SUSTAINABLE FURTHER EVOLUTION OF THE GLOBALIZED SOCIETY => REQUIRED LIMITATION OF THE ECONOMIC, ECOLOGIC AND DEMOGRAPHIC MOMENTUM

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Abstract: In this paper the different kinds of world wide existing momentums are pointed out inclusive their interactions and possible countermeasures for a sustainable further evolution of the globalized society.
The investigations for stabilizing the economic, the ecologic and the demographic momentum have been carried out on the one hand by analytical considerations based on functional block diagrams and on the other hand by quantitative simulations, both based on a holistic global dynamic model. Therein the parameterizing and the verification of the global model were done by the comparison of simulation results and corresponding measurements taken from referring statistical yearbooks.

Keywords: Globalized society, economic momentum, ecologic momentum, demographic momentum, positive feedbacks, automation degree, countermeasures.

1. INTRODUCTION

The ever-faster progress of technological and scientific development, linked with the increasing consumption of resources and strain on the environment, began quantitatively considered first after the second world war, and thus a few decades ago (Welfonder and Frederking, 2002). Electronic data process and the widespread use of intelligent electrical and electronic equipment in control circuits have made a major contribution in this area.

Since the early 1970's, system analysts (Meadows, 1972) and control engineers (Mesarovic and Pestel, 1975) have already dealt with the question of a suitable further development of industrialized society. However, at that time the considerations on this subject, which had also lead to the founding of the Club of Rome, were not nearly as relevant for the present as they are in our days. This also applies to the early statements (Welfonder and Henning, 1978) of the first author of this paper.

Then at that time the different cultural and economic sectors were still largely disconnected from each other, and this among others, due to

- the economic and political borders that still existed,
- only limited mass production as the result of still minor automation,
- only few communications options as the result of only limited possession or access to telephones and television sets, especially in the threshold and developing countries, as well as the lack of fax machines, cell phones and modern email systems, as well as due to
- only little intercontinental tourist traffic caused by high airfares in earlier times.

Since the mid/late 1990's, reality has caught up with, if not overtaken, the considerations of that time (Meadows, 1972; Mesarovic and Pestel, 1975).
After all, the different world economic and cultural areas move ever closer together due to the growing exportation of goods, due to the shifting of produc-

tion plants to low-wage countries, due to worldwide low-cost tourism and due to state-of-the-art communication and IT systems to form a world which is globalized, but continues to be extremely heterogeneous (Huntington, 1996). This development entails a constantly growing consumption of resources (von Weizsäcker, *et al.*, 1999; Schmidt-Bleek, 2000) with a corresponding increase in the strain on the environment (Lozan, *et al.*, 2001). Already today, the major power countries attempt to secure access to the as yet untapped mineral resources in foreign regions, which is answered with insidious aggressions by the other side.
In addition, the industrialization in the threshold countries striving for prosperity is advancing rapidly, which leads to additional production and to a related worldwide increase in overall production, as well as to a further increase in the consumption of resources and the strain on the environment.
On the other hand, the world population is continued to grow exponentially, by others due to poverty in the developing countries and in large areas of the threshold countries (Leisinger, *et al.*, 1999; Birg, 2001).

Therefore, what we need are objectives for a sustainable further development of globalized society (Gore, 1992; Laszlo, 1998; Annan, 2001; Radermacher, 2004), even if we have to adapt these over the course of time.
To show the backgrounds, i.e. the positive feedbacks of the three momentums described in the following, as well as to examine the effectiveness of possible countermeasures, the authors have developed a corresponding socio-economic white-box dynamic model (Welfonder and Frederking, 2002; Welfonder, 1988; Welfonder, 2000). In the course of this paper there will be reported by others on simulation studies already conducted and those planned for the near future.

2. SUMMARIZING MODEL DESCRIPTION

In the foreground of the overall model, there is the Momentum I, i.e. increasingly rapidly progressing techno-economic development, taking into account “supply and demand” as well as the social reactions due to increasing rationalization and the related structural unemployment particularly in industrialized countries.
Coupled with this is the increasing consumption of resources and the growing strain on the environment; Momentum II.
For a holistic consideration of a suitable further development of globalized society there additionally belongs the advancing population increase due to decreasing death rates and higher birth rates in countries with a lower standard of living; Momentum III.
The close interplay of these three momentums has been covered in detail in (Welfonder and Frederking, 2002). Effective countermeasures for the stabilization of the momentums have also been proposed.
In addition, a discrete time-varied population model has been developed for Momentum III, the demographic population development. This has already been applied to various world socio-economic areas, forecasting:

- the increasingly high percentages of old people within the industrialized countries, as well as in China, due to birth limitation, and
- the further continuous increase of population in the threshold and developing countries caused by further on continued high birth rates (Frederking, *et al.*, 2003).

2.1 Model structure

The overall structure of the developed socio-economic model is based on the social accountings (Peto, 2000) of the national/supranational statistic offices, such as the Statistical Yearbooks for the Federal Republic of Germany, National accounts of the European Commission, the National Accounts of OECD countries (Federal Statistical Office, 2003; European Commission, 2002; OECD, 2004) etc.
This enables a model adjustment on the basis of the extensive data material matched to each other and being available there.

2.1.1 Socio-economic areas

For the model parameterizing the large worldwide number of countries is aggregated – in the sense of the targeted, holistic global consideration – to a limited number of supranational socio-economic areas, i.e. initially in the areas

- Industrialized Countries,
- Threshold Countries and
- Developing Countries.

For being also able to examine a different participation of parts of the industrialized countries concerning the execution of necessary countermeasures, the industrial economic area is further divided into:

- Germany,
- "Rest of Europe” and
- "Rest of OECD”.

The carried out aggregation of the most important countries to the different national/supranational socio-economic areas can be seen in the results-figure 3/1.

2.1.2 Socio-economic sectors

In accordance with the social accountings each economic area in turn consists of four sectors: I "Enterprises", II "Banks and Insurance Companies", III "Government“ and IV "Households". In each sector all individual institutions of the respective type are grouped, e.g. the "Total of existing enterprises" or the "Total of all individual households" within each considered economic area.
A further division of the sectors into sub-sectors, such as the sector enterprises in the part sectors "Production", "Services" and a non-IT-dependent part sector named "Other branches", is always possible. However, additional fine tuning of the model should only take place for specific tasks, and therefore only for a certain time, as limits are set for an increasing model complexity due to the holistic consideration which is always to be maintained.

