Policy use of Environmental-Economic Accounting in Germany

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Karl Schoer

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Environmental-Economic Accounting (EEA)
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Summary

The data of the EEA are mainly used as a base for a policy approach that is directed at integrating environmental concerns into the sector policies, or - more broadly - for a policy towards sustainable development (SD). Therefore this paper will focus on the use of the EEA-data for a SD-policy.

The main purpose of GEEA data is their utilisation for analysis in the context of scientific policy advising. In practice it is rather difficult to detect the impact of statistical information, which is employed in such an indirect and complex manner, on final political decisions.

The main steps of a policy approach which is based on empirical information can broadly be described as a policy cycle. The policy cycle consists of different main steps: problem description, analysis, measures and performance control. EEA data are needed in all stages of the process.

The data of the EEA are part of an expanded accounting data base which consists of the SNA and its satellite systems EEA and SEA with common concepts, definitions and classifications for all three sub-systems. An important feature of the EEA is that it provides a link between the environmental pressures and their driving forces, i.e. to the causing economic activities.

The indicator set of the German National Strategy for Sustainable Development is comprised of 21 indicators. Many of the economic and environmental and one of the social indicators of the National Strategy are embedded into the expanded accounting system. That holds for the indicators public sector financing, capital-outlay ratio, gross domestic product, productivity of energy and raw materials, emissions of greenhouse gases, increase in land use for housing and transport, transport intensity and share of railways in providing transport, air pollution and labour force participation rate.

The integrated accounting data can be applied for different types of analysis. Usually the environment related physical data are combined with monetary data in hybrid analytical approaches. Very common are descriptive approaches, like the calculation of eco-efficiency indicator on a national or an industry level, decomposition analysis (e.g. decomposition of the development of a variable by factors like economic growth, economic structure and intensity), and input-output analyses (e.g. calculation of indirect use of environmental resources). The most important and powerful application is the utilisation of the database in environmental-economic modelling approaches.

Branch indicators are an important information for policy makers to arrive at a more concise understanding about the driving forces that are behind the development of an economy-wide indicator. The results of decomposition analysis can give an idea about important reasons for the change of an indicator in a summarising way, which can be communicated comparatively easy to policy makers and to an interested public. The calculation of indirect effect can among others be used to analyse the environmental impact of external trade.

The examples for the application of environmental-economic models in Germany range from modelling scenarios of rather comprehensive SD-policy approaches to more specialised exercises. An important example is the contribution of those modelling scenarios to the decision process for the introduction of an eco-tax in Germany. The basis idea of the German eco-tax system is to get a double dividend by reducing environmental pressures and by improving employment. For that purpose energy consumption is taxed and the revenue is used for subsidising the public old age pension system in order to reduce the rate of social contributions on wages. The simulations of the proposed measures demonstrated the effects on energy use, CO₂-emissions and economic variables like GDP, tax revenue and employment.
1. Use of statistics for policy purposes

Statistical information is needed for all steps of the political information and decision process. One can find examples were statistical information is directly transformed into political action. However, in most cases the political process is supported more indirectly by statistical data.

The legal link between a given threshold of ozone-concentration and legal restrictions for car driving could be quoted as an example from the German context for the first type of direct interaction between environmental statistics and policy. Another German example from the economic area is the legal link between the annual change of average wages and the increase of old age pensions. However, as far as data of the German Environmental-Economic Accounting (GEEA) are concerned only the indirect use is relevant. The main purpose of GEEA data is their utilisation for analysis in the context of scientific policy advising. In practice it is rather difficult to detect the impact of statistical information, which is employed in such an indirect and complex manner, on final political decisions.

The data of the EEA are mainly used as a base for a policy approach that is directed at integrating environmental concerns into the sector policies, or - more broadly - for a policy towards sustainable development (SD). Therefore this paper will focus on the use of the EEA-data for a SD-policy.

The main steps of a policy approach which is based on empirical information can broadly be described as a policy cycle as shown in figure 1. The policy cycle consists of different main steps: problem description, analysis, measures and performance control. EEA data are needed in all stages of the process. Sustainable development policy should follow that pattern as well, but compared to sectoral policy approaches it is even more complex, as SD-policy has to integrate economic, social and environmental aspects.

