GLOBAL AND REGIONAL HISTORY

GLOBAL HISTORY AS A SEQUENCE OF TRANSIENT ECONOMIC FOCI

Gilbert Ahamer
Global Studies, Institute for Economic and Social History, Graz University, Graz

Empirical evidence shows that the sub-sectors of national economies are likely to follow a certain regularity in their phase of emergence and decrease, measured by the relative share of their contribution to the total Gross Domestic Product (GDP). This indicates the possibility of viewing techno-socio-economic evolution as a sequence of transient economic foci which corresponds to societal preferences, even 'values.' A step of generalisation suggests that any 'societal value' can be understood as the second derivative of a characteristic parameter forming a trend. In a view perceiving long-term history as a sequence of regular phases (be these generated by hypothesized cycles or saturation effects), even these second derivatives undergo a principal change and switch from positive to negative signs. These epochs of 'switching values' are both logically necessary, historically perceivable and correlated with profoundly changing societal values. The author's Global Change Data Base (GCDB) serves as an empirical foundation for such interpretations of paths in worldwide statistics and provides statistical diagnosis of several transitions that occur in history and techno-socio-economic evolution: deforestation transition, economic transition and energy transition.

Keywords: *evolution, Big History, saturation, blossoming evolution, economic sectors, sectoral GDP, Global Change Data Base, transition, values, switching values.*

1. The Historic Sequence of Economic Sectors

1.1. Suggestions from Literature

The generally known decomposition of economic activity into the three main sectors of agriculture, industry and services shows a regular historic sequence in single countries, as exemplified for Sweden by the geographer Haggett (2001), among others (see Fig. 1). Such a theme contributes to Global Studies (Bader *et al.* 2013, 2014; Chumakov 2014; Duraković *et al.* 2012; Fischer *et al.* 2016; Zinkina *et al.* 2013), especially when based on systems analysis and evolution (Vernadsky 1926; Bertalanffy 1968; Foerster 1975).

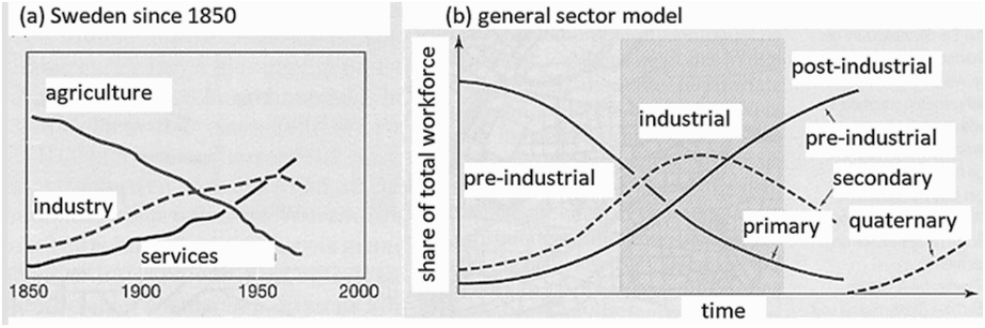


Fig. 1. Trends indicating structural shifts in Sweden pertaining to settlements and workforce (at left and centre, according to data from the Royal Swedish Ministry for Foreign Affairs) and presumed future global structural shifts by Haggett (2001)

1.2. The empirical evidence from the GCDB

More detailed analyses of globally accepted statistical data are performed by the author's Global Change Data Base (GCDB) and its analytical tool (World Bank, International Energy Agency IEA; Ahamer 2013a, 2013b, 2018), based on *systems analysis* (Vester 1980; Pilch *et al.* 1992).

For a thorough understanding, 'economic sector' (see the list in Table 1) means the type of human activity to which the emphasis is shifted by the societal optimisation mechanisms, or by collective consciousness, depending on which worldview readers are subscribing to.

Table 1

Economic sectors according to UN sectoral division, including this article's colour codes, while sectors 1 = Agriculture is green

Colour legend for four industrial sectors:	Colour legend for four service sectors:
Violet = (2) Mining and quarrying	Orange = (6) Wholesale and retail trade
Light blue = (3) Manufacturing	Brown = (7) Transport, storage and communications
Turquoise = (4) Electricity, gas and water	Yellow = (8) Finance, insurance, real estate and business services
Dark blue = (5) Construction	Coral = (9) Community, social and personal services

The GCDB provides sectorial GDP shares (Ahamer 2020) and moreover, their change rates (see Fig. 2).