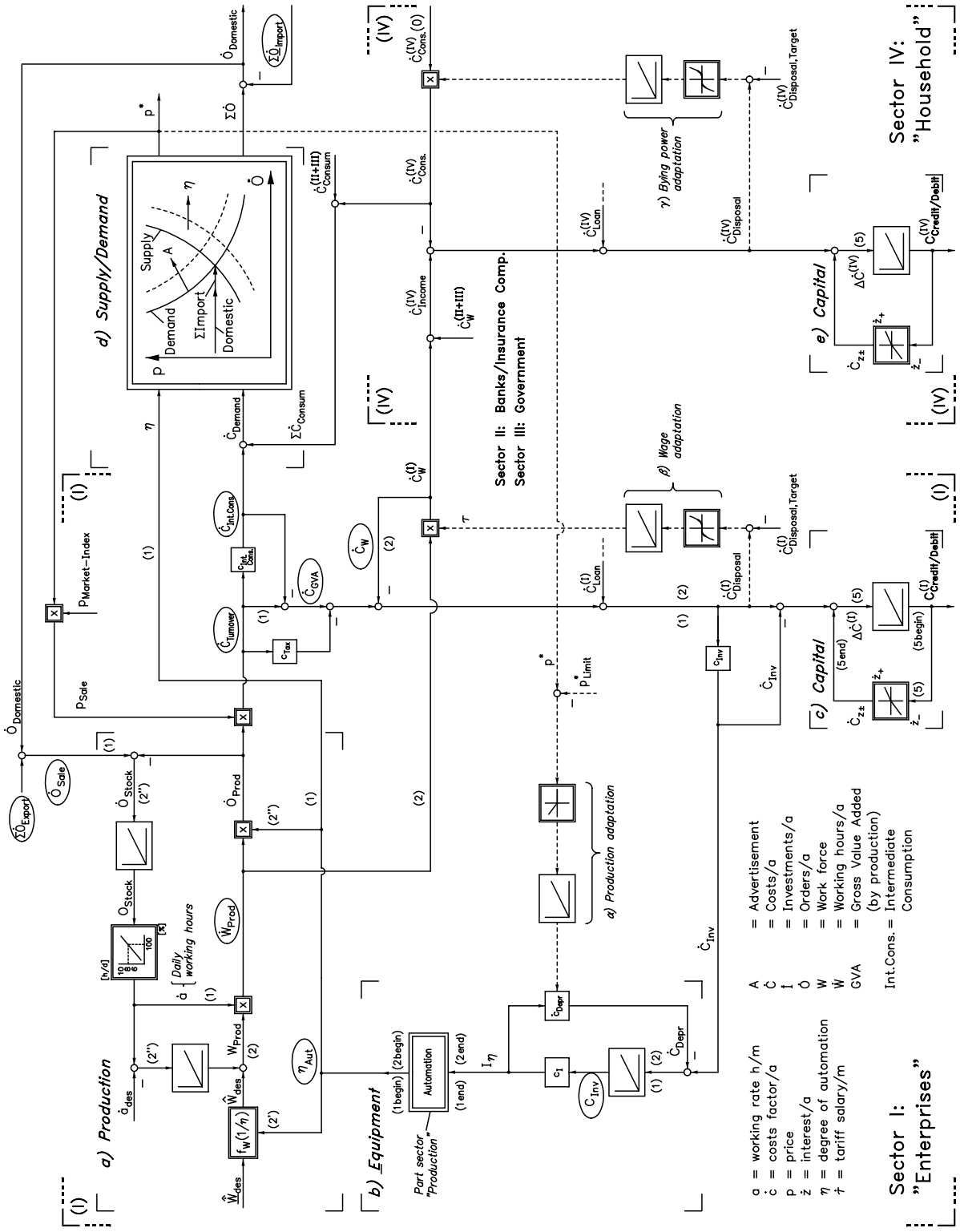


Fig. 2/1: Cooperation of the sectors I „Enterprises“ and IV „Households“
=> Compressed functional consideration

The inputs and outputs of the various economic areas, and within these of the various sectors, are linked by "0" or "1" elements via switching matrices. Here logical "1" stands for "existing link".

The structural layout of the two most important sectors, I "Enterprises" and IV "Households", is already described in detail in (Welfonder and Frederking, 2002; Welfonder, 2000). In Figure 2/1 the functional interaction of both sectors is shown in compressed form taking only the most important components and influence variables into account.

In the following the individual sub-figures are briefly explained. The additional negative feedback branches – entered in Figure 2/1 as dashed lines – will be specifically explained in section 4.2.

- Part model “Supply and Demand"
  As can be seen by sub-figure 2/1d, each economic area has its own market with its individual supply- and demand-curve. On this domestic market the sectors “Enterprises” of all economic areas offer their products and services. The demand of each economic area is based on the intermediate

consumption of the domestic sector I "Enterprises", and on the consumption of the other domestic sectors. Depending on the point of intersection of the supply- and demand-curve, which move to the right with an increase of the automation degree η or with increased advertising A, respectively a market-specific order flow $\sum \dot{O}$ and price p result.

After deducting the order flows placed by foreign companies, the domestic order flow results to:

$$\dot{O}_{Domestic} = \sum \dot{O} - \sum \dot{O}_{Import}$$

The order flow of the "Enterprises" sector in turn consists of the domestic order flow and the orders placed on the markets of the other economic areas, i.e.:

$$\dot{O}_{Sale} = \dot{O}_{Domestic} + \sum \dot{O}_{Export}$$

- Part model "Production"

  In the case that more orders $\dot{O}_{Sale}$ are received than carried out by production $\dot{O}_{Prod}$, the stock of orders O_{Stock} will increase, see sub-figure 2/1a. In the short term, i.e. with the same number W of employees (workers), this leads to:
  - an increase in the daily working time $\dot{a}$, combined with
  - more employment hours $\dot{W}$ and due to this
  - increased production $\dot{O}_{Prod}$.

  However, in order to fulfill the specification negotiated between employers and employees $\dot{a} = \dot{a}_{des}$ again, at least over the long term the number of employees W must be increased.

  On the other hand assuming constant order flows, with an increasing rationalization/automation degree η_{Aut}, the number of working hours $\dot{W}$, and with it the number of employees W, must be reduced to fulfill the condition $\dot{O}_{Sale} = \dot{O}_{Prod} = \eta_{Aut} \cdot \dot{W}$ further on. As production cannot increase indefinitely, this simple equation is the basis reason for the structural unemployment (Welfonder and Frederking, 2002; Welfonder, 1988; Giarini and Liedtke, 1997).
- Part model "Equipment"

  The automation degree η_{Aut} is in turn dependent on the annual investments in modern machinery and equipment $\dot{C}_{Inv}$, see sub-figure 2/1b. These are dependent on the annual balance of the companies, whereby the following one applies to the sector "Enterprises":

  $$\dot{C}_{Disposal} = \dot{C}_{Turnover} - \dot{C}_{Int.Cons.} - \dot{C}_{Tax} - \dot{C}_{W} + |\dot{C}_{Loan}|$$
- Part model "Capital"

  As illustrated in Figure 2/1c, the respective capital $C_{Credit/Debit}$ changes annually by the difference $\Delta\dot{C} = \dot{C}_{Disposal} - \dot{C}_{Inv} + \dot{C}_{z\pm}$.

  The same also applies to the sector IV "Households", highly simplified illustrated in sub-figure 2/1e.

In Figure 2/1 there are also signed three of the five positive feedback loops concerning momentum I (Welfonder and Frederking, 2002). Therein the automation degree η is positively fed back by the increasing orders $\dot{O}_{Sale}$ as well as by the decreasing working hours $\dot{W}_{Prod}$, comp. loop (1) and (2). The same belongs to loop (5). There the capital is positively fed back by the interests.

2.2 Model adjustment and parameterization

Model adjustment and parameterization are carried out based on time series, which have been taken from the respective Statistical Yearbooks for the period from 1980 to ≤ 2000[1] with regard to the main state variables of the individual sector models.

Based on this, the initial model values have been specified so that the interface conditions for the inputs/outputs of the various sectors and overlaid of the individual economic areas are fulfilled.