Figure 1:

![The policy cycle](image)

For the **problem description** highly aggregated indicators are the most suitable instrument, as they can reduce the complex reality to a limited number of figures. Therefore indicators can serve as a comparatively simple communication tool mainly directed to the general public and the media. The indicators are used for describing important problems under a sustainability perspective and, depending on the process of developing the indicator set, may more or less reflect the political preferences of the society. The sustainability gap, - i.e. the difference between the actual situation of the society and a state, which is desired under an sustainability perspective - is measured indicator by indicator by comparing the observed values with the target values. Indicators sets are used in many countries as a statistical basis for a strategy on sustainable development. The indicators can either be taken from basic statistical sources or they can be derived from the accounting data base by aggregation.
For the analysis highly aggregated indicators alone are generally not sufficient. An analysis of the underlying mechanisms and reasons for change of the indicator values requires detailed disaggregated information which also covers the interaction between the different areas of SD-policy. The data base for further analyses can either be provided by detailed basic statistics or by an accounting system, which is rather situated at a meso-level.

Political measures for achieving the sustainability goals of the society should be cost efficient and above all should be tailored for balancing conflicting goals. The general objective sustainable development requires a holistic policy approach, as the issues of a SD-policy are closely interlinked. A policy for SD is characterised by not only looking on how far the goals for the individual indicators can be achieved, but has to have in mind the interdependencies between the topics and the simultaneous achievement of different economic, environmental and social goals. Decisions on measures aiming at the improvement of one indicator at the same time have to consider the effects that may occur on the other relevant goals of the overall strategy for SD. The rather sophisticated analytical modelling tools\(^1\) required for that type of policy approach demand a homogeneous and coherent database depicting the interdependencies between the different indicators. For that reason it will usually not be sufficient to deal with the different indicators individually. That is, the underlying data for the individual indicators should be part of a comprehensive framework that ideally integrates all relevant topics. An expanded accounting system, which covers the economy and the environment and preferably also the social system, would meet that requirement in an ideal manner.

The System of national Accounts (SNA) is the world wide accepted standard for describing the economic process. The Environmental-Economic Accounting (EEA) and the Socio-Economic Accounting (SEA) extend the economic accounts by a description of the interrelationships of the economic to the environmental and the social system and between the environmental and the social system. The satellite systems in principle use the same concepts, definitions and classifications as the SNA. One central classification of the accounting system is detailed break down by economic activities (homogeneous branches of production or industries and private households). The conceptual coherence guarantees that the data of all three sub-systems can be combined with each other, i.e. they form an integrated database that covers the three principal topics of SD-policy.

It is one crucial advantage of the SNA data set that it is being widely used as a basis for already existing and proven analytical tools that are related to the economic process. For analysing environmental-economic questions those instruments have to be extended. The construction of especially multi-sectoral scenario models have already been put into practice successfully in Germany and other countries.

The indicators, especially if they are combined with quantitative goals, serve as an instrument for general performance control of political measures. A reduction of the gap between the observed and the target values indicates improvement of sustainable score keeping for individual indicators. Modelling can provide a more complex approach of score keeping by comparing the “business-as-usual Gross Domestic Product” (GDP) to a “sustainable GDP”\(^2\). This can be achieved by comparing a modelling scenario for the economic-social-environmental system without measures (business-as-usual) with a scenario that simulates the effects of a bundle of measures which are orientated towards respecting the sustainability goals of the society.

2. The German EEA-system

As already mentioned, the data of the EEA are part of an expanded accounting data base which consists of the SNA and its satellite systems EEA and SEA with common concepts, definitions and classifications for all three sub-systems. An important feature of the EEA is that it provides a link between the environmental pressures and their driving forces, i.e. to the causing economic activities.