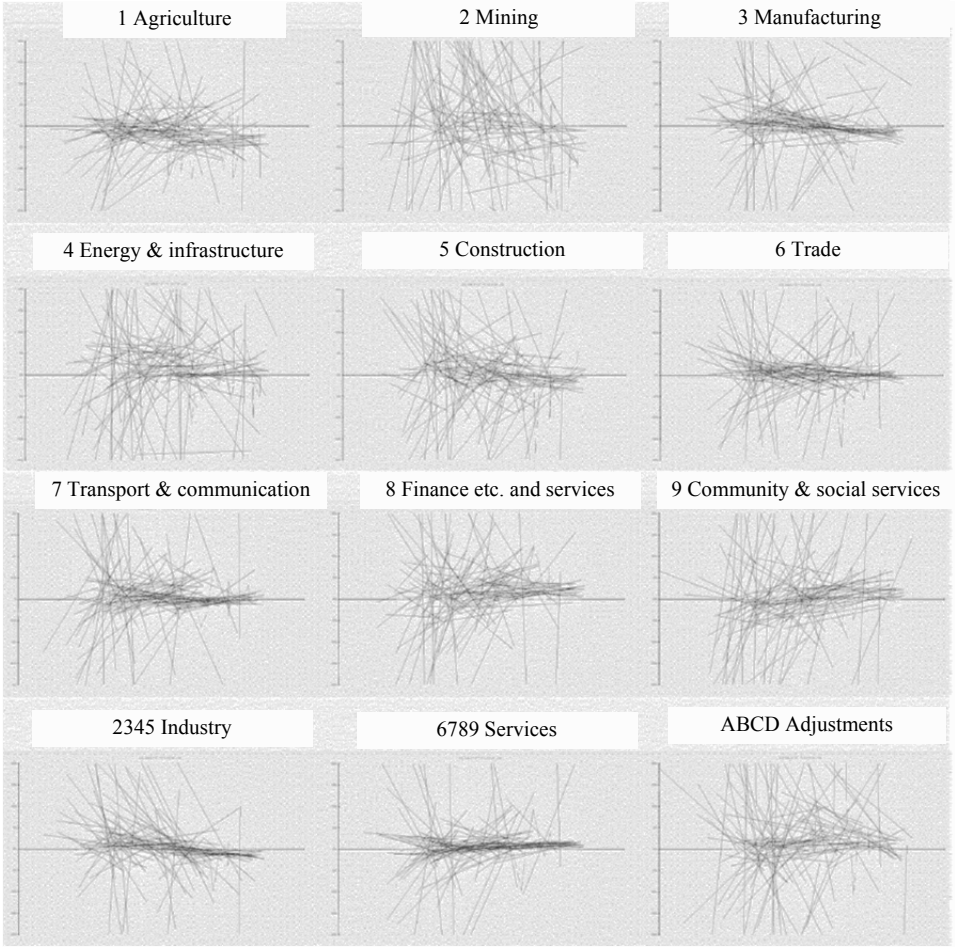


Fig. 2. Growth rates (vertical axis: –20 % to +20 %) of the shares of the single nine distinct economic sectors with a country's total economic output (GDP), as a function of the economic level GDP/capita (horizontal axis: 10 to 100000$/cap). *Source*: Ahamer (2018).

Interpretation of GCDB data, especially of Figure 2, shows contradictory trends in the distinct sectors' growth rates, and still the convincing overall impression of the following tendencies:

1. Agriculture ↓↓
2. Mining and quarrying ↗↘
3. Manufacturing →↘
4. Electricity, gas and water ↗→
5. Construction →↘
6. Wholesale and retail trade ↗→
7. Transport, storage and communications →→
8. Finance, insurance, real estate and business services ↑↗
9. Community, social and personal services ↗↗

What overall impression do we take from these figures with country-wise trends?

1. Agriculture (= 1) decreases at high percentual speed, and seems to maintain this path.
2. Industry (= 2345) shows a mixed picture. For example, electrical / gas / water is increasing significantly everywhere, while manufacturing / trade and construction are decreasing.
3. Services (= 6789) increase by percentual rates, but trade and especially transport show a flattened trend.

A review of this global system dynamics therefore requires a sufficiently precise differentiation in individual sectors in order to be able to determine the presumably consecutive wave-like movements.