The subsequent model parameterization was carried out by means of identification and this so that the differences between measured and simulated time curves are minimized according to the method of least square errors:

$$J = \frac{1}{\hat{k}+1} \sum_{k=0}^{\hat{k}} \left[\dot{\underline{C}}_{Sim_i}(k, \underline{p}) - \dot{\underline{C}}_{Meas}(k) \right]^2 \rightarrow Min(1)$$

with $\hat{k} = (\leq 2000 - 1980)$.

As far as possible the identification has been carried out section by section and this for time-invariant parameters p_0. Only where necessary slightly time-variant parameters like the equation

$$p(t) = p_0 [1 + \alpha t]^n$$

with: $|a| < 1\%/a$ and $n = 0, 0.5, 1, 2$
have been assumed.

The agreement of measurements and simulations achieved by means of this procedure is shown in the results-figure 3/1 for the period from 1980 to ≤2000.

3. BASIC SIMULATION CASE "without future-oriented countermeasures"

The results of the basic simulation case "without future-oriented countermeasures" are shown in Figure 3/1 and 3/2.

3.1 General consideration remarks

- As the acquisition and evaluation of the statistical data of all countries proves to be extremely time-consuming, during the first time of quantitative consideration only the behavior of one typical country within each supranational economic area has been regarded. Using the national accounts of the regarded countries, i.e. France, USA, Thailand and India, the behavior of the whole supranational economic areas has been extrapolated with reference to the respective percentage of the Gross Domestic Product, as to be seen in row 5 of

[1] Due to the time required for acquiring, processing and evaluating the extensive data material, there is already a gap of several years in the Statistical Yearbooks between the year of publication and the year of the most recent time values taken into account.

National/Supranational socio economic areas

0) **Population per area**

a) Germany

P_{1999} [mill.] = = 81

b) „Rest“ of Europe

- **France = 58**
- United Kingdom
- Italy
- Spane
- ...

= 293

c) „Rest“ of OECD

- **USA = 276**
- Japan
- Canada
- Australia
- ...

= 742

d) Threshold countr.

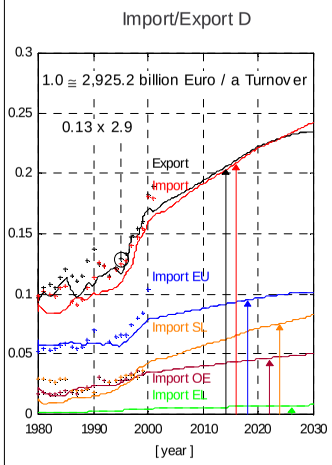
- OPEC-countries
- Russia
- China
- Brasil
- **Thailand = 61**
- ... = 2758

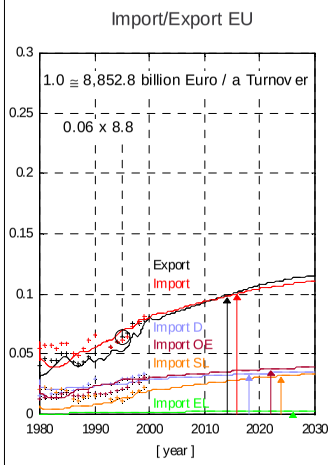
e) Developing countr.

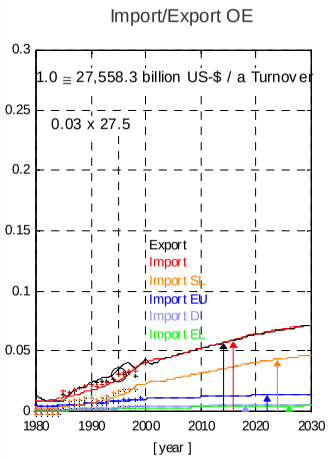
- **India = 998**
- Pakistan
- Africa
- Bangladesh
- ...