The German EEA-system follows the framework as described in the SEEA (System of Environmental-Economic Accounting). The German EEA comprises modules on physical flow and stock accounts as

\(^1\) See Chapter 3.2

well as on environmental expenditure and taxes. But no “adjusted macro-economic aggregates”, as discussed in the SEEA as a possible but highly controversial issue, are calculated in the GEEA. With respect to the data requirements of an SD-policy the physical or material flow accounts (MFA) are the most relevant module. The elements of the system of German MFA are shown in figure 2.

Figure 2

The monetary input-output tables (MIOT) of the national accounts are the conceptual starting point of the material flow accounts. The physical input-output tables (PIOT) provide the conceptual framework for the system of material flow accounts. PIOTs mirror the monetary tables in physical terms (tonnes and other units like joules regarding energy consumption), but in addition and as the most important feature they widen the scope of the monetary tables by including the material flows between the economy and the environment. The PIOT contain, like the MIOT, tables on the supply and use of products, but moreover include inputs from the environment to the economy (mainly raw materials, ecosystem inputs) and outputs from the economy to the environment (residuals: air emissions, waste and wastewater emissions and other outputs to the environment). The tables also comprise material integration tables in a detailed breakdown by economic production and consumption activities (NAMEA-type breakdown) and type of material. Such, they provide a most complete, systematic and rather detailed description of the material flows related to the economic activities.

In principle the PIOT are covering the whole system of material flow accounts. As their calculation is rather resource intensive they are not compiled on an annual basis, but only in larger intervals. Until now PIOTs for Germany are available for the years 1990 and 1995. Therefore a number of conceptually closely related sub-modules to the PIOT on important selected topics have been developed for the current observation on an annual basis.

The economy-wide material flow accounts are an aggregation of the PIOT. They show the inputs of material to and the outputs of material from the economy on an economy wide level by type of

Federal Statistical Office Germany, Environmental Economic Accounting 2006
material. Moreover, a number of annual NAMEA-type accounts (breakdown by economic branches and private households) like the energy flow accounts, primary material flow accounts, the water flow accounts, the air emission accounts and the waste flow accounts are available. The regional material flow accounts which are provided by a working group of the statistical offices of the Federal States are a further extension of the system.

The whole system of NAMEA-type material flow accounts is supplemented by a number of other NAMEA-type flow accounts in Germany. In that type of accounts issues are covered which among others are also relevant for the national SD-strategy, like the use of settlement and traffic area, transport (e.g. passenger-kilometres, tonnes-kilometres) and environmental taxes as well as environmental expenditures.

The German government adopted the National Strategy for Sustainable Development in April 2002. The indicator set of the strategy is comprised of 21 indicators. Many of the economic and environmental and one of the social indicators of the National Strategy on Sustainable Development are embedded into the expanded accounting system. That holds for the indicators public sector financing, capital-outlay ratio, gross domestic product, productivity of energy and raw materials, emissions of greenhouse gases, increase in land use for housing and transport, transport intensity and share of railways in providing transport, air pollution and labour force participation rate. (See figure 3).

The economic indicators and the raw material indicator are original results of the accounting system. The other indicators originate from other statistical sources. These indicators have been embedded into the accounting system by reformatting and supplementing the original data according to the concepts and definitions of the accounting system.

Figure 3

Integration of the German sustainability indicators into the accounting data set

National Accounts

Environmental
Economic
Accounts

Socio-economic
Accounts

1 Productivity of energy and raw materials
2 Emissions of greenhouse gases
3 The proportion of renewable energy sources in overall energy consumption
4 Increase in land use for housing and transport
5 Development of stocks of specified animal species
6 Balance of public sector financing
7 Private- and public-sector expenditure on research and development
8 Capital-outlay ratio
9 Educational outcomes for 25-year-olds and number of new students
10 Gross domestic product
11 Transport intensity and share of the railways in providing transport
12 Proportion of ecological agriculture and general statement on nitrogen surplus
13 Air pollution
14 Satisfaction with health
15 Number of burglaries
16 Labour force participation rate
17 Full time children care facilities
18 Relationship between male and female gross annual earnings
19 Number of foreign school-leavers who have not completed secondary school
20 Expenditure on development collaboration
21 EU imports from developing countries

See also: http://www.ugrdl.de/index.asp
See also: http://www.destatis.de/allg/e/veroe/proser4senv_e.htm

