Employment and Environment in a Sustainable Europe[1]

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Abstract

Environmental policy faces major challenges in Europe. The European Treaties require an integration of environmental, economic and social policies in order to allow for a Sustainable Development. This is of special importance for the link between environmental and employment policy. This paper starts with a definition of the three pillars of sustainable development, the viability (resilience) of environmental, economic and social systems. With regard to economic development and the social field, these objectives are relatively easy to operationalise: GDP and employment are a generally used headline indicator of sustainable development. The total material input into an economy can be seen as an indicator showing the environmental impact.

This view brings about major challenges for economic theory: We include the total material input along with resource productivities to describe, explain and evaluate possible developments of economic and environmental variables.

With the help of the results from a German research project we show the relationships between the indicators, the productivities and how they can be influenced by policy measures. The simulation results indicate the possibility of win-win situations concerning the environment and employment. Additionally we investigate whether the developed minimum conditions of sustainable development are valid for Austria.

Keywords

minimum conditions for sustainability, employment and environment, indicators, sustainability strategies, integration of environmental concerns

JEL codes

E12, E24, E27, J20, Z01

I.Introduction: Sustainable Development - A European Goal

European environmental policy is shaped by Article 6 of the EU Treaty, which reads as follows: "Environmental protection requirements must be integrated into the definition and implementation of the Community policies and activities (...), in particular with a view to promoting sustainable development."

In line with this principle, environmental protection is not considered to be a sectoral policy, but a maxim involving all sectors. This does not mean that environmental ministries are not needed any more, but rather that interfaces are required in other sectors (see Görlach et al. 1999, Schepelmann et al. 2000).

Another important European process was triggered by the Lisbon Summit in June 2000 on economic reform, employment and social cohesion, which agreed on what was called in European "language" a new strategic goal for the EU for the next decade: to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion. The European Council acknowledged the need for an interlinked economic, employment and social policy and triggered a mechanism of Council meetings each spring to examine economic and social questions and to ensure overall coherence and effective monitoring of progress.

In June 2001, the European Summit in Gothenburg launched a European strategy for sustainable development, in which it states how the integration of environmental, social and economic concerns should look like. According to the EU treaty (article 2), sustainable development is to be characterised by a high degree of employment and social security, by continued economic growth and the strengthening of the competitiveness of European industry, as well as by environmental protection and improved environmental quality. The improvement of the quality of life is indicated as an overall objective.

There is wide agreement today and it follows also from the legal requirements formulated above that sustainable development being a normative-integrative concept has to pursue environmental, economic and social objectives at the same time. The most important objectives of the environmental dimension include the long-term conservation of the ecosphere as a basis of human life, the sustainable utilisation of renewable resources and minimised utilisation of non-renewable resources (Hinterberger et al. 1996). The economic dimension mainly focuses on competitiveness as a prerequisite for the development of new eco-efficient technologies (Hinterberger/Luks 2001). Other key elements are price stability, foreign-trade balance as well as economic growth and the resulting potential increase in the quality of life. The central objective of sustainability's social dimension is the fair distribution of opportunities both in intra- and inter-generation terms. A high employment level combined with high-quality jobs is an important link between the economic and social dimensions.[2]

II.Indicators for the three Dimensions of Sustainable Development

The aims of sustainable development are quite general and need further refinement. It is especially important to measure progress (or set-backs) towards sustainability. The process of integration requires therefore the development of a political strategy to be evaluated by indicators in order to allow a transparent mechanism of reporting in order to see if goals are achieved within the determined time-tables.

The European Council of Vienna (1998)[3] invited the Commission to present a report on the development of environmental and integration indicators in Helsinki. The so-called Helsinki Report on Environmental and Integration Indicators (European Commission 1999) outlines the function of indicators, in particular with regard to transparency and accountability in the Union. According to the Commission, the following criteria to be met by the indicators are identified:

- limited in number,
- relevant,
- responsive,
- simple and,
- policy-relevant.

With regard to economic development and the social field, these objectives are relatively easy to operationalise; indicators exist in both areas (for example, the gross domestic product and the unemployment rate). According to widely accepted norms in an economy, the values of these indicators are to be raised (GDP) or reduced (unemployment rate). These goals and indicators are of course not indisputable but widely used and can be taken as a general starting point.