The structure of these transitions is characterized by saturation effects (not by cyclic effects as in Nefiodow 1999, nor by merely rising trends as in Naisbitt and Aburdene 1990). Based on GCDB data analyses, Figure 3 illustrates the pattern of idealised growth and decay of relative importance of key economic sectors which at the same time characterizes the emphasis on societal and collective will and strife, leading from materialized to de-materialized sectors.

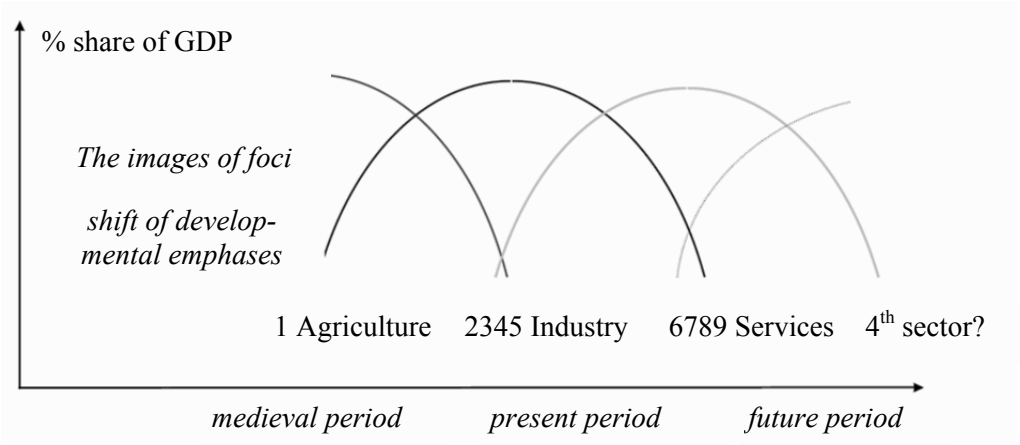


Fig. 3. The 'image of societal attention': idealised quantitative process of the relative importance of the three classic economic sectors in economic performance depending on the level of economic development with an intended future fourth sector 'well-being'. *Source*: Ahamer 2019.

As an econometric parameter, the elasticities of sectoral GDP shares (with GDP/cap) are shown in Figure 4. This depicts the tendencies for future decades. A similar graphical representation is provided by Figure 5, showing bars for average sectoral growth in percent per year.

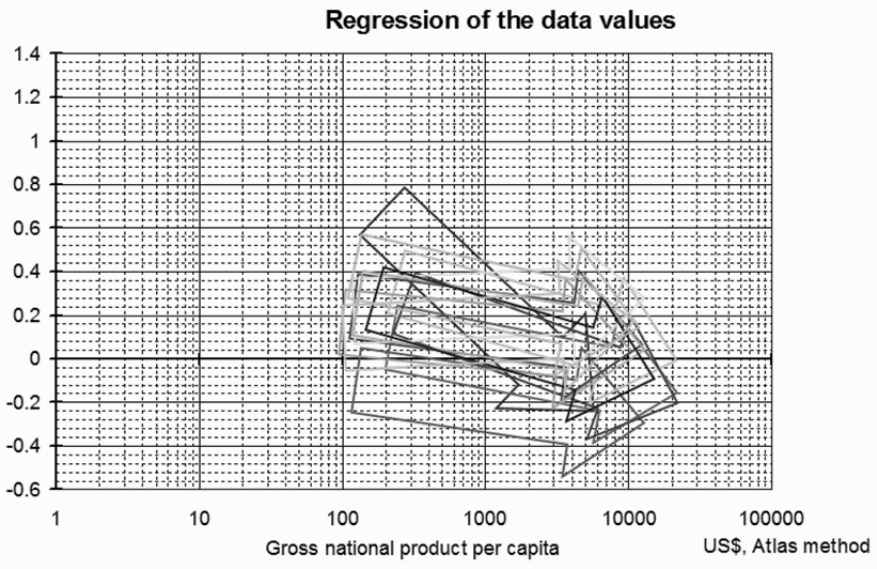
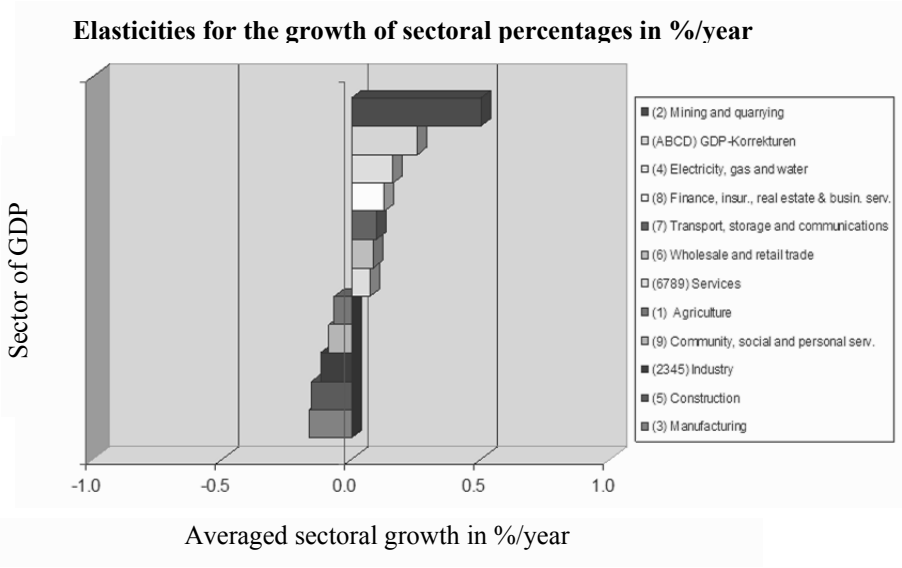