Federal Statistical Office Germany, Environmental Economic Accounting 2006
3. Use of the EEA data for SD analysis

The results of EEA in Germany are generally used for all stages of the policy cycle. The general public is addressed by the annual press conference of the Federal Statistical Office on results of the GEEA. The extensive attention that the press conference now attracts is illustrated, for example, by the fact that all of the national newspapers usually take up the themes presented and by the large number of visits to the press conference’s website. The central publication of the GEEA, the annual report, presents detailed results on all GEEA-topics. The report is disseminated as an online publication and attracts comparatively high interest. For the last report about 40,000 downloads were counted. GEEA results are also used in publications of the Federal Environment Agency.

The integrated accounting data can be applied for different types of analysis. Usually the environment related physical data are combined with monetary data in hybrid analytical approaches. Very common are descriptive approaches, like the calculation of eco-efficiency indicator on a national or a industry level, decomposition analysis (e.g. decomposition of the development of a variable by factors like economic growth, economic structure and intensity), and input-output analyses (e.g. calculation of indirect use of environmental resources). The most important and powerful application is the utilisation of the database in environmental-economic modelling approaches.

3.1 Descriptive analysis

3.1.1 Economy-wide indicators

Figure 4 shows important economy-wide SD-indicators which can be derived from the German expanded accounting system by aggregation.

Figure 4:

Environmental pressure factors and economic factors in Germany
Change 1995 to 2003 in percent

<table>
<thead>
<tr>
<th>Environmental factor</th>
<th>Change 1995 to 2003 in percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>0.5</td>
</tr>
<tr>
<td>Primary material</td>
<td>-7.8</td>
</tr>
<tr>
<td>Green house gases</td>
<td>-7.7</td>
</tr>
<tr>
<td>Air pollution</td>
<td>-28.3</td>
</tr>
<tr>
<td>Settlement and traffic area</td>
<td>8.7</td>
</tr>
<tr>
<td>Goods transport performance</td>
<td>19.9</td>
</tr>
<tr>
<td>Gross Domestic Product</td>
<td>11.7</td>
</tr>
<tr>
<td>Employment</td>
<td>-3.5</td>
</tr>
<tr>
<td>Capital formation</td>
<td>-6.9</td>
</tr>
</tbody>
</table>

3 See: Reports of the press conferences of GEEA and other publications of GEEA http://www.ugrdl.de/index.asp http://www.destatis.de/allg/e/veroe/proser4senv_e.htm
4 At present, the report (Umweltnutzung und Wirtschaft 2004) is only available in German language under the following address: http://www.destatis.de/allg/d/veroe/d_ugr03.htm
5 A publication of the English version is forthcoming.
In the strategy the environmental pressure factors energy, primary material and transport performance are defined as efficiency indicators, i.e. they are related to the GDP. The figure shows that only goods transport performance was growing faster than GDP since 1995 in Germany. For the other pressure factors a strong decoupling to economic growth (decrease of environmental pressure factor with an increasing GDP) or at least a weak decoupling (increase of the pressure factor is lower than GDP-increase) can be stated.

3.1.2 Branch indicators

An important feature of the expanded accounting system is to provide a detailed and uniform break down by economic activities for various economic, environmental and also social indicators. Thus among others, the SD-indicators shown in Figure 4 are available in a so called NAMEA-type break down in Germany. For the environmental variables that type of subdivision links the respective pressure indicators to the driving forces (causing economic activities) in a rather detailed break down.

As an example Figure 5 shows the indicator use of abiotic primary material in such a disaggregation for selected branches in physical units (tons). Primary material is comprised of domestic extraction or raw material and the imports of raw material and manufactured and semi-manufactured products. The share of the consumption of the private households of 3.5 % on the total use of abiotic primary material is rather small whereas the productions branches cover 96.5 %.