On the basis of the indicators and the objectives defined, measures can be designed that could be conducive to reaching the objectives. The objectives in the environmental field, however, are much more difficult to operationalise. This is in part due to the complexity of the matter because environmental burdens materialise and can be measured in many ways. Additionally, considerably less experience exists in this comparatively new policy area that has only been given high priority in EU's policy for a relatively short period of time. In order to achieve an equal representation of economic, social and environmental aspects of the sustainability vision, simple, well-known and accepted indicators as well as comprehensible objectives that can be operationalised are also required for the environmental field (Hinterberger et al. 1998).

From an environmental point of view the main environmental problems result less from resource scarcity, but rather from the ecological impacts of resource extraction, processing and use in the economic process. Materials and energy are flowing through the socio-economic (sub)system just like it is the case with living organisms - to underline this parallelism the term of society´s metabolism has been introduced (Ayres/Simonis 1994, Baccini/Brunner 1991, Fischer-Kowalski 1998).

To get a clear picture of the interrelations between the natural and the socio-economic (sub)system, it is therefore of highest importance to develop a comprehensive system for physical accounting of resource flows

(Schmidt-Bleek et al. 1998). One of the methodological approaches for measuring material flows that gained intensive echo in the scientific community was developed at the Wuppertal Institute in Germany (e.g. Schmidt-Bleek at al. 1996, Schmidt-Bleek 1998).

This methodology focuses on the material inputs that form the material base for every human activity. In comparison with the traditional environmental policy, which focused on the regulation of the output side of economy, this input-related approach guarantees a higher regulatory efficiency with much less effort in control (Spangenberg et al. 1998).

In this approach, the Total Material Input (TMI) comprises all materials, which are required for the production, usage and final deposit of a certain product. The TMI of a product includes the so called "ecological rucksack", which can be defined as the amount of material, which has to be extracted from the environment in addition to the dead weight of the product itself (Hinterberger et al. 1996). Relating this Total Material Input to the service units, which are delivered by the analysed product, allows to compare different products and production technologies with regard to their potential environmental burden.

Subtraction of domestic hidden flows and foreign hidden flows from TMI leads to a second concept of material input - the Direct Material Input (DMI). The DMI comprises "the flow of natural resource commodities that enter the industrial economy for further processing. Included in this category are grains used by a food processor, petroleum sent to a refinery, metals used by a manufacturer, and logs taken to a mill" (Adriaanse et al. 1997, p. 8).

An important relationship is seen between 'stock' and 'flow' measures. The use of stock measurements (such as capital or habitat) is generally being recognized as a means to replace more conventional flow variables (e.g. savings or emissions) in the context of sustainable development. Although our focus is on the material flows we emphasize that stocks are as well important especially in those sectors where material flows depend on the capital used by households and industry (Kletzan et al. 2001).

Whereas the size of stocks and their accessibility is an economic issue, from the ecological point of view resource flows are the crucial parameters, since they contribute to environmental impacts (see Spangenberg et al. 1998). Thus ecological economic discussion refers to natural capital as stock of goods that enable the existence of flows such as various ecosystem services and life supporting functions (Hinterberger, et al. 1997. pp. 1- 14.) "Ecosystem services consist of flows of materials, energy and information from natural capital stocks which combine with manufactured and human capital services to produce human welfare" (Costanza et al 1991 p. 6). Total material flows are a way to operationalize this concept.

The challenge for economists is therefore

- to understand the role of material flows in modern economies (**theory**, see sec. 3 below)
- to develop quantitative and qualitative scenarios for possible futures of the economy-environment-relationship (**data**, see sec. 4 below)

- to make concrete suggestions for policies to reconcile the goals of dematerialization and socio-economic development (**policy**, see conclusions below).

This paper deals with the first two challenges.

It has to be emphasised that the indicators mentioned above (TMI, GDP growth, unemployment rate) are possible indicators for the three dimensions, but are by no means exclusive and fully. Concerning TMI reasons for its choice have been given above. The unemployment rate in its usual form as social indicator will be discussed below (sec. 3). The literature on the limitation of GDP growth as an indicator of economic performance is vast, while general agreement seems to exist that it is not a useful indicator of societal well-being. Nevertheless GDP growth is still an accepted goal within economic policy. It is also criticised by environmentalists pointing out that economic growth is not compatible with environmental protection, and therefore sustainable development. But in taking GDP growth as one economic indicator allows us to show the trade-offs between and the links to different aims of sustainability.

