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Economic and Environmental Effects of Material Efficiency Gains

by

Bernd Meyer

University of Osnabrück
Department of Economics
49069 Osnabrück
Tel.: +49 541 969 2767
Fax: +49 541 969 2769
bernd.meyer@uni-osnabrueck.de

GWS mbH
Weissenburgerstr. 4
49076 Osnabrück
Tel.: +49 541 409 3314
Fax.: +49 541 409 3311
meyer@gws-os.de

1. Introduction

Material efficiency gains or the rise of material productivity:

GDP in constant prices rises in relation to material inputs in physical units

Can be caused by:

- A change in the vector of final products (Substitution of material intensive products).
- Material saving innovations in the production of a given vector of final products.
- Avoiding inefficiencies in the use of known technologies to produce a given vector of final products.

Dematerialization policies should be targeted to all three reasons, the third one is in the focus of the presentation.

Why do firms operate at a sub optimal level concerning the inputs of materials?

- Controlling instruments do normally not show material losses explicitly.
- Cost reductions usually mean reductions of labour costs.
- In the past material prices have had strong cyclical movements, but no trends.
- Procurement decisions for machines are often influenced only by the price of the machine and not by their life-cycle costs.
- The management often is not aware of the available technical alternatives and their implications for the costs.
- The exchange of information about material management is lacking because institutional premises are not provided.

Result:

- Too heavy machines and construction.
- Material waste in industry, construction, trade and private households.
- Lack of recycling.

Diagnosis:

- Market failure.
- Government could be the moderator of an information and consulting program for a more efficient material management.

Empirical evidence from consulting firms (Fischer et al. 2004):

- In manufacturing sectors there is a saving potential of 20% of material inputs.
- This **permanent** reduction of costs can be achieved by additional capital and service inputs in the magnitude of the savings of **one year**.
- One third of the additional inputs are consulting services, two thirds are additional capital inputs.

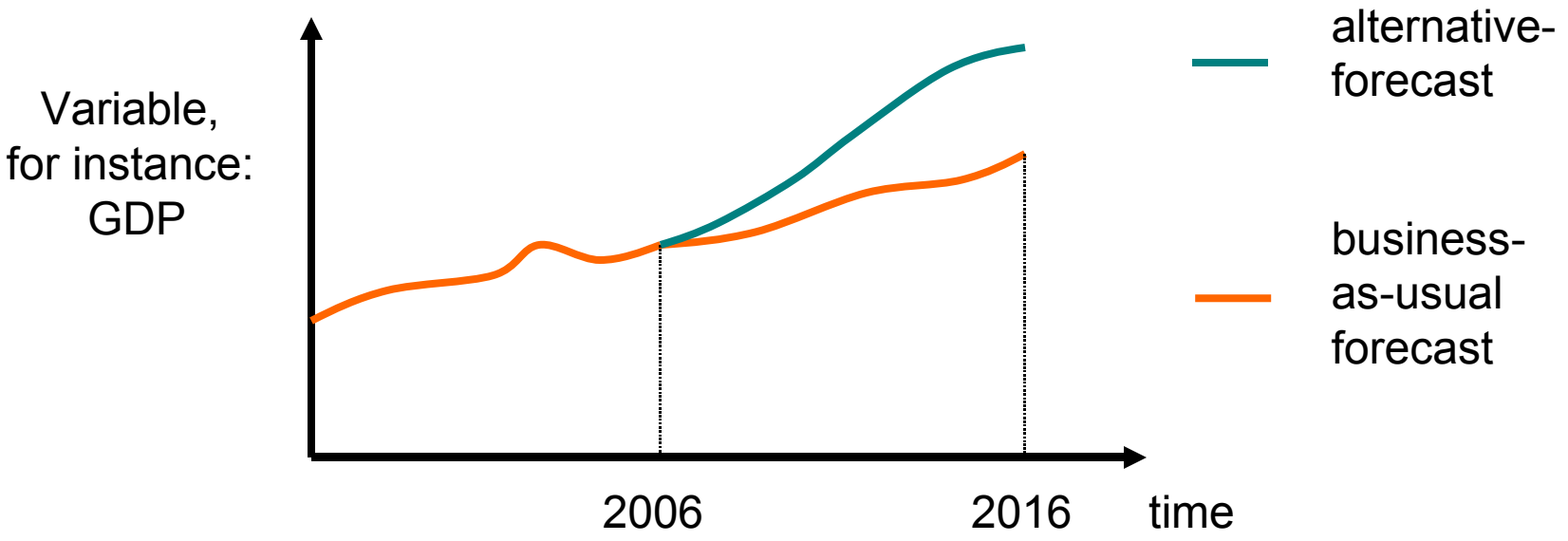
Question of the presentation:

- Taking these relations as realistic: What are the economic and environmental impacts of an information program, which would reach all firms of the economy?
- Results published in Distelkamp/Meyer/Wolter 2005 a.

2. How do we measure the economic and environmental effects of rising resource productivity?

Experiment with a model of the economy

Comparison of a business- as– usual forecast with an alternative forecast assuming higher resource productivity



Requirements for the structure of the model

Structure of the model:

- Modeling on the sector level with full output- and cost structures
- Variable interindustry relations
- Linkage with the world economy in deep sectoral detail
- Modeling the behaviour of consumers, investors and producers considering the use of stocks like cars, houses.
- Labour market in deep sectoral disaggregation
- Redistribution of income between public and private households
- Energy demand of households and producing sectors in carrier detail

- Material extractions and imports of different kind
- Indirect material inputs of goods imports.

Ability of the model:

- Empirical validation that allows a good explanation of the historic development

Requirements are fulfilled by the model PANTA RHEI

- Deeply disaggregated simulation and forecast model for the analysis of economic environmental interdependencies.
- Since many years successfully used as an instrument in research and consulting.

3. A Program for Growth of Material Productivity: The “Aachen” Scenario

Assumptions, based on considerable experience of consulting firms:

⇨ 20 % reduction of material and energy costs of manufacturing sectors, construction and public administration in 11 years (linearly from 2005 to 2016),

⇨ savings of material inputs induce for one year additional consulting and capital costs of the same magnitude,

⇨ in the case of energy inputs the induced costs equal the savings of six years,

⇨ one third of the additional costs are consulting costs, two third are capital costs.