Figure 5:

Among the production branches substantial direct users of primary material are “Manufacturing of other non-metallic mineral products” with a share of 25.2 % and “Construction” with a share of 21.1 % on the total of industries followed by “Electricity, gas, steam and hot water supply” with a share of 18.4 % and “manufacture of metals” (7.2 %). These branches together use almost two thirds of the total domestically used primary material. This high concentration of the total use of primary material on a few branches indicates that the overall development of the use of primary material as well as the raw material indicator is mainly influenced by the development of these few branches. This information alone may already be an important one for policy makers to arrive at a more concise understanding about the driving forces that are behind the development of the indicator.
Figure 6 relates the environmental pressure variable to the economic world. It shows the branch-specific intensity of the use of primary material. Primary material intensity is defined as the ratio between the mass of the used material of a homogeneous branch to its gross value added.

The primary material intensity in different branches is, depending on different technical conditions, quite heterogeneous. The average intensity over all branches achieved 663 kg per 1,000 Euro in 2002. Far below average was the intensity for the service branches with 49 kg per 1,000 Euro gross value added. The average value for the manufacturing and construction was 2298 kg per 1,000 Euro gross value added. Within manufacturing and construction several branches show rather high primary material intensities. That are “Coal and lignite; peat” (11,490 kg per 1,000 Euro), “Mining and quarrying products” (1,278 kg per 1,000 Euro), “Other non-metallic mineral products” (21,503 kg per 1,000 Euro), “Basic metals” (6,150 kg per 1,000 Euro), “Electrical energy, gas, steam and hot water” (7,599 kg per 1,000 Euro) and “Construction” (2,872 kg per 1,000 Euro). Of course also the other environmental pressure variable could the related in this way also to economic, environmental or social variables.

3.1.3 Decomposition analysis

In this chapter results are presented on the decomposition of the change of various indicators of the German SD-strategy. The pressures go back partly to production and partly to consumption activities. The share of production ranges from 100 percent for goods transport performance and nearly 100 percent for primary material to about 40 percent for settlement and traffic area.

The following examples shown in figure 7 are confined to production related share of the indicators. The total change was decomposed into three effects by a mathematical approach: an intensity effect, a structural and a scale effect. Intensity is defined as the relationship between the respective pressure indicator and gross value added for the individual branches. Structure is depicted by a vector as the share of the individual branches at the total gross value added. The scale component is represented by development of the total gross value added. It should be noted that the calculation of that type of structural effect requires a breakdown by economic branches. The individual effects are calculated

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For the methodology of decomposition analysis see Seibel, S (2003) http://www.destatis.de/allg/d/veroe/proser4fumw2_d.htm
under the assumption that the other factors were unchanged over time. The approach transforms the relationship between the factors into an additive equation, i.e. the total change of the variable can be expressed as the sum of the three effects.

The results of the decomposition analysis for a number of SD-indicators for the period 1995 to 2001 read as follows:

Figure 7:

As a matter of course, the increase of the economy-wide gross value added has a burdening effect for all environmental variables. This reflects the principal conflict of goals between increase of GDP and reduction of environmental pressures. For most of the variables, but not all, there was a relieving intensity effect. Also the structural effect worked in most cases towards diminishing the environmental burden. I.e. the weight of economic branches with a high intensity went down over time. As far as environmental pressures could be reduced in spite of economic growth, in many cases this was the compound result of a favourable intensity and a favourable structural effect.

\[\text{Scale effect} = 100\]

7 Unlike for environmental pressures for employment the scale effect has to be viewed as a positive factor ad vice versa a deceasing intensity is considered as a burdening effect.
But for example the decomposition of the development of primary material use yields a rather 
remarkable result. The analysis reveals that the positive trend of a decreasing economy-wide material 
use goes exclusively back to a strong favourable structural effect. Against this the development of 
the primary material efficiency within the individual branches showed even an opposite trend and thus had 
a burdening effect on overall primary material use. In other words, the decrease in the use of raw 
material on an average was not the result of efforts to improve the raw material efficiency in the 
individual branches, but goes rather back to a general change in the demand structure. Among others 
the change of the demand structure in Germany is reflected in an increase of share of the service 
sector and a sharp decrease of the weight of especially construction activities.

The results of decomposition analysis can give an idea about important reasons for the change of an 
indicator in a summarising way, which can be communicated comparatively easy to policy makers and 
to an interested public.

