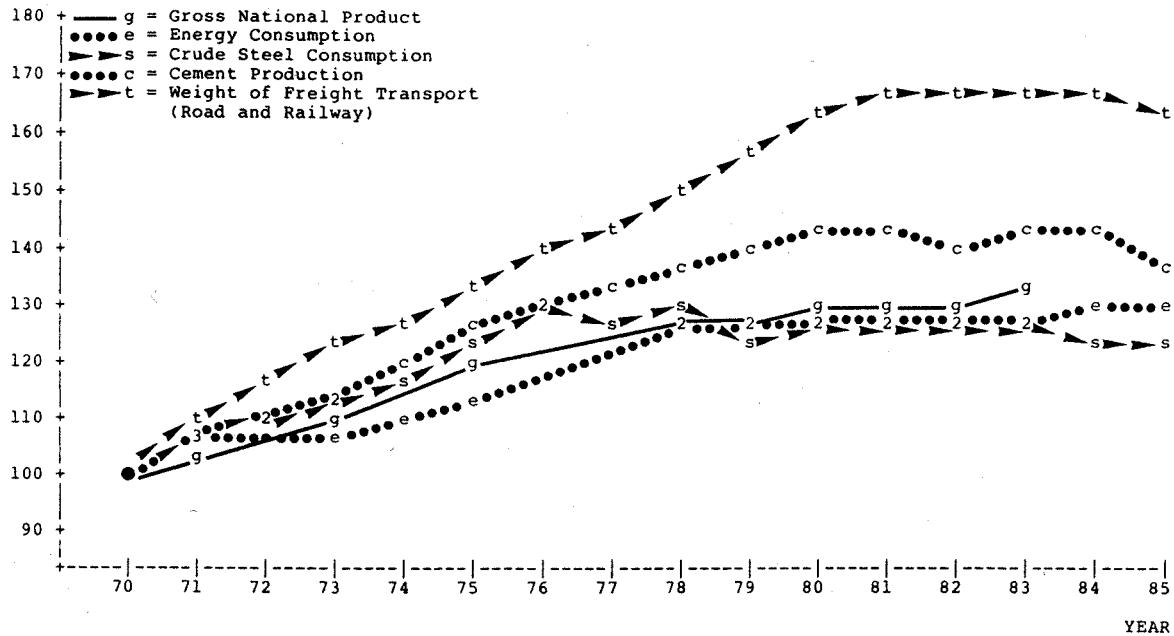


Fig. 8 Structural economic change in the CSSR, 1970–1985 (1970 = 100) (Source: Jänicke et al., note 8)

and West. The question of substitution processes (steel/plastics, for example) is of high relevance and should be further investigated.<sup>22</sup> Additional information is needed if, for instance, *industrial* and not overall consumption of energy, or the specific impacts of energy *production* (such as lignite v. gas), are taken into consideration. The international trade in wastes and the transfer of polluting industries and technologies from developed to developing countries need further study, etc. That means that economic structural change is about not only quantity of energy and materials inputs, but also, and increasingly, about quality, transformation, and interrelations.

Beyond these analytical limitations, however, the advantages of comparing the development patterns of individual countries become evident:

- Restructuring, in the sense of delinking energy and materials inputs from economic growth, was significant in many of the industrial countries. In the period under investigation, less than half of these countries clung to the traditional modes of quantitative growth in physical output *per se*. Countries that did so were the low-income Western countries and most of the countries of Eastern Europe.
- Certain Western countries enjoyed environmental *gratis* effects as a result of structural change. In some cases, especially in Sweden, these beneficial effects were quite considerable.
- In other Western countries, the possibly beneficial environmental effects of structural change were levelled off by the rapid economic growth pursued. This was especially true in the cases of Japan and Norway.
- The relationship between the scale of the economy (GDP) and environmental impacts from energy- and materials-intensive production, still evident in 1970, had weakened by the 1980s. The economically advanced countries underwent fairly rapid structural change.
- In the low- and medium-income countries among the industrial countries, distinct development patterns emerged. There were cases of rapid quantitative growth and also cases of qualitative growth, i.e. economic growth with constant or decreasing energy and materials input.

All in all, it is, unfortunately, not yet possible to speak of *one* dominant development trend among the industrial countries towards dematerialization, recycling, improved industrial metabolism, or sustainable development.



## **General conclusions**

The differences between these development patterns should be of particular interest for future environmental and economic policy in general, and structural policy in particular. It seems that the reasons for such differences and their consequences deserve further attention.

Economic or industrial restructuring is more than an economic phenomenon, particularly if it is understood to convey a break in energy and materials intensity and in pollution trends, that is, a shift towards a significantly different environmental impact pattern. Structure is the key to many theoretical problems; industrial restructuring can be a key to solving present and preventing future environmental problems. Structure is both a comforting and a disturbing notion; restructuring should be made a less uncomfortable, more environmentally friendly strategy.