Fig. 4. Change rates of correlation coefficients of sectoral GDP shares with GDP total (= elasticities), as an averaged function for all states, depicted against GDP/capita. The colours of the arrows can be better distinguished in the online version. *Data source*: GCDB.



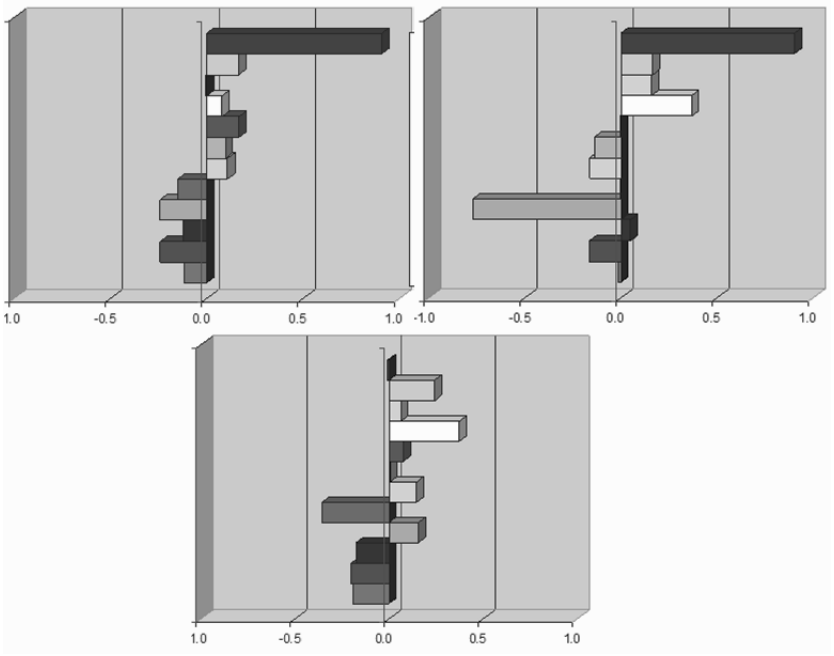


Fig. 5. Elasticities for the growth of sectoral shares worldwide (above on the previous page), and below for Western Europe (at centre left), Eastern Europe (at centre right) and Austria (bottom). *Data source:* Ahamer (2013a)

2. Sequential Structure of the Long-Term Trends

2.1. Thinking in wave-shaped evolutionary steps

In a long-term time horizon, as is useful with *global change*, qualitatively new developments can arise principally any time, and seemingly unexpectedly. Just think of the budding internet 20 years ago!

The question therefore arises of whether we can find a method to detect such (systematic but) unexpected changes in evolution early enough. Thus, instead of mere trend extrapolation (at left in Fig. 6) a method is required that should be able to enter on the one hand to recognize new emerging issues (at right in Fig. 6) and, on the other hand, the sliding out of previously important topics (at right in Fig. 6), mostly because they slide into saturation. As well as paying attention to 'facts,' we should also pay attention to the evolution of their (mentally) perceived importance.