Beyond the "standard decomposition approach" shown above various types of decomposition 
approaches with more than three factors are possible\(^8\). One further example for a decomposition 
analysis is shown below for direct CO\(_2\)-emissions of private households by motorised individual 
transport activities. Here, it is possible to distinguish between two central questions, and hence 
influencing factors:

1. How CO\(_2\)-intensive is private households’ individual transport?
   The CO\(_2\) intensity of individual transport is derived by the CO\(_2\) intensity of fuel consumption (CO\(_2\) 
   emissions per fuel consumption in terajoules, TJ) and fuel intensity (fuel consumption in TJ per 
kilometres covered).

2. What is the volume of private households’ individual transport? This mobility volume is quantified 
   using the kilometres covered. The decomposition analysis provides the results shown in Table 1. 
   Here, the mobility volume was split into an individual share (kilometres covered per person = 
   individual mobility), the household size (persons per household) and the number of households. 
   This means that the dissection of components carried out here creates the cross-relationships 
   between social, transport-related and environmental values.

Table 1:
Decomposition of change of mobility-related CO\(_2\)-emission of private households by 
influencing factors, 1991 to 2000

<table>
<thead>
<tr>
<th>Million tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO(_2)-intensity of individual transport</td>
</tr>
<tr>
<td>CO(_2)-intensity of fuel consumption</td>
</tr>
<tr>
<td>Fuel intensity</td>
</tr>
<tr>
<td>Mobility volume</td>
</tr>
<tr>
<td>Individual mobility</td>
</tr>
<tr>
<td>Household size</td>
</tr>
<tr>
<td>Number of households</td>
</tr>
<tr>
<td>Total Change in CO(_2)-emissions</td>
</tr>
</tbody>
</table>

According to Table 1 the reduction in emissions caused by the decrease in the CO\(_2\) intensity of 
individual transport in the period described 1991 to 2001 is 27 million tonnes of CO\(_2\). This factor is 
decomposed further into the emission-lessening impact of the fallen CO\(_2\) intensity of fuel consumption, 
amounting to 6.4 million t CO\(_2\), and the effect of the reduced fuel intensity, amounting to 20.6 million t 
CO\(_2\). The reduced CO\(_2\) intensity reflects the considerably increased share of fewer carbonaceous 
diesel fuels among the total fuel used. The fall in fuel intensity is mainly the result of a shift to 
passenger vehicles with lower fuel consumption per kilometre. The CO\(_2\) intensity effect of individual

\(^8\) See for example the GEEA press conference report 2002
http://www.destatis.de/allg/e/veroe/e_ugr02.htm
transport is hence able to compensate for the increase of 18.2 million t CO₂ caused by the increase in kilometres covered, so that it was possible to reduce emissions overall.

The mobility volume was influenced by three factors. The fall in household sizes has the effect of reducing mobility volume, whilst the growing number of households increases the burden. The corresponding impact amounting to −4.4 and +7.0 million t CO₂ is however much smaller in volume terms than the arithmetical increase in emissions by 15.6 million tonnes which was caused by the increase in the kilometres covered per capita.

It becomes clear that there are a number of highly unequal effects behind the total change of the mobility-related CO₂-emissions of private households which are different not only in their extent, but also in their direction. The decomposition of the total change into individual factors opens the chance for formulating more well-aimed measures to influence the development of that indicator.

3.1.4 Indirect effects

The combination of disaggregated physical data on direct environmental pressures with monetary input-output tables can yield further analytical insights. The input-output tables provide information on the intertwining of the economic branches. With that information also the indirect environmental pressures which are related to all steps of the production chain can be assigned to the products of final use with a Leontiev type approach.

Among others the results can be used for analysing the environmental impact of external trade. This will be demonstrated below at the example of German CO₂-emissions. The question to be answered will be whether the indirect CO₂-emissions related to the imported products are higher than the export-related indirect emissions.

The indicator of the national SD-strategy refers to the CO₂-emissions on the territory. I.e. they comprise the emissions related to the production and the consumption activities on the territory. According to that concept the emissions related to the imported products are assigned to the rest of the world. But on the other hand emissions that are generated by manufacturing the exported products are ascribed to the domestic economy. The comparison of indirect emissions for the imports and for the exports shows whether an economy is a net-exporter or a net-receiver of emissions.