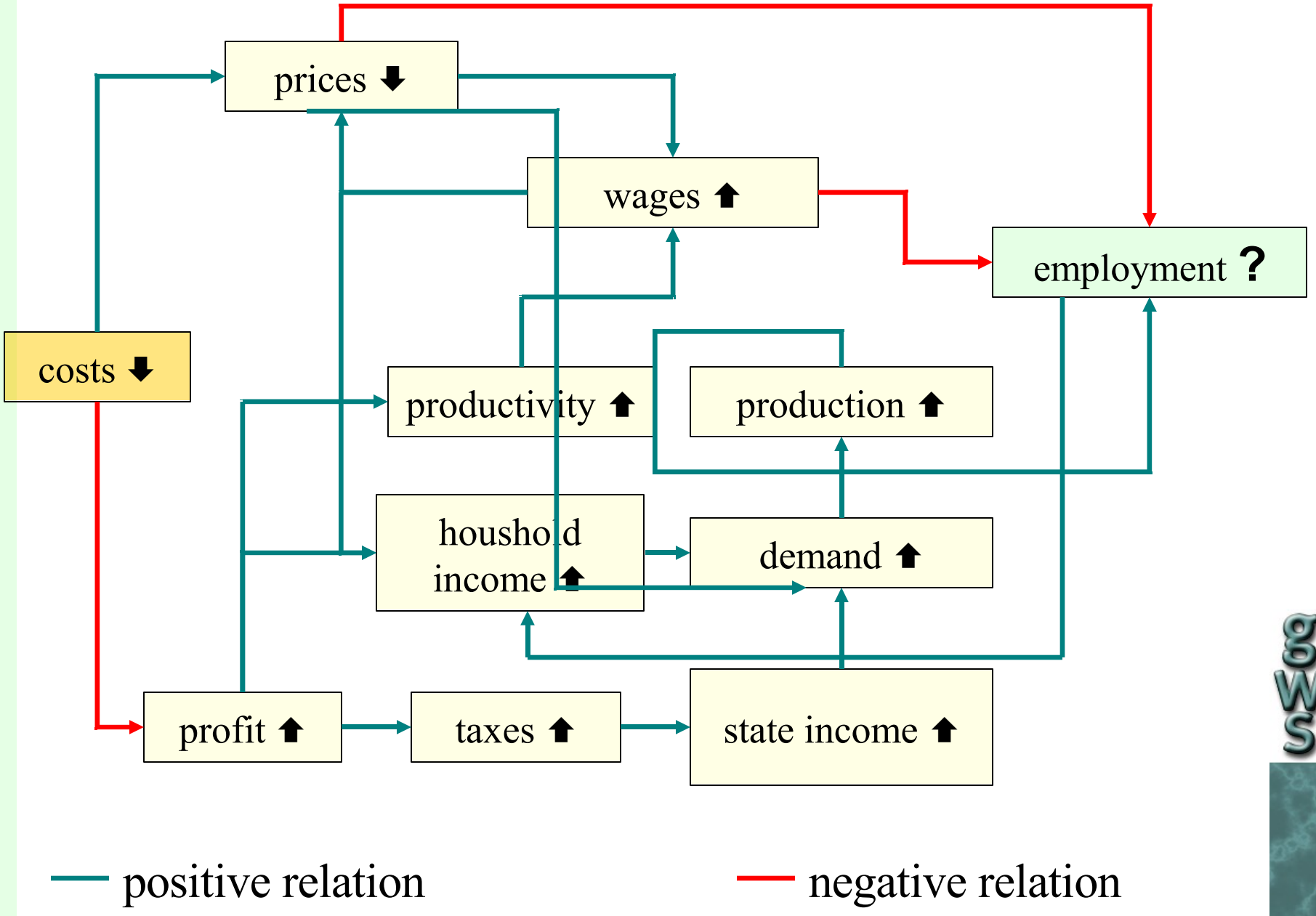
Results:

⇨ direct effects:

- winners: receivers of material inputs
  -domestic firms
- losers: deliverers of material inputs
  -domestic firms
  -firms from foreign countries
  ➔rising GDP