III.Theoretical Aspects of the Economy-Employment-Environment Relationship

III.1The macroeconomic view

General and macro-related statements on the economy-employment-environment relationship from a theoretical point of view can be made by looking at productivities and inequations. The indicators introduced in the preceding sections have the advantage of being applicable as variables in various concepts of economic theorizing – just like employment and economic growth which serve at the same time as economic variables and arguments in the political debate.

If we use the usual macroeconomic terminology, with Y being defined as an economy's income/production, K the (human-made) capital stock, L the labour force employed (employment measured in physical terms of persons employed) and h the total amount of working hours worked by these persons, we can add the total material input (TMI) as defined in the last section. If we add prices of the factors of production employed, we get i as the interest rate (i.e. the price for the use of capital), w (the wage rate as the price of an hour of average work) and p_{TMI} as the price to be paid for the extraction of resources. This price usually equals 0, because the cost of extraction matches the costs of labour and capital used in the extraction business, while the extraction companies usually receive some profit, all of which is accounted for in the usual economic income accounting and therefore is included in Y.

From this we can derive a macroeconomic production function including material inputs. They play a twofold role. On the one hand, material inputs are a fundamental basis of any economic activity because it is impossible to produce something out of nothing. Therefore the assumption that production is solely the result of the use of capital and labour is shortcoming. Rather TMI can be interpreted as a factor of production. On the other hand, as stated above, TMI is an indicator of the environmental pressure by human activities.

One attempt to consider Material Input in a production function was made by Klingert (2000), who includes TMI in a neoclassical Cobb-Douglas production function and integrates it with a simple comparative static macroeconomic model. By integrating the concept of TMI into a macroeconomic model not only the possible effects for production but also the consequences for demand must be considered.

She also discusses taxing TMI in this model which leads to the expected result that, "all equilibrium quantities are affected by the imposal of the input tax t, and all of them are non-linearly reduced compared to the original situation" (p. 7).

The analytical deduction shows, that the effect of this tax is not limited to the reduction of TMI. In addition the output level decreases and so does employment. But these undesirable accompanying effects could be avoided, if a subsidy to reduce labour costs is introduced, as also shown in Klingert (2000).

From the presented results, it can be concluded that using resource oriented instruments alone are not adequate for reaching sustainable development, because the interdependencies of the factor markets are neglected. A dematerialization strategy which combines a material input tax with a labour subsidy would be more promising because it raises the material costs and simultaneously reduces labour costs.

Within the research project "Labour & Environment" (see section 4) a scenario was developed where a mix of policy instruments is suggested. One of the main measures is the implementation of a Material Input Tax on the German TMI, raising from 1 to 60 DM per ton MI from 2000 to 2020. Labour costs were not reduced per se, but there are several instruments influencing labour costs, such as the negative income tax and a real wage orientation on labour productivity, where 50% of the additional labour productivity are paid out in wages, the remaining 50% are transformed into reduction of working hours.

In a dynamic and long-term view, it could be argued that the restriction in the input of labour (introduction of social policy more than 100 years ago) and the reduction of working hour per person employed created an incentive for an increase in labour productivity together with the possibility to get almost for free most which eventually lead to the unprecedented economic growth of the last 150 years, while the material flows involved increased for the longest time at a rate similar to the rate of economic growth. A similar argument could then be made for the present time, where an increase in resource productivity would not only be an imperative in ecological terms but also strengthen the path towards an information-based economy.

Indicators for sustainable development as defined in sec. 2, namely GDP growth, unemployment rate, and TMI and the productivities of labour and resource use are not independent of each other but show interesting links and resulting criteria for sustainability patterns, which are described in the following.

III.2Inequations

In order to reach a dematerialization or delinking of material use and economic growth (as described in sec. 2), the material intensity (TMI/Y) must decrease or the material productivity (Y/TMI) must increase. This can happen due to 3 reasons:

1. Change of demanded goods and services
2. Technological change (increasing efficiency)
3. Substitution effects between resources

A relative delinking (decreasing TMI) is not sufficient, an absolute is necessary (decrease of TMI is stronger than increase of GDP).