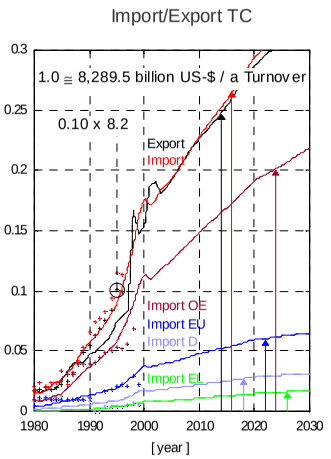
=2095

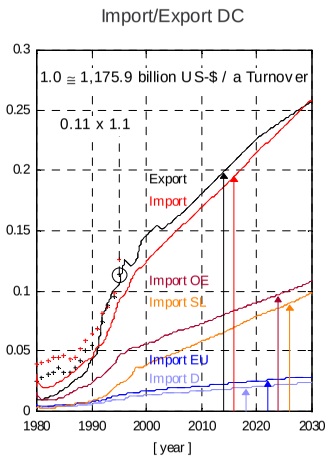
1) **Import to the economic areas**



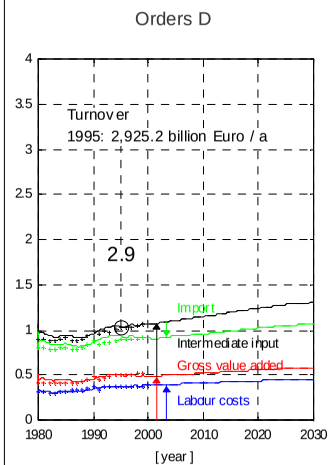


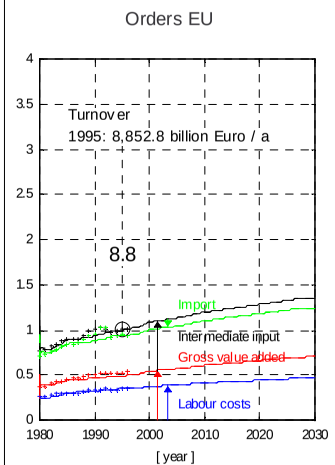


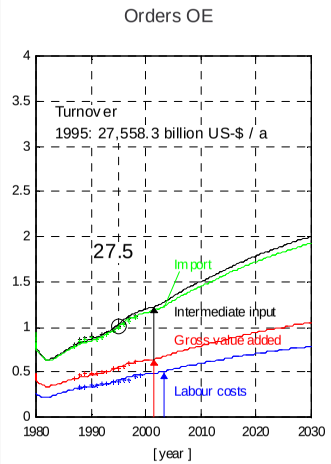


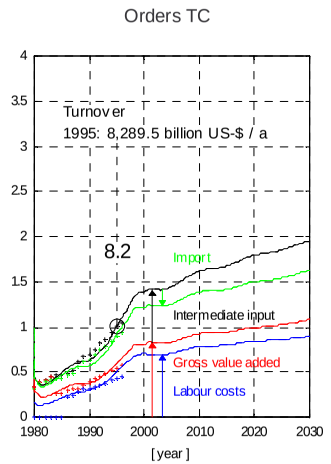


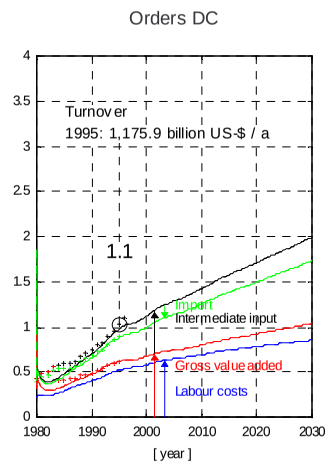
2) **Balance: Σ Enterprises**











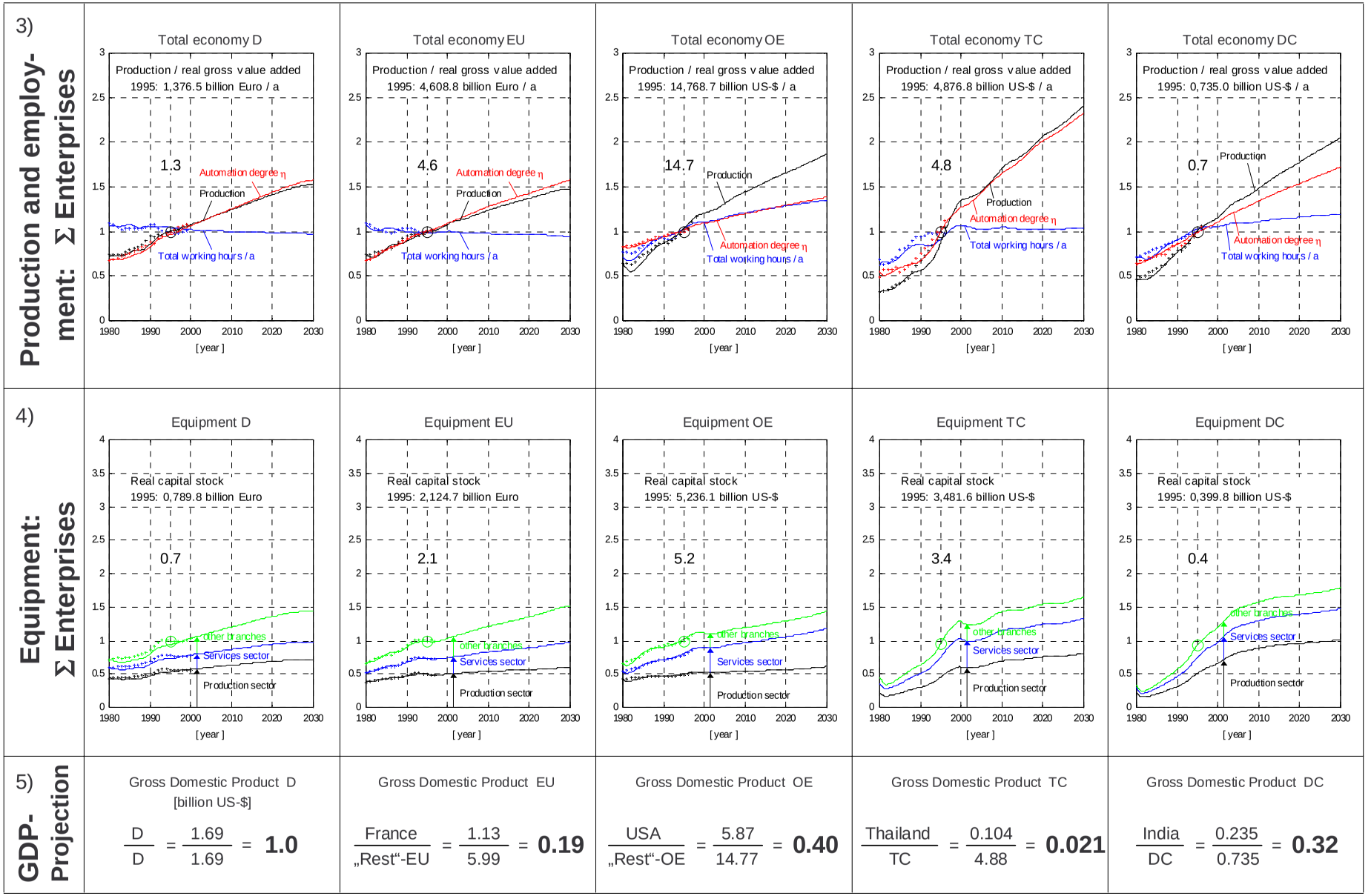


Fig. 3/1: Sustainable social economic evolution of the globalized society: **"without future-oriented countermeasures"**
=> "Measurements" and Simulation results, each time in real values

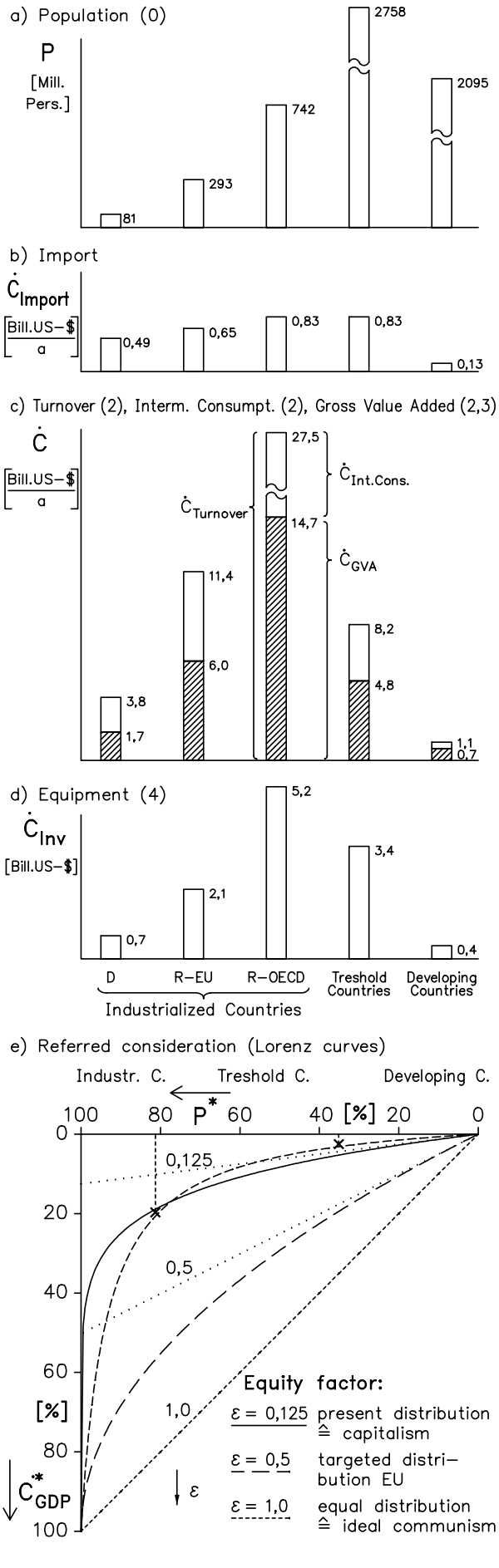


Fig. 3/2: Stationary behaviour of the five economic areas (1995) => Data according to Fig. 3/1, row (i) with 1 EUR = 1,3 US-$

Fig. 3/1. This procedure meets the demand for a holistic consideration and already enables a quantitative consideration of the trend behavior of the supranational economic areas to be predicted by simulation. Of course, the statistical data basis of the supranational economic areas must be further refined as part of further studies.

- The time curves shown in the individual subfigures refer to the sector "Enterprises" in each case. The functional assignment of the different time curves shown in Figure 3/1 can be seen by the block diagram in Fig. 2/1 where the corresponding variables are marked by elliptical frames.
- In addition, to each economic area there has been assigned a detail-figure in which the time curves of the main model variables of all sectors I to IV are compared with each other. For space reasons these detailed figures could not be included in this paper.
- For easy comparison all costs C_i or cost flows $\dot{C}_i = \frac{dC_i}{dt}$ illustrated in the results-figure 3/1 are shown as real values[2], i.e. without inflation. In addition, the graphical presentation of the result-curves is made in the per-unit system with reference to the respective cost values in 1995. This kind of presentation enables a simple comparison of the different economic areas when looking from the dynamic standpoint, such as percentage growth rates and the effects of countermeasures.