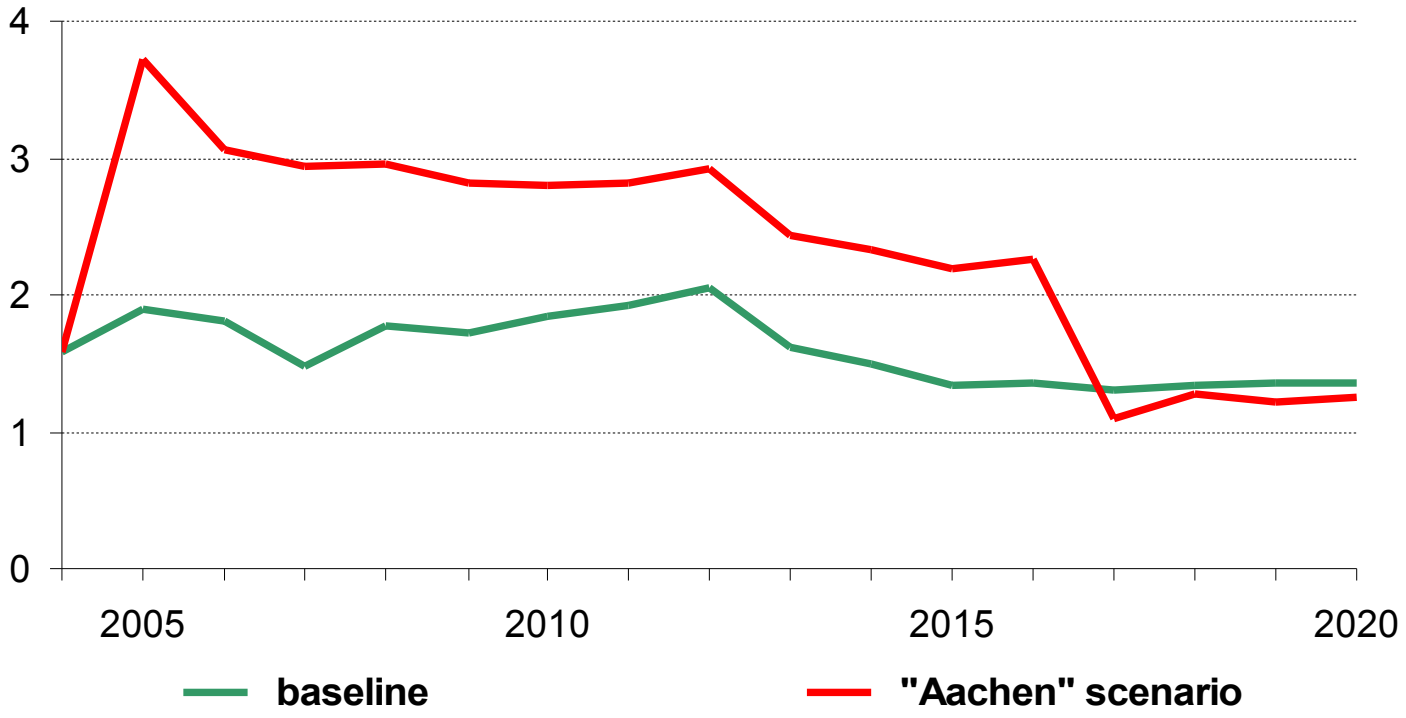
⇨ indirect effects:

- rising productivity,
- falling prices,
- rising production, income and employment.