The resource productivity derived from the material input, the labour productivity and the economic growth can be related to each other via three inequations to show the minimum conditions for sustainable development (see for the following also Spangenberg et al. 2000).

If we accept that we are already close to the limits of nature's carrying capacity (on either side), following the precautionary principle industrial economies should reduce the total throughput of resources. Consequently, with Y the output of the economy and R the total volume of resources used, Y/R is the *resource productivity* (frequently referred to as eco-efficiency; R stands for e.g. TMI, CO_2 etc.). R can be either accounted for in different categories, or for the sake of simplicity with only limited mistake incurred in standard applications (Spangenberg/Kuhndt 1996), simply counted as material flows in tons, the Total Material Input TMI (Adriaanse et al. 1998).

Only if in a given period of time the productivity increases faster (or drops slower) than the volume of output Y, an absolute reduction can be achieved. This criterion

$$dY < d(Y/R) \qquad [1]$$

is a necessary condition for all environmentally sustainable strategies; it is not a sufficient criterion, since the rate and/or the speed of delinking might be too slow to solve our environmental problems. This implies that economic growth can only lead to an environmentally sustainable path if it is accompanied by resource productivity increases at a higher rate than the rate of economic growth. In the long run this relative limit to growth transforms into a quite strict one, as far as the growth potential of resource productivity is limited by the laws of thermodynamics (see e.g. Georgescou-Roegen 1971, 1976). We can thus assume that there are limits to the increase of the resource productivity (a Factor 10 may be possible, but a Factor 100?); hence economic growth has to be restrained to fulfil inequation [1].

The total output Y can be written as the total active labour force L multiplied by the *labour productivity* Y/L, measured as the average per capita production. The production per capita is given as the average output per working hour Y/h multiplied by the average working hours per capita h/L.

The number of people employed L increases only if during a period the economy grows faster than the average production per capita, that is if

$$dY > d(Y/L). \qquad [2]$$

If we regard the creation of additional jobs at least in Europe as an indisputable precondition of social sustainability or as one indicator for the social dimension of sustainable development (see sec. 2), this relation describes a necessary, although not sufficient precondition for social sustainability.

Since

$$Y/L = Y/h \times h/L \qquad [3],$$

the labour productivity Y/L depends on the hourly productivity Y/h as well as on the number of working hours h/cap. It is increasing with growing labour productivity per hour and decreasing with reduced working times. So weekly working time, early retirement, part time jobs etc. are captured here in their effect on employment through their effect on the average working time.

The growth of labour productivity is supported by technical innovations. They have got an upper limit as well as the increase of the resource productivity. When this limit will be reached, only a part of the labour force will be employed in classical employee situations.

The creation of additional jobs can reduce the high rate of unemployment but is not an adequate strategy to react to recent developments in European societies.

The flexibility of paid work regarding location time type of labour and content of labour) is already about to appear. The differentiation of labour time (overtime, flexible working hours, time accounts, part time employment and early retirement,...) as well as the organisation and the division of labour are becoming increasingly important as well as informal labour (caring work, work in/for the community etc.).

In the context of social sustainability an extended definition of the term "work" itself is necessary, which comprises additionally to the usual gainful employment the already mentioned types of labour: the ", caring work, voluntary work in the community and parts of work as self-provider.

This extended definition of labour is suitable to realize the "mixed work", which is defined as

- the individual combination of different jobs at the same time (horizontal mixed work)
- the different biographically combinations (vertical mixed work)
- and the transitions between the different combinations.

The concept of mixed work tries to connect the dynamic of development of employment with the requirements and potentials of social sustainability. It presupposes the revaluation of the so called informal work, the possibility of various multiple combinations and the promotion of transitions. It focuses more on equality of rights and participation due to the reallocation of work against the gender and age groups, and on more quality of live because of the inclusion of employment in the whole live (WZB Mitteilungen 89, 2000).

Still the reduction of the unemployment rate can be regarded as an adequate indicator for social sustainable development, because formal work (traditional jobs) do play a role also in the concept of "mixed work" in the sense that people should work still in the formal economy (probably less hours per year on average) *while* working additionally in the informal sectors.