3.2 Stationary behavior of socio-economic areas

As the greatly differing stationary behavior of the various socio-economic areas can be seen from the results-figure 3/1 only by the respective numerical data, the stationary behavior is also shown graphically in Figure 3/2.

Here the existing poor-rich conflict between the threshold and developing countries on the one hand, and the industrialized countries on the other hand can be seen especially clearly from the related presentation in sub-figure 3/2e. As shown there, ΔP^* = 81% of the world population have only a $\Delta \dot{C}^*_{GDP}$ = 20% share in the global gross national product. By the upper dashed regression curve the two “measuring” points x are fulfilled as optimally as possible. The lined curve shows the corresponding Lorenz curve.

If the tangent is positioned in the origin of this so-called Lorenz curve, then an equity factor of ε = 0.125 results, with which the economic divide between poor and rich can be read off.

If this real behavior is considered as the capitalistic world order, then this can be compared with the ideal communist world order which results for ε = 1, i.e. everyone has the same income.

Thus, the European Union strives for an equity factor of ε = 0.5 for the expanded EU of 25 + x nations, i.e. the income of the poorer citizens within Europe should not be lower than half of the average per-

[2] In the normally used **nominal consideration** the inflation is included.

capita income, i.e. the standardized gross national product (Radermacher, 2002).
A corresponding objective also applies in the long term for the implementation of a targeted worldwide Marshall Plan (Gore, 1992; Radermacher, 2004).

3.3 Dynamic behavior of the socio-economic areas
=> "without future-oriented countermeasures"

The curves in results-figure 3/1 show the behavior over time and this:

- for the period from 1980 ÷ ≤ 2000 including the comparison of measurements and calculations, and
- up to 2030 the forecasted further development, which seems to be realistic "without taking aimed future-oriented countermeasures", but already regarding the slight saturation influence occurring since the mid of the nineties in the economies mainly of the industrialized countries.
- As can be seen in **row 1**, the import flows $\dot{C}_{Imp}^{(ij)}$ as interface variables between the various economic areas i,j are simulated quite well. Here i,j = 1, ….., 5 with $i \neq j$ applies for import flow indexing.
  The much smaller import flows for the areas "Rest of OECD" and "Rest of EU" are based on the fact that these economic areas had, with 3 % and 6 % respectively, a much smaller import/export share of the respective turnover in the reference year 1995 than the other economic areas, such as Germany with 13 % of its turnover as well as the threshold and developing countries with 10 and 11 % respectively.
- In **row 2** the **real increase** of the turnover within the individual economic areas is shown. This results due to the consideration "without inflation". Concerning the illustrated time curves there applies $\dot{C}_{Turnover} = \dot{C}_{GVA} + \dot{C}_{Int.Cons.}$.
  Here the cost flow for the imported goods is included in the cost flow for the intermediate consumption of the suppliers.
- The difference between gross value added $\dot{C}_{GVA}$ and wage costs $\dot{C}_{W}^{(i)}$ is – apart from taxes and other obligations, like debt-interests – available for new investments to be made. Based on the consideration in the per-unit system, the time curves concerned demonstrate a similar behavior for the various economic areas, however with less growth gradients of the turnover in Germany and the European Union.
- In **row 3** the production-dependent gross value added $\dot{C}_{GVA}$ is illustrated again, here however together with the respectively annual working hours $\dot{W}$ and the resulting rationalization/automation degree $\eta = \frac{\dot{C}_{GVA}}{\dot{W}} \left[\frac{US-\$}{h}\right]$.
  As can be seen, the specific production costs per hour in the reference year 1995 are, with $\eta \approx 34 \left[\frac{US-\$}{h}\right]$ nearly the same[3] within the different industrialized economic areas. On the other hand, in the threshold and developing countries, the values concerned are lower by powers of ten due to the fact, that the industrialization is first beginning there or not present at all, respectively. These statements agree with the results from the stationary consideration in chapter 3.1.
- As can be seen from the simulation curves, the annual working hours $\dot{W}$ in Germany and the "Rest of Europe" will further on be reduced in the future – due to the continued strong increase in the rationalization/automation degree η predicted for these economic areas.
  On the other hand, for the economic area "Rest of OECD" reduced social security must be assumed. Due to this, lower wage costs and an increase in the total number of annual working hours $\dot{W}$ do occur, combined with a simultaneous minor rise in the automation degree η.
- In **row 4** the capital stock of the sectors "Enterprises" is illustrated, too. This is the machinery and equipment to be provided for the various branches of production, and therefore being the basis for the respective automation degree. As can be seen, the capital stock will continue to increase in the future for all economic areas.

These forecasting results are specifically valid for the up to now considered realistic basic case "without future-oriented countermeasures".

4. EFFECTS OF FUTURE-ORIENTED COUNTERMEASURES

4.1 Possible countermeasures

For reducing or even stabilizing the existing techno-economical, ecological and demographic momentum various options for future-oriented countermeasures are required, such as

- with regard to Momentum III: co-financing of the poor developing countries, paid by others through worldwide reduction of arms spending,
- with regard to Momentum II: promotion of developments and investments for the reduction of resource consumption, as well as for recycling and environmental protection measures,
  e.g. by collecting additional resource consumption taxes.
  => Here energy consumption plays a key role. This is based on the fact that the basic industrial materials – like iron, aluminium and other metal materials as well as cement, plastic and other non-metal materials – do already need for the extraction and processing of the raw materials 2/3 of the energy requirement of the entire production sector.

[3] Strictly speaking, this determined agreement applies to the countries Germany, France and the US, as the statistical time series have been determined and evaluated for these countries, comp. section 3.1.

This means an increase in the energy prices would at the same time result in a reduced consumption of other resources due to the related increase in the raw material prices.

=> A transition from the throw-away society to the creation of more durable products which must be maintained with long-lived operation and repair services appears possible in this way.

- with regard to Momentum I: co-financing of the costs caused by structural unemployment, e.g. by collecting "machine taxes" for technical equipment.

  => As shown in section 4.2, this simultaneously leads to a decrease in the wage level.

Further on, the countermeasures for Momentum II and III in turn exert an additional stabilizing effect on Momentum I, as already pointed out in (Welfonder and Frederking, 2002).

4.2 Model-related implementation

On account of the holistic consideration, the global model, which serves as the basis for the simulation, represents a closed, autonomous system, besides of few external influences concerning non-regarded "rest-world events", like

- natural catastrophes,
- political events such as regional wars or the reunification of Germany as well as
- financial market events.

Besides of this non-regarded external events, countermeasures to be taken into account must be carried out by corresponding parameter changes $\Delta\underline{p}$.

Here a previously conducted parameter sensitivity study $\frac{d\,\underline{x}}{d\,\underline{p}}$ and $\frac{d\,\underline{y}}{d\,\underline{p}}$, i.e. concerning the state variables $\underline{x}$ and output variables $\underline{y}$, has shown that individual state variables x_i react quite sensitively to minor parameter changes or corresponding countermeasures and that they do leave the state range – permissible from a user standpoint – rather quickly. To counteract this unstable behavior, corresponding internal feedback branches for automatic parameter adjustment have been provided. These negative feedbacks correspond in reality with rapid human interventions after the activation of countermeasures, and this on underlaid levels, i.e. within the individual enterprises, households etc.