By implication, the temporally uneven development of the economies studied (discontinuity and gradualism) manifests itself in uneven spatial and social patterns. Our concern here was with the environmental impacts involved in and induced by structural change. The better the environmental impacts of industrial structures are understood, and the earlier they are taken into consideration, the easier it should be to channel industrial development in a direction that is consonant with environmental protection, and thus to improve on industrial metabolism.<sup>23</sup>

In this sense, the "economic late-comers" need not fall into the environmental trap that most of the "economic forerunners" ended up in. By the same token, there is enough evidence that some of the "economic forerunners" could do more to escape from being "environmental late-comers." This, however, would require not only proactive structural change in the economy but also a preventative environmental strategy. This means that environmentally benign market forces would have to be stimulated by structurally innovative policies.

## **Notes**

1. For instance, in the book *Restructuring the City* by Susan S. Fainstein et al., New York: Longman, 1986, the relationship between economic or industrial restructuring and the natural environment was not even mentioned, let alone elaborated.
2. The latter point generated some interest after the first, much-discussed report to the Club of Rome; see D. H. Meadows, D. L. Meadows, J. Randers, and W. W. Behrens, *The Limits to Growth*, London: Earth Island Limited, 1972.

3. For these and other approaches to the concept see R. A. Beauregard, "Space, Time, and Economic Restructuring," in Fainstein et al. (note 1 above), pp. 209–239.
4. World Commission on Environment and Development, *Our Common Future*, London: Oxford University Press, 1987.
5. This concept was well developed by R. B. Reich, *The Next American Frontier*, New York: Penguin, 1983.
6. See R.U. Ayres, "Industrial Metabolism. Theory and Policy," in this volume.
7. Ayres, note 6 above.
8. The following data and arguments rely on M. Jänicke, H. Mönch, T. Ranneberg, and U. E. Simonis, "Structural Change and Environmental Impact. Empirical Evidence on Thirty-one Countries in East and West," *Environmental Monitoring and Assessment* 12 (1989), no. 2: 99–114.
9. See W. Leontief, "Environmental Repercussions and the Economic Structure. An Input–Output Approach," *Review of Economics and Statistics* 52 (1970): 262–271.
10. See: OECD, *The State of the Environment 1991*, Paris: OECD, 1991; UNEP, *Environmental Data Report*, 3rd ed., Oxford: Basil Blackwell Ltd, 1991.
11. If one wished to include indicators on the agricultural sector (like fertilizers or pesticides), the service sector (computers or paper use), and other industries (the chemical industry), data availability and interpretation would, no doubt, become more complex.
12. See F. L. Pryor, "Growth and Fluctuations of Production in OECD and East European Countries," *World Politics* 2 (1985).
13. Particularly in German literature. See: H. H. Härtel et al., *Zusammenhang zwischen Strukturwandel und Umwelt*, Hamburg: Verlag Weltarchiv, 1987; and Rheinisch-Westfälisches Institut für Wirtschaftsforschung, *Strukturwandel und Umweltschutz*, Essen: RWI, 1987. See also: R. G. Healy, *America's Industrial Future. An Environmental Perspective*, Washington, D.C., 1982; J.G. Speth, *Needed: An Environmental Revolution in Technology*, Washington, D.C.: World Resources Institute, 1990.
14. OECD, *The State of the Environment*, Paris: OECD, 1985.
15. See Environment Agency, *Quality of the Environment in Japan 1982*, Tokyo, 1983, p. 52 ff.
16. See note 8 above.
17. Excluding local deliveries, in the early 1980s some 65 per cent of the weight of freight transport in the Federal Republic of Germany consisted of natural resources and materials. See Federal Ministry of Transport, *Verkehr in Zahlen*, Bonn, 1983, p. 175.
18. As indicated, the environmental relevance of the chemical industry could be considerable, changing somewhat the overall picture drawn in this chapter.
19. Translated from K. Steinitz, "Veränderungen in den Produktionsbedingungen der Volkswirtschaft der DDR," in W. Sydow, ed., *In die Zukunft gedacht*, Berlin, 1983, p.16.
20. One may call this the "dematerialization effect" of structural change. See: E. D. Larson, M. H. Ross, and R.B. Williams, "Beyond the Era of Materials," *Scientific American* 254 (1986), no. 6; and R. Herman, S. A. Ardekani, and J. H. Ausubel, "Dematerialization," in J. H. Ausubel and H. E. Sladivic, eds., *Technology and Environment*, Washington, D.C.: National Academy Press, 1989, pp.50–69.
21. Such a refinement, which takes the data and method used above further, is available now in German. See M. Jänicke and H. Mönch, in cooperation with M. Binder, *Umwelentlastung durch industriellen Strukturwandel*, Berlin: Sigma, 1992.
22. See note 20 above.
23. See Timothy O'Riordan, "The Precaution Principle in Environmental Management," in this volume.