As a condition for increasing employment is

$$dY > d(Y/L) = d(Y/h \times h/L), \qquad [4]$$

ceteris paribus the increase in hourly labour productivity Y/h must be limited to $d(Y/h) < dY$, otherwise the working time h/L has to decrease sufficiently to offset increases in Y/h to keep the increase d(Y/L) below the total economic growth dY.

Combining the two relations above, $dY > d(Y/L)$ and $dY < d(Y/R)$ (both include implicitly the economic dimension of sustainable development with dY) we can conclude that as a necessary precondition, sustainable growth is only possible, if

$$\mathbf{d(Y/L) < dY < d(Y/R).} \qquad \mathbf{[5]}$$

We call this the *minimum condition of socio-environmental sustainability*. As a minimum condition, it helps to distinguish growth patterns that are definitely not sustainable from those that might be so. The key criterion to identify the real sustainable conditions would then be a quantitative one, i.e. whether the difference between the terms is significant enough to signalise a growth pattern distinctly different from the current unsustainable one. Guidance for assessing the quantitative necessities can be drawn from targets derived from the ecological research regarding the carrying capacity of natural systems for the right hand side of the inequation (e.g. factor 4 for energy consumption, factor 10 for material flows). For the left hand side input can be gained from social and political sciences and from societal debates, regarding the accepted levels of unemployment and the preferred working times in different countries.

We see, that there is a *trade-off* between [1] and [2]. [1] requires slow economic growth, which increases the chance for a sustainable path, whereas [2] supports strong economic growth to reduce the unemployment rate. As said above, the growth of resource productivity is limited, so is economic growth to fulfil [1] and growth of labour productivity to fulfil [2]. Looking to the past 150 years labour productivity has been increasing and still is. From [2] we know, that it is decreasing with reduced working time. Hence part time jobs, reduced yearly working time and other forms of working time reduction can be seen as a solution for this trade-off (Omann/Nordmann 2000).

IV.Empirical Application

IV.1Experiences from a German Case Study

A German research project, named "Labour and Environment" (running from 1998 to 1999), suggested possible future sustainability scenarios for Germany and fed them into a macroeconomic simulation model. The results show the relationships between the indicators, the productivities and how they can be influenced through policy measures.

The relationship [5] has been at the heart of the development of the so called socio-environmental sustainability scenario or integrated scenario (see Hans-Böckler-Stiftung 2000, ch. 4.4), and it was used to evaluate the scenario assumptions based on dynamic model simulations. A highly disaggregated econometric model, "Panta Rhei"[4], serves for the quantitative illustration of the different possible issues and instruments proposed by the scenario. Panta Rhei is a dynamic input/output model, based upon empirical data and is expanded with environmental data, namely energy, emissions (CO_2, SO_2, NO_X) and material flows[5]. It divides the economy into 58 sectors, like the "System of National Accounts" in Germany and is thus able to provide information about inter- and intrasectoral structural change as induced by a certain policy approach. The simulation was calibrated from 1980 to 1994 and is running from 2000 to 2020 (for more details see Bockermann et al. 2001, Meyer et al. 1999). The results provide insights into possible trade-offs between macroeconomic, social and environmental variables such as economic growth, the unemployment rate and material flows due to specific policy instruments, that are suggested by and tested in the scenario (see Table 1). While searching for "double dividend" opportunities, the scenario shows how policies for dematerialization and the reduction of unemployment can be designed and how macroeconomic, social and environmental parameters are interrelated (see Spangenberg et al. 1999).

Table 2 shows the development of the main quantitative indicators over the 20 years of simulation. They are measured in monetary terms (GDP) or in physical terms (TMI, CO_2).

At a first glance the results in Table 2 are satisfying. The GDP is still growing with a rate between 1.57% and 1.97%, the unemployment rate is decreasing significantly to a level that can be seen as full employment and both environmental indicators show negative growth rates. But these numbers must be seen in connection with the sustainability requirements developed in 3.3.

The first criterion is deducted from relationship [1].

In order to be environmentally sustainable, the resource productivity has to increase faster (or drop slower) than the volume of output Y.

The growth rates of the environmental indicators are both decreasing from the first year the policy measures set in, resulting for each period in a growth rate below the one for GDP. This satisfies the condition set out in equation [1].