These internal parameter adaptations are illustrated in Figure 2/1, marked by the dashed feedback branches $\alpha \div \gamma$:

α) Production adjustment

As soon as the selling price p drops below the marginal cost price p_{Limit}, this leads to the shutdown of less profitable production systems, and therefore to the shifting of the supply curve to the left. This circumstance is taken into account in Figure 2/1 with a corresponding increase in the depreciations.

β) Wage adjustment

As soon as the target liquidity limit for the Sector I "Enterprises" is dropped down to

$$\dot{C}^{(I)}_{Disposal} - \dot{C}^{(I)}_{Disposal,Target} < 0$$

a negative wage tariff adjustment $\dot{\tau}$ becomes active. This kind of wage adjustment already takes place in practice when for nominal consideration the annual wage increase $\Delta\dot{\tau}$ is lower than the inflation rate $\dot{r}_{Infl}$.

Due to the reduction in the standard of living, the companies of the economic area concerned become competitive again. This leads, among other things, to a reduced outsourcing of wage-intensive orders to cheap-wage countries.

γ) Buying power adjustment

As soon as the liquidity limit for Sector IV "Households" is dropped down to

$$\dot{C}^{(IV)}_{Disposal} - \dot{C}^{(IV)}_{Disposal,Target} < 0$$

the buying power decreases. This leads to a shifting of the demand-curve to the left.

Corresponding internal adaptations also prove necessary for the Sectors II "Banks and Insurance Companies" and III "Government". A further possibility to reduce debt burdens $\dot{C}^{(i)}_{target}$ is the sale of buildings and equipment. This additional kind of parameter adaptation is especially used by the Sector "Government", thus e.g. at present in Germany.

4.3 Future-oriented countermeasures, simulation scenarios

To examine the implementability and efficiency of future-oriented countermeasures, extensive simulation studies are required.

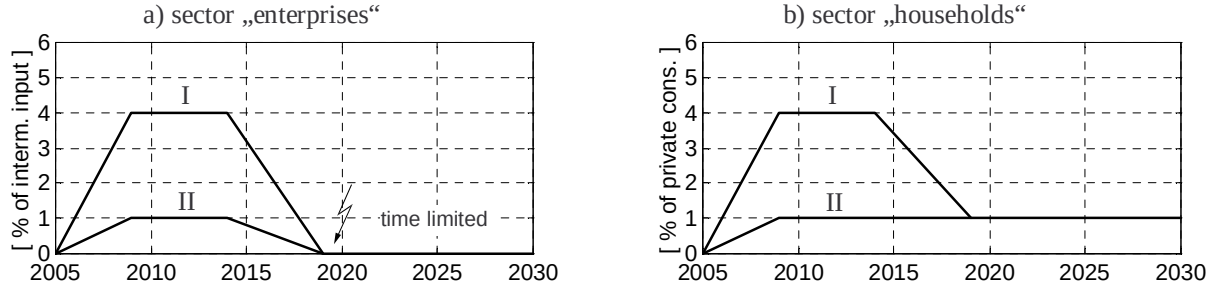


Fig. 4/1: Taxis to be paid by the industrialized countries for
I further consumption of non-renewable resources
II co-financing of the developing countries

National/Supranational socio economic areas

0) Population per area

a) Germany

P_{1999} [mill.] = = 81

b) „Rest“ of Europe

- **France = 58**
- United Kingdom
- Italy
- Spane
- ...

= 293

c) „Rest“ of OECD

- **USA = 276**
- Japan
- Canada
- Australia
- ...

= 742

d) Threshold countr.

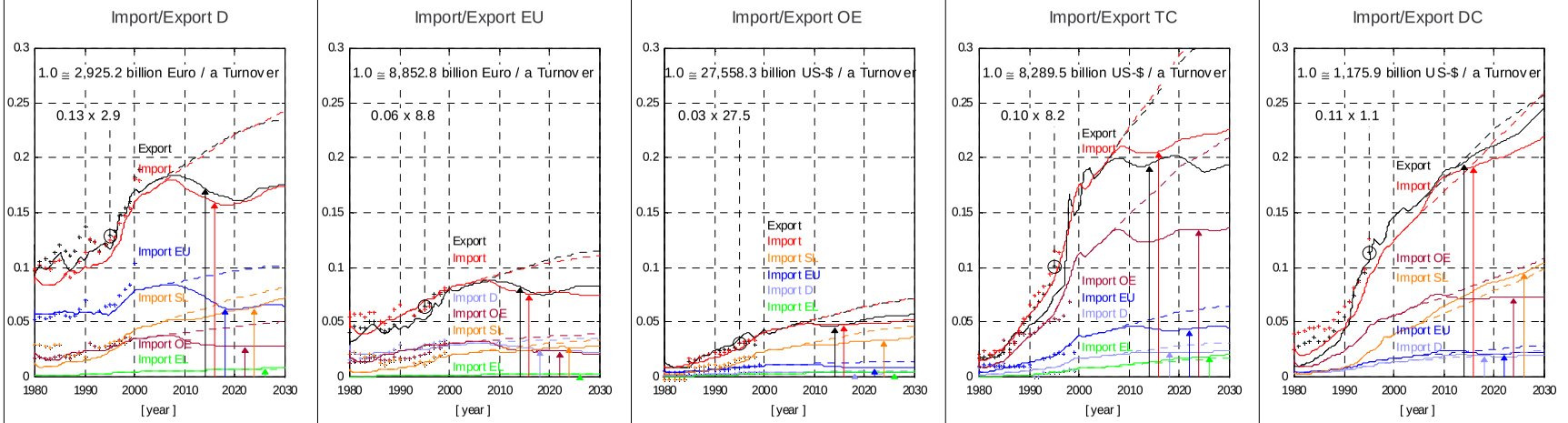
- OPEC-countries
- Russia
- China
- Brasil
- **Thailand = 61**
- ... = 2758

e) Developing countr.

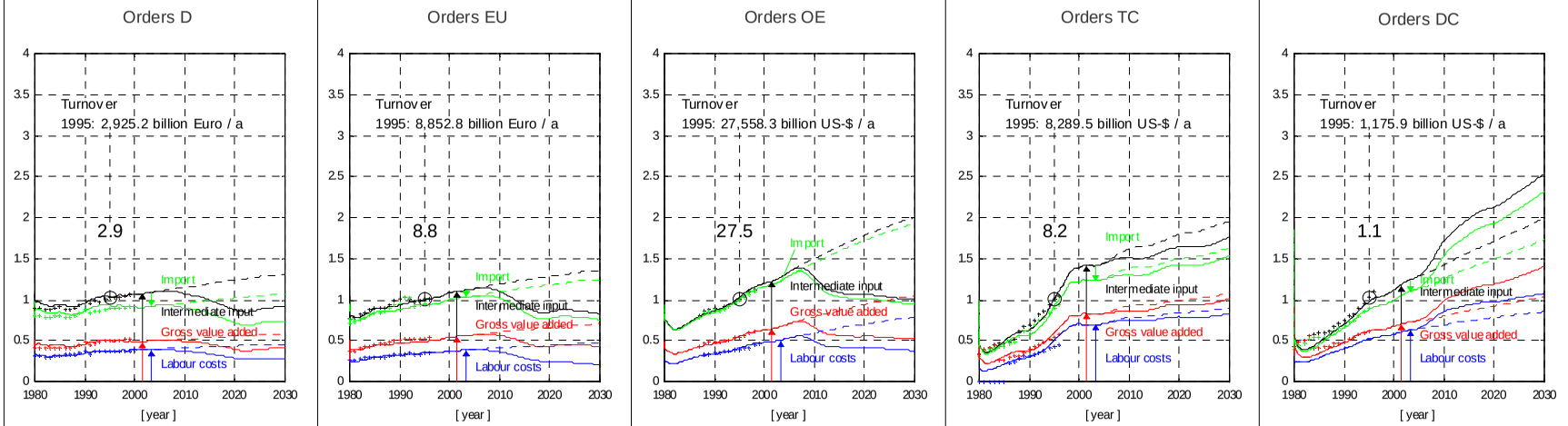
- **India = 998**
- Pakistan
- Africa
- Bangladesh
- ...