The results are shown in figure 8 for Germany for the years 1995 and 2002. In 1995 the export related CO₂-emissions (285,7 million tons) were higher than the import related emissions (257,3 million tons), i.e., Germany was net-receiver of emissions. Between 1995 and 2002 the imports and exports were increased substantially. However, the rise in export related indirect emissions (+89.2 million tons) was higher than the growth of import related emissions (+61.8 million tons). Consequently the German economy has become a net-receiver of CO₂-emission burdens to a growing extent.

This type of information on the effects of the development of external trade is an indispensible supplement for analysis and political decision making.

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9 Following the concepts of the National Accounts, the monetary data refer to the resident units. The emission data had to be demarcated accordingly. The quantitative difference between the “residence concept” and the “territory concept” can be obtained by adding the emissions of non-resident units on the domestic territory and deducting the emissions of resident units on the territory of the rest of the world. For Germany the difference is comparatively small.
3.2 Econometric modelling

The approaches for analysing the underlying causes of the development of SD-indicators discussed above are confined to the description of the past (ex post). Additional insights can be obtained by relating the indicators to empirically founded econometric models, which can cover the relationship between the economic and the environmental system in a much more systematic and comprehensive manner and in an ex ante perspective.

In Germany such instruments for environmental-economic modelling have been developed parallel to the implementation of the German system of environmental-economic accounting (GEEA). The scientific advisory committee of the ministry of environment for GEEA played a leading role in promoting the development and the use of that instrument\(^\text{10}\).

The starting points were already existing modelling instruments for the economy. By utilising the data of the EEA these models very extended by including important environmental-economic interactions. Meanwhile the Pantha Rei model of the GWS Osnabrück\(^\text{11}\) turned out to be the most used model for that purpose. That model is a multi-sectoral approach which can make maximum use of the disaggregated data base.

Such models relate the integrated data of the expanded accounting system to each other by a complex system of empirically based mathematical behaviour equations. The model-relationships which are based on that equations can be of economic, environmental-economic or socio-economic nature. The models can be used for forecasting and scenario simulations. Those simulations are indispensable for an SD-policy approach, as they can quantify the effects of political measures on the target variables but at the same time the side effects on other economic, environmental and social variables, which are relevant for the SD-policy. That type of information supports the process of finding cost-efficient solutions and balancing conflicting goals.


\(^{11}\) See: Meyer, B. (1998)
The examples for the application of environmental-economic models in Germany range from modelling scenarios of rather comprehensive SD-policy approaches to more specialised exercises.\(^{12}\)

An important example is the contribution of those modelling scenarios to the decision process for the introduction of an eco-tax in Germany. The basis idea of the German eco-tax system is to get a double dividend by reducing environmental pressures and by improving employment. For that purpose energy consumption is taxed and the revenue is used for subsidising the public old age pension system in order to reduce the rate of social contributions on wages. The simulations of the proposed measures demonstrated the effects on energy use, CO\(_2\)-emissions and economic variables like GDP, tax revenue and employment.

Similar more specialised exercises have been carried out referring to the situation of individual economic branches (e.g. steel industry or coal mining) or other SD-indicators, as area use. The Ministry of Research and the EU also financed more comprehensive approaches, which included a wide range of political measures for improving simultaneously the performance of economic, transport related and environmental variables like energy use, air emissions and area use.

A recent example refers to the simulation of transport related measures which were formulated by the Federal Environment Agency. The proposed measures were aimed at improving the performance of transport-indicators of the national SD-strategy. In addition to the direct effects on the transport indicator values the trends of a number of other environment-related, economic and social SD-indicators were simulated with the Panta-Rhei model.

Table 2 shows the forecast for the basic scenario for a number of SD-indicators until the year 2020.