But as can be seen easily from Table 2, the growth rate of the material inputs is loosing its upward tendency from 2005 on. It is still negative, but at a lower rate. The growth rate of the GDP is slightly decreasing, however remaining positive. This signals that the effects of the tested policy measures are worn out over time. In the long run this trend might lead to a situation where the growth rate of the GDP and the one of the material inputs would cross each other (see Fig. 1), indicating a non sustainable development according to the inequations above. To prevent that kind of dynamics, in the medium term (> 20 years) additional policy measures need to be taken (Spangenberg et al. 2000).

Equation [1] can also be formulated for other resources, such as R in general or CO_2-emissions. Concerning CO_2-emissions, the equation is as well satisfied, but the result is not satisfactory in the long run. The relationship of the indicators and their development can also be seen in Figure 1.

Relationship [2] shows a minimum criterion for social sustainability. The number of people employed L increases only if during a period the economy grows faster than the average production per capita.

The fulfilment of [2] can also be proved with the data of Table 2. The unemployment rate is decreasing, having thus a negative growth rate. Social sustainability expressed in equation [2] is satisfied, the growth rate of the labour productivity is always below the growth rate of the GDP. This reflects the reduction of working time and the increase of gainful employment (number of employed persons is increasing with 1% per year from 2000 to 2020).

The rate of unemployment as indicator for social sustainability is decreasing from 12% in 2000 to about 3% in 2020 with 1.2 millions of unemployed left. The working time per capita per year is decreasing, the average weekly working time in 2020 is about 27 hours per week. The available income is increasing by closely to 30% (Spangenberg et al. 1999). In contrast to the environmental criterion, the very long run fulfilment of the social criterion seems to be sustained.

Figure 2 shows relationship [2] and its development.

Finally we regard the minimum condition of socio-environmental sustainability,

$$d(Y/L) < dY < d(Y/R). \quad [5]$$

which says that the GDP growth rate has to be in between the growth rate of the labour productivity and that of resource productivity, which of course is confirmed, since both the right and the left hand side of [5] are fulfilled. It is shown in Figure 3.

Despite these satisfying results, the impression that the trade-off between economy and environment might have been overcome does not hold in the long run. The strategies recommended in the scenario and integrated into PANTA RHEI lead to an absolute decoupling (Luks 1995) of economic growth and resource depletion, but in the long run additional policy measures will be necessary to cope with the effects of continued economic growth.

IV.2Austrian Data

Based on data of Biffl (2000)[6] and Statistik Österreich/IFF Social Ecology[7] we also checked the minimum conditions for sustainability developed in 3.3 for Austria.

Table 3 indicates that the minimum criterion for social sustainability condition (i.e. the number of people employed L increases only if during a period the economy grows faster than the average production per capita) is valid for Austria over the periods 1970 – 1980 and 1980 – 1990. But if we use the labour volume (LV)[8] as reference data (table 4), the minimum condition for social sustainability is no longer fulfilled.

If we consider the environmental sustainability, the growth rate of GDP has to increase slower than that of resource productivity (d[Y/DMI]). The Austrian data (see table 5) indicate that neither from 1970 to 1980 nor from 1980 to 1990 this minimum condition is satisfied. The gap between both growth rates was very high in the first decade, showing a decrease during the second decade, which indicates a development that approaches environmental sustainability, as we defined it above.

V.Conclusions

This paper showed how the relatively recent concept of total material flows can be integrated in economic modelling as well as in empirical studies. Exploring this further will help to discuss the effects and effectiveness of measures and policies for dematerialization on all relevant macroeconomic variables. The whole range of instruments usually discussed in environmental economics can be used also for the more recent goal of dematerialization: from the provision of relevant information, over fiscal reforms and tradable permits for the extraction of primary resources to command and control measures. In principle, the usual theoretical pros and cons that are discussed, for example, on energy taxation apply. The macroeconomic modelling, however, can show in more detail the overall possible outcome of a specific mix of such instruments. Further research is certainly needed to explore in more detail the structural, distributional, allocation and scale effects of such policies – especially for the Austrian and European cases.