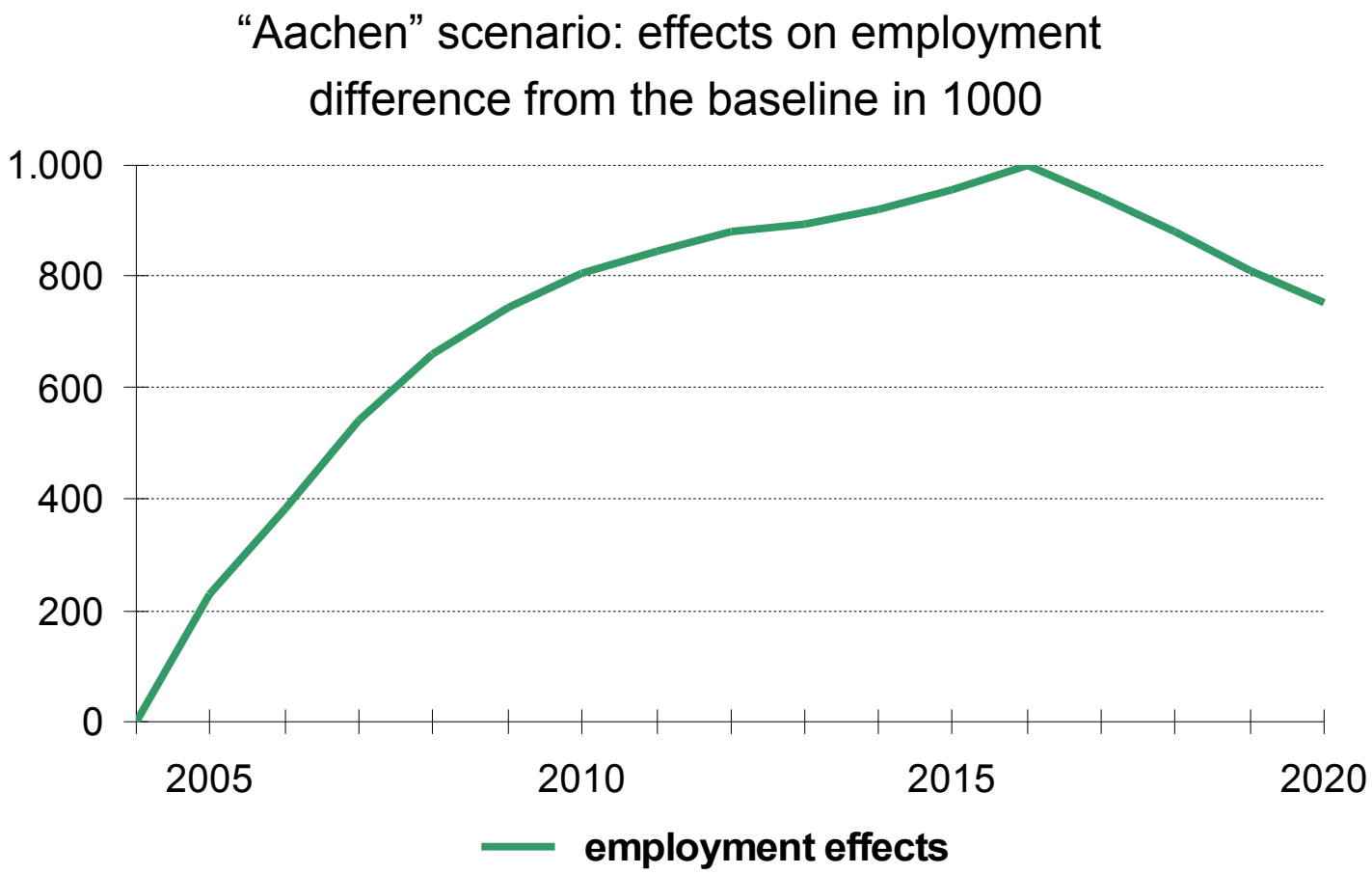

prices ⬇
wages ⬆
employment ?
costs ⬇
productivity ⬆
production ⬆
household income ⬆
demand ⬆
profit ⬆
taxes ⬆
state income ⬆
positive relation
negative relation