**Table 2:**

**German sustainability indicators: business-as-usual forecast**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>1991</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity of passenger transport</td>
<td>1999=100</td>
<td>102.9</td>
<td>94.7</td>
<td>84.9</td>
<td>77.1</td>
</tr>
<tr>
<td>Intensity of goods transport</td>
<td>1999=100</td>
<td>90.6</td>
<td>99.8</td>
<td>102.8</td>
<td>106.4</td>
</tr>
<tr>
<td>Share of rail transport to total goods transport performance</td>
<td>in %</td>
<td>21.5</td>
<td>15.1</td>
<td>13.3</td>
<td>11.6</td>
</tr>
<tr>
<td>Energy productivity</td>
<td>1990=100</td>
<td>104.6</td>
<td>122.5</td>
<td>137.7</td>
<td>170.5</td>
</tr>
<tr>
<td>Green house gas emissions</td>
<td>1990=100</td>
<td>95.6</td>
<td>81.2</td>
<td>78.8</td>
<td>78.1</td>
</tr>
<tr>
<td>Air pollution</td>
<td>1990=100</td>
<td>85.7</td>
<td>50.2</td>
<td>44.5</td>
<td>38.9</td>
</tr>
<tr>
<td>Increase of the settlement and traffic area</td>
<td>hectare per day</td>
<td>119.7</td>
<td>129.2</td>
<td>93.4</td>
<td>81.5</td>
</tr>
<tr>
<td>Gross domestic product per capita</td>
<td>Euro</td>
<td>21312</td>
<td>23943</td>
<td>27034</td>
<td>32010</td>
</tr>
<tr>
<td>Employment ratio</td>
<td>in %</td>
<td>65.8</td>
<td>65.5</td>
<td>67.2</td>
<td>73.2</td>
</tr>
<tr>
<td>Increase of budget deficit</td>
<td>in % of GDP</td>
<td>3.0</td>
<td>-1.3</td>
<td>3.3</td>
<td>2.7</td>
</tr>
<tr>
<td>Capital formation ratio</td>
<td>in % of GDP</td>
<td>23.8</td>
<td>21.7</td>
<td>17.3</td>
<td>15.6</td>
</tr>
</tbody>
</table>

Source: Gesellschaft für wirtschaftliche Strukturforschung

As one example of the results of the project the effect of doubling the existing road toll for heavy goods vehicles is shown in table 3. The table describes the differences between the results of the “measurement scenario” compared to the “basic scenario” for a selected number of variables.

According to the modelling results it can be expected that the measure will yield an improvement for the indicators values related to goods transport. The intensity of goods transport will go down by 3.6 percent points and the share of rail transport will rise by 1.8 percent points. However, compared to the target values of the strategy the proposed measure alone will not be sufficient. For reaching the target it is necessary to achieve a decrease of the transport intensity by more than 11 percent points and an increase of the share of rail transport by nearly 13 percent points compared to the business-as usual scenario. The side effects of the measure on other SD-variables are positive. CO\(_2\)-emissions will go down – but only by 2.9 million tons against a current level of total CO\(_2\)-emission of more than 800 million tons – and there will be no negative effects on GDP and employment, but a slight increase.

\(^{12}\) See for example Mayer, B. (2004).
Table 3:

Simulation of the effect of doubling the road toll for heavy goods vehicles

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity of goods transport (1999=100)</td>
<td>-3.3</td>
<td>-3.6</td>
</tr>
<tr>
<td>Share of rail transport to total goods transport</td>
<td></td>
<td></td>
</tr>
<tr>
<td>performance (%)</td>
<td>1.6</td>
<td>1.8</td>
</tr>
<tr>
<td>CO₂-emissions (million tons)</td>
<td>-2.7</td>
<td>-2.9</td>
</tr>
<tr>
<td>GDP per capita (Euro 1995)</td>
<td>16.0</td>
<td>34.0</td>
</tr>
<tr>
<td>Employment (1000)</td>
<td>10.0</td>
<td>28.0</td>
</tr>
</tbody>
</table>

Source: Gesellschaft für wirtschaftliche Strukturforschung

References


http://www.destatis.de/allg/d/veroe/proser4fumw2_d.htm


http://www.destatis.de/allg/e/veroe/e_ugrbeirat.htm