The German project on „labour and environment“, from which much of the data presented in this paper is derived, showed that under the assumptions made a policy towards sustainable development can lead to favourable results in all relevant dimensions of sustainable development, as required by the European treaty and sustainable development strategy. There are certainly paths possible which lead to better results in *one or two* of the dimensions, and it could be shown that only relatively minor trade-offs exist if adequate strategies are developed to follow economic, social *and* environmental policy goals.

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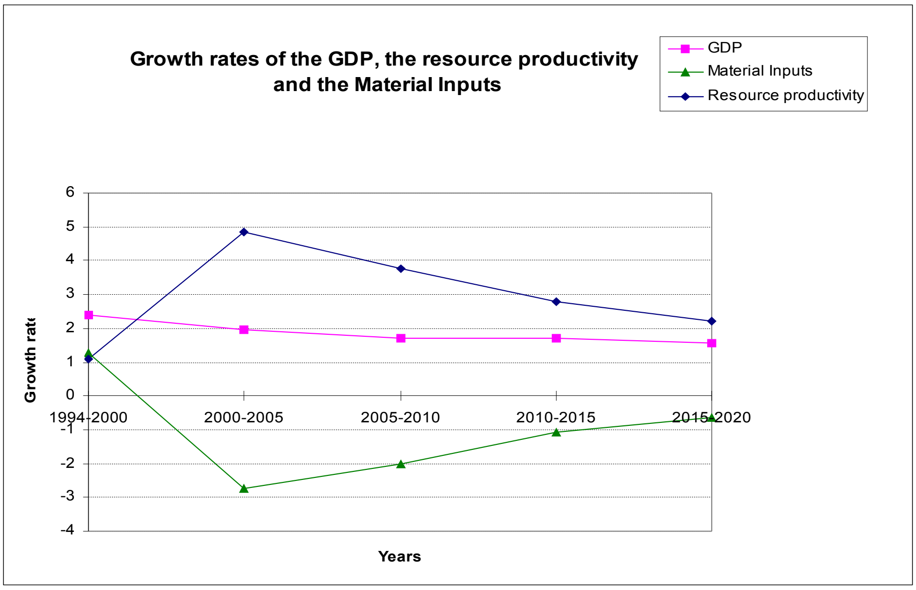
Tables:

. *Source*: own

	Y (1960 = 100)	d(Y)	DMI (1960 = 100)	Y/DMI	d(Y/DMI)
1970	158,7		130,8	1,21	
1980	229,6	0,4468	176,5	1,30	0,0722
1990	288,4	0,2561	186,3	1,55	0,1900

Figures:


Growth rates of the GDP, the resource productivity and the Material Inputs
GDP
Material Inputs
Resource productivity
6
5
4
3
2
1
0
-1
-2
-3
-4
Growth rate
1994-2000
2000-2005
2005-2010
2010-2015
2015-2020
Years

[1]Notes:

□ Earlier versions of this paper were presented at the University of Pisa, October 2000 and the Annual Meeting of the Austrian Economic Association, Graz May 2001.

[2] Additionally, a fourth dimension, i.e. the institutional one, has increasingly been integrated into this concept (Spangenberg 1999). The inclusion of the *institutional* dimension takes account of the fact that each economic activity is performed within an institutional framework that decisively influences the result of the activity (Hinterberger/Luks 2001). Therefore, socio-economic changes, such as the implementation of the sustainability concept, also require the further development of institutions.

[3] See http://www.europa.eu.int/council/off/conclu/dec98.htm or the documentation in Schepelmann et al. (2000).

[4] Panta Rhei was developed by Prof. Bernd Meyer at the University of Osnabrück, Germany. It is the environmental expansion of INFORGE, a dynamic input/output model that belongs to the international INFORUM family (Meyer et al., 1999); see also http://www.gws-os.de for more details.

[5] The data for the material inputs in all 58 sectors were provided by the Wuppertal Institute.

[6] Biffl (2000) shows the development of labour volume and productivity from 1964 to 1999 for the Austrian economy.

[7] To represent the material efficiency of the Austrian economic over time, Statistics Austria and IFF – Social Ecology (see Gerhold/Petrovic, Statistische Nachrichten 4/2000) have published input time series of the material flows for the years 1960 to 1997. To operationalise the material input, the indicator Direct Material Input (DMI) is used.

[8] Calculated as number of emloyees multiplied with the average yearly working hours.