⇨ GDP: growth rate expands by 1 point per year

GDP growth rates in the baseline
and in the “Aachen” scenario

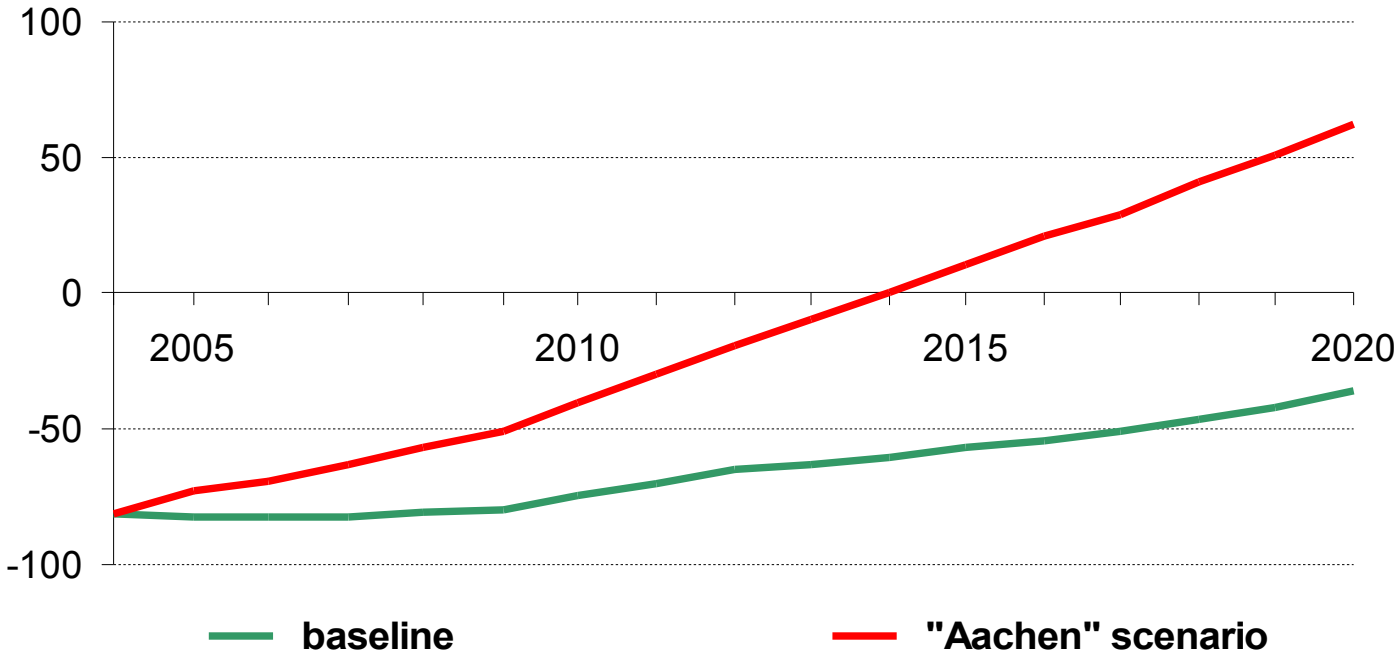


⇨ employment: rises up to 1 million persons in 2016



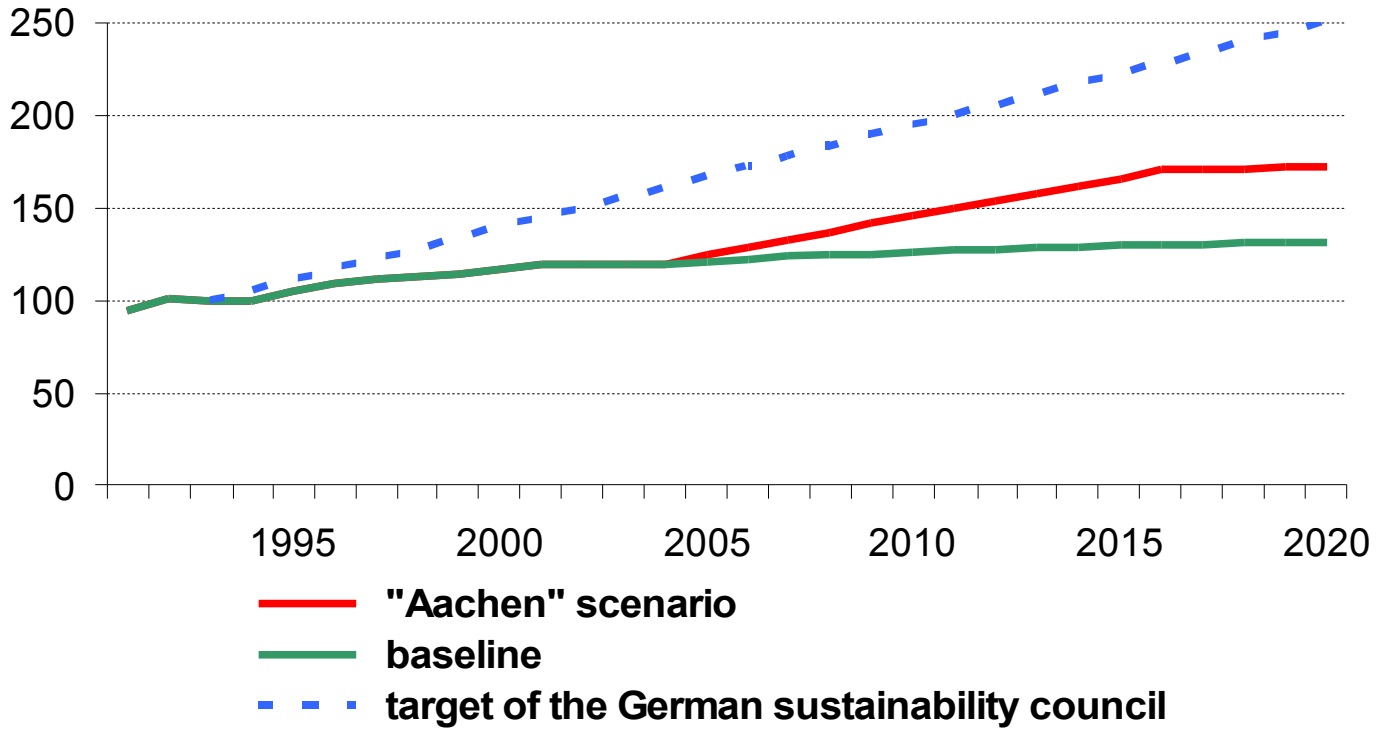
- net lending of the government: zero in 2014, plus 60 billion € in 2020