=2095

1) Import to the economic areas



2) Balance: Σ Enterprises



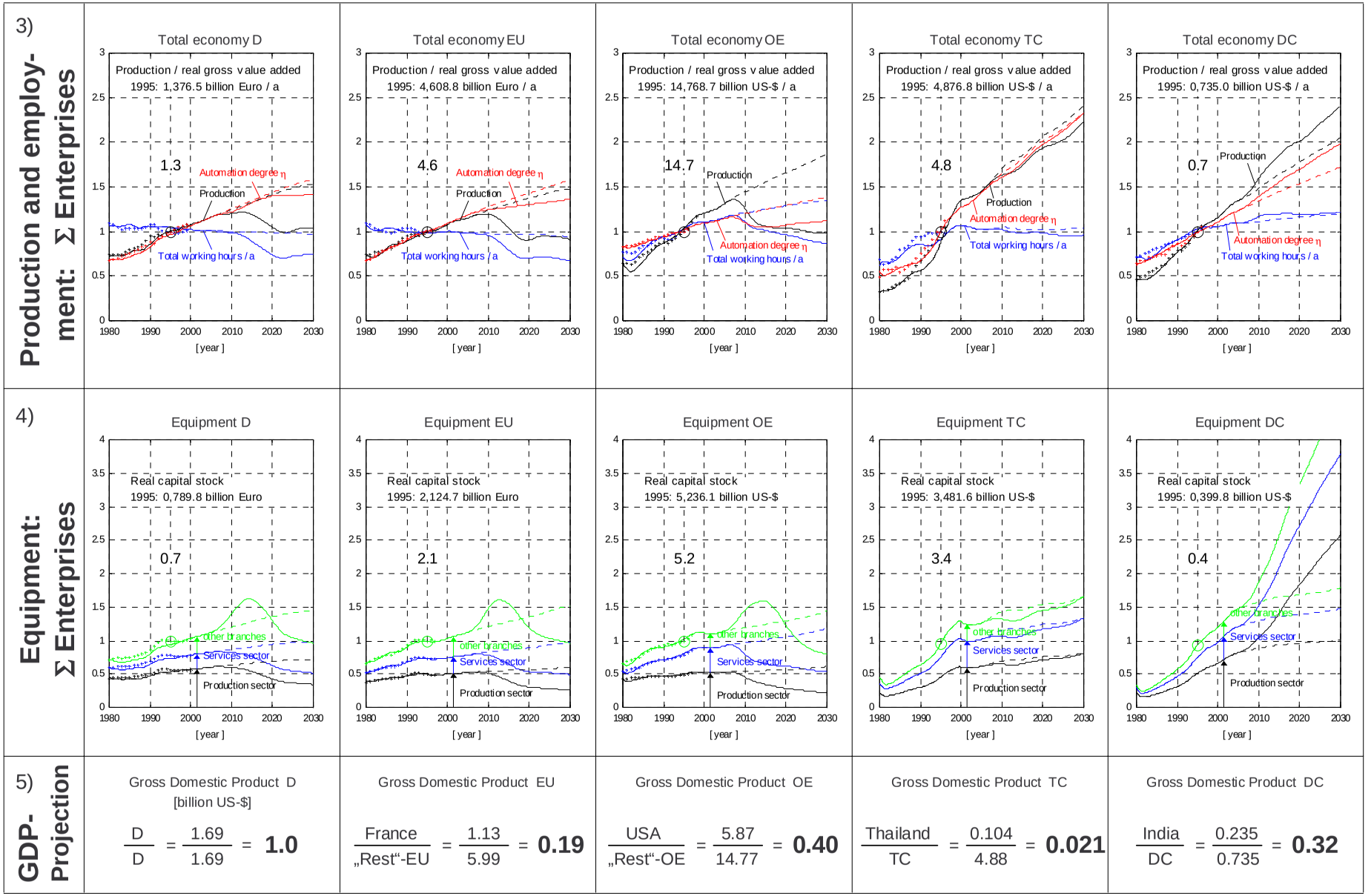


Fig. 4/2: Sustainable social economic evolution of the globalized society:
{ **„with future-oriented countermeasures"**, according to Fig. 4/1
„without future-oriented countermeasures", comp. Fig. 3/1

=> "Measurements" and Simulation results, each time in real values

a) Already considered countermeasures

As the first step there has been considered, that all industrialized nations, gathered in the OECD, will do equally

- on the one hand pay additional taxes for further consumption of non-renewable resources and this – as to be seen by Fig. 4/1 – over a certain duration of ten or fifteen years until a corresponding new industrial area will have grown up and
- on the other hand co-finance the underdeveloped countries and this – as to be seen by Fig. 4/1 too –
  - by the households for an unlimited time and
  - by the enterprises – again only over a limited duration of ten to fifteen years – due to competition-reasons.

These costs to be paid by the sectors "enterprises" and "households" to the public authorities for additional taxis and co-financing will correspondingly be distributed on behalf of the belonging governments.

As to be seen by the simulation results in Fig. 4/2 "with future-oriented countermeasures" there do not occur any transient chaos or even steady-state instabilities within the industrialized nations, when fulfilling the pre-condition of equal participation.
In detail there is to be seen by Fig. 4/2:

- The additional rates to be paid for the further consumption of non-renewable resources as well as the rates for co-financing the underdeveloped countries leads to a reduction of the real capital stock of the enterprises, see Fig. 4/2, row 4, a-c (industrialized nations). The same belongs to the corresponding sectors „Households".
  Therefore these countermeasures can be activated only for a limited duration, comp. Fig. 4/1.
- The decreasing income of the households in the industrialized countries leads to a reduced demand. Due to this the production and the turnover of the enterprises are going – caused by adaption γ – down too, see Fig. 4/2, row 3 and 2, a-c.
- Due to the demand reduction in the industrialized countries the price would go down to $p^* < 0{,}95$. To avoid this, the supply of the enterprises is – caused by adaption α - shrinking within 2006 and 2019, too.
- The enterprises in the industrialized countries do counteract to this shrinking process with a reduction of the real wages, caused by adaption β. This measure as well as a reduction of the total working hours, comp. Fig. 4/2, row 3, a-c, lead to a reduction of the wage-costs, see Fig. 4/2, row 2, a-c.
- In opposite to this a resulting increase of the real wages in the developing countries by about 15% leads to a greater demand of the households. This causes an increase of the production and the turnover within these poor countries, see Fig. 4/2, row 3e.
- In addition the capital stock of the enterprises in these economic areas will climb up, see Fig. 4/2, row 4e, combined with an increase of the belonging automation degree η, see Fig. 4/2, row 3e.
- Due to the shrinking process of the economies in the industrialized countries the exports to the threshold and developing countries decrease, see Fig. 4/2, row 1, a-c. For equalizing the import/export balance, i.e. for reducing the import too, import limitations from side of the industrialized countries would be unavoidable if the export/import will not be regulated itself by flexible currencies, as shown in Fig. 4/3.
- The returns of the non-renewable resources consumption rates to be paid by the industrialized nations for ten to fifteen years, comp. Fig. 4/1, are foreseen and used for the development and production of more effective equipments in the field of renewable energies, recycling and environmental-protection.
  These additional, automation-neutral economic activities will be attached to the part sector "other branches" and lead due to this to an increase of the turnover within this part sector. In the same way the turnover of the production part sector is declimbing correspondingly, both see Fig. 4/4a.
  Due to this circumstance in the industrialized countries there take place corresponding changes of the investments as well as of the real capital stock from the production part sector towards the part sector "other branches", and here to the new pushed branch "equipments for saving resources and protecting environment". The automation degree η in this automation neutral part sector remains nearly constant, whereas the automation degree of the production part sector does grow more slowly further on, see Fig. 4/4b.

b) Further countermeasures to be considered

To further questions which have to be considered and investigated by simulations, there are belonging by others:

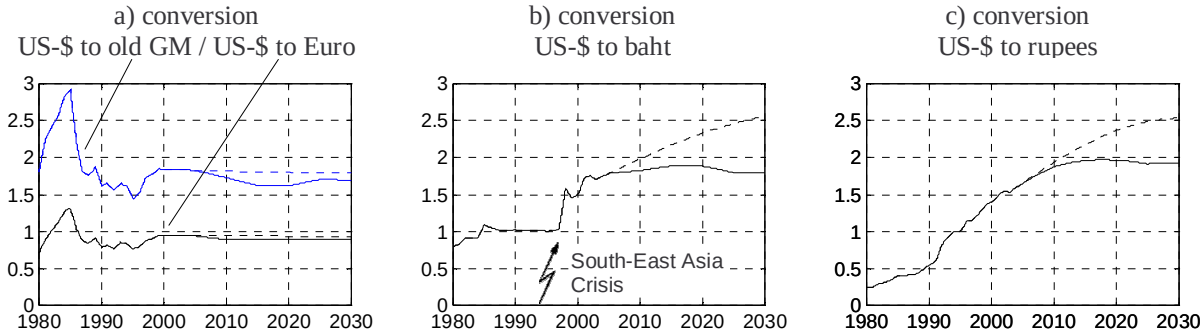


Fig. 4/3: Export-/Import as well as capital market dependent currency deviations, each time referred to OECD currency, i.e. US-$ „with countermeasures" „without countermeasures"

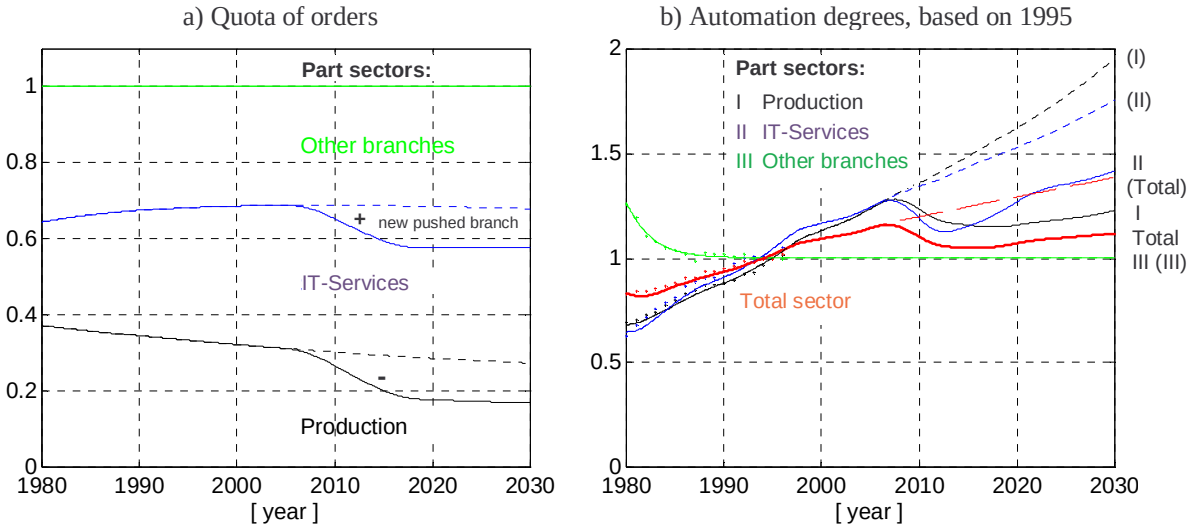


Fig. 4/4: Quota of orders and automation degree of the different enterprise part sectors, shown for the biggest economic area "Rest-OECD"
„with countermeasures" „without countermeasures" ≙ (..)

What does happen when individual industrialized countries do not participate or take part with varying intensity? Or what does happen when the production and resources' consumption of the threshold countries are strongly growing?
Besides this to the final problems to be solved there are belonging

- Up to which amount the overall requirements, stated by top long-term forecasting researchers, like (von Weizsäcker, *et al.*, 1999; Schmidt-Bleek, 2000; Radermacher, 2002), concerning an extreme sparing of resources up to a factor ten within fifty to hundred years seems to be realisable within the next decades? And this
- by smoothing the poor-/rich-conflict as far as possible within the same time scale.

5. SUMMARY

For achieving a sustainable socio-economic further evolution of the globalized society the more and more increasing techno-economic momentum has to be regarded and this strongly combined with the ecological momentum as well as the demographic momentum.
Doing this, the influences of the information and automation technologies as the main motors of progress have to be taken into account, too.

In this sense a global model concerning the techno-economic and ecological behavior has been developed consisting of supranational areas and underlaid socio-economic sectors.

For being near to practice the parameter estimation and model verification has been carried out on the basis of time-dependent data series, called "measurements", taken from the world-wide existing statistic data bases.
The obtained agreements between measurements and simulation results are shown by corresponding time-curves for the period from 1980 to 2000. In addition there is forecasted by simulation the further development of the globalized society which seems to be realistic up to 2030 from the present state of view, and this in the basic simulation case. Further on there has been considered one first simulation case "with taking future-oriented countermeasures". Fulfilling the regarding pre-condition that all industrialized countries will support the considered countermeasures – to be agreed before internationally – there will occur no transient collapse or even steady-state instabilities.
On the examination of the implementability and efficiency of further future-oriented countermeasures – also in case of unequal participation of the industrialized nations – there is being worked at present, see section 4.3.

To the main advantages of the developed global model there are belonging its functional structure and due to this the possibility to carry out not only simulation studies but also aimed analytical investigations, e.g. concerning the occurance of positive feedbacks or for getting insight on special simulation results by considering the referring function relations, documented in block diagrams.

Finally there has to be marked that for the investigation of the strongly coupled demographic momentum also a discrete population model was developed and already applied to various world socio-economic areas (Frederking, *et al.*, 2003).

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