net lending/borrowing of the government in the baseline and in the „Aachen" scenario in billion €



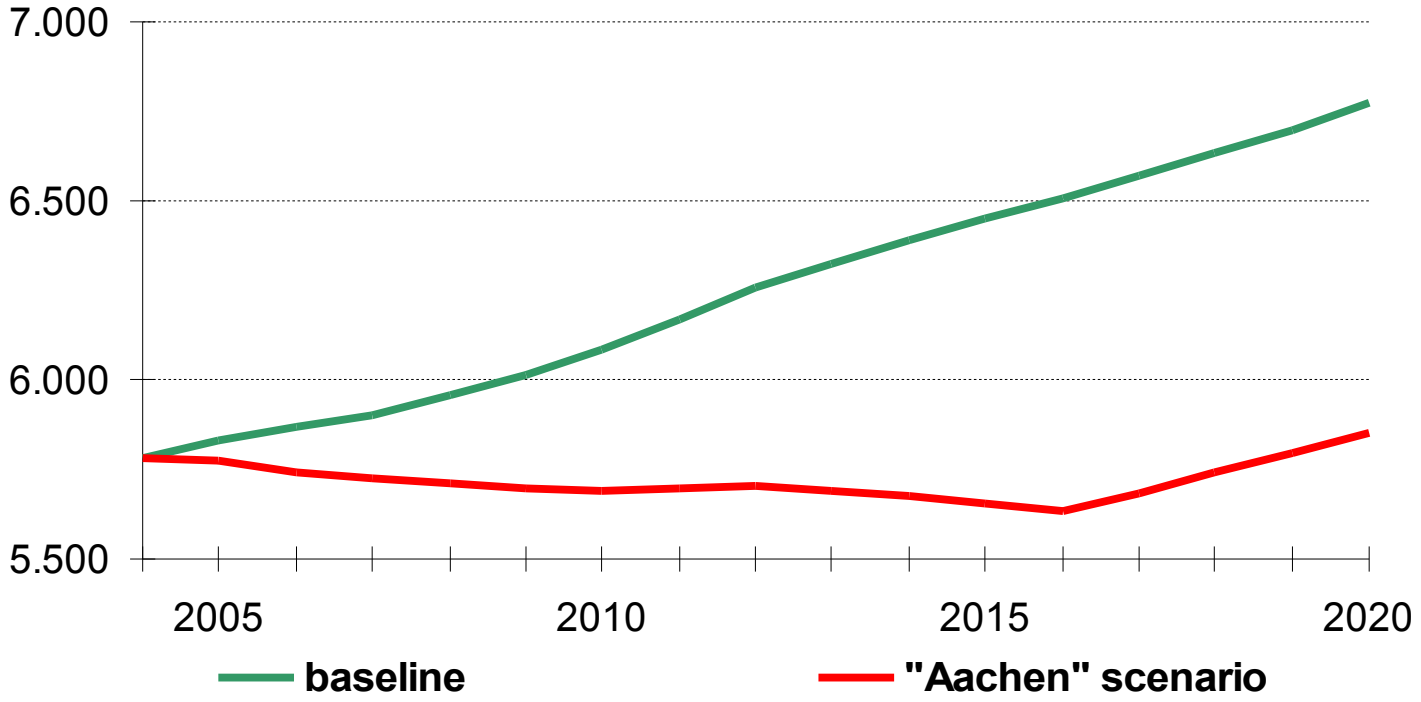
⇨ material productivity: growth rate during the program about 2.9% per year

material productivity in the baseline,
the „Aachen“ scenario and the target



⇨ total material requirement: rise of material productivity is just strong enough to disconnect economic total material requirement from economic growth

total material requirement in the baseline and in the „Aachen“ scenario in mill. tons



4. The Aachen - Scenario in European countries

- EU-project Mosus (MOdeling SUStainability in Europe)

- focus
  - domestic material extraction
  - land use

- Instrument

  Economic – environmental model

  GINFORS (Global INterindustry FORcasting System)

  Global multisector / multicountry economic-environment model
  - 43 sectors, 42 countries
  - connected by a bilateral world trade model for 26 product groups

- Scenario, differencies from the PANTA RHEI simulations:

  - Only manufacturing sectors, not public services reduce their intermediate inputs.
  - Only the inputs of primary products (sector 1-14) without energy (sector 2 and 7) are in the focus of the information program.
  - Longer simulation period (2006-2020)

- Results:

- The same qualitative results as in the PANTA RHEI simulation:

  - rising GDP
  - rising employment
  - rising material productivity
  - falling prices

- Great quantitative variety between the countries

Table 1: Impacts of technological change on selected variables in 14 European countries. Percentage deviations from the baseline in the year 2020.

		Deflator			Nominal		Total	Total Prim.	
		GDP	Consumption	Real GDP	wage	Employment	Dom. Extr.	Ene. Supply	CO2 Emission
1	AT	-10.27	-4.61	4.66	-8.78	0.91	-5.04	-1.89	-1.60
2	BE	-17.15	-12.54	7.53	-2.65	-2.13	2.99	-2.16	-0.90
3	DK	-8.57	-8.57	8.81	-5.22	1.51	-2.83	-0.03	-9.48
4	FI	-16.26	-14.78	13.99	-9.75	5.16	-3.85	-3.04	-3.14
5	FR	-10.87	-9.88	11.65	-6.97	4.70	4.32	5.15	2.98
6	DE	-12.88	-8.13	10.01	-5.87	1.16	-1.70	2.53	0.76
7	GR	-24.73	-16.24	3.57	-21.13	-0.73	-3.81	-2.48	-2.97
8	IT	-11.77	-8.51	9.38	-5.06	-0.64	4.45	0.32	-0.33
9	NL	-9.90	-5.77	5.58	-6.04	0.53	0.58	0.07	-0.74
10	ES	-23.68	-18.42	10.32	-14.22	4.02	3.02	3.31	-4.74
11	SE	-25.36	-20.56	9.51	-16.08	2.50	-1.92	-1.58	-4.87
12	GB	-10.71	-9.03	4.86	-6.97	0.46	0.23	-0.03	-0.32
13	CZ	-4.79	-2.92	13.44	4.52	1.73	2.41	5.68	5.10
14	HU	-10.33	-7.40	15.60	-0.77	7.15	3.83	8.55	11.67

5. Conclusions

Result of the "Aachen" scenario remarkable:

⇨double dividend: improved economic performance plus rise of material productivity.

⇨but: rebound effect (more economic growth means more material input) allows only stabilization of total material requirement.

Improvement of the design of the program:

⇨further rise of material productivity by concentration of dematerialisation efforts on strategic technologies.

Project for the identification of strategic technologies just finished. (Distelkamp/Meyer/Wolter, 2005b)

A reduction of the 1% most important input-coefficients by a certain amount gives 60 % of the material savings that can be achieved by the reduction of all input-coefficients.