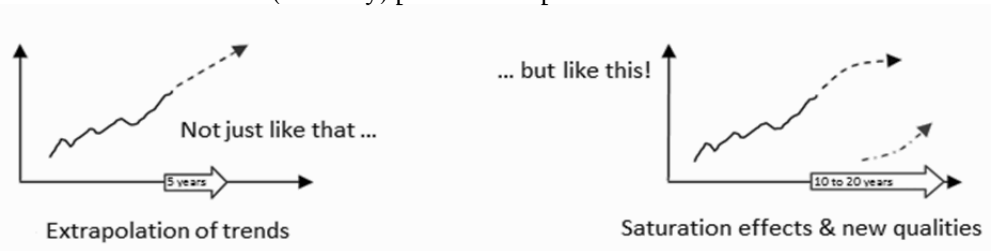


Fig. 6. A long-term analysis should think in wave-shaped evolutionary steps. *Source:* Ahamer (2018).

For this purpose, and as a case study, the shares of the economic sectors were first analysed quantitatively, namely identify the relevant (= virulent, by their themes) subject areas within evolution.

2.2. How can evolution in a finite world look like?

In order to frame single data analyses such as in the previous chapter, a generic theory is developed based on repetitive curve shapes of trends. Deducible from the fact that we live in a limited world, the growth rates are doomed to depend on the principal availability of matter-like entities. In general, two types of growth rates can be conceived mathematically, depending on the evolutionary phase:

- no shortage signal noticeable yet: delta x = const * x exponential
- shortage signal is already noticeable: delta x = const *x * (1–x) saturated.

Based on this structural-mathematical deliberation, any resulting real-world increase rate is determined by the upper and lower natural limit, and hence is a sigma curve which results from the superposition of both these fundamental dynamic patterns. One single line in Figure 7 shows this behaviour. Ultimately, it is the shortages that control developments in a bounded world!

Environmental protection means management of scarcity and is therefore essentially *economy*. This is true because economic means the care and management of goods only when they are available to a limited extent.

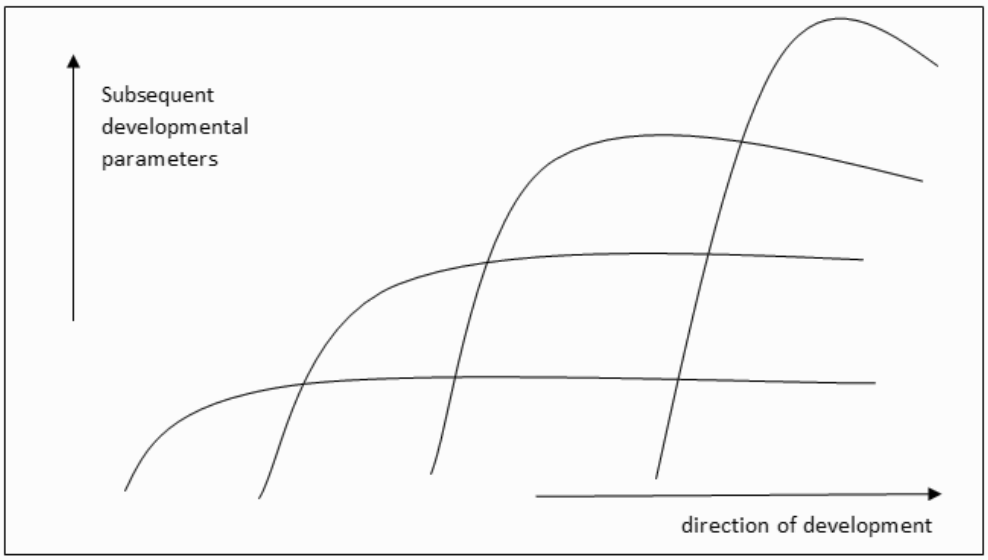


Fig. 7. Successively 'blooming' sequence with several development parameters

From the above analysis of the values, their change rates for the individual sectors, and especially with the synopsis of economic sectors peaking at subsequent evolutionary times in Figure 8, the following conclusion is drawn regarding a basic architecture of techno-socio-economic evolution, when starting with the sequence of societal needs that is to be fulfilled:

- in a society, the sequence of meeting needs first starts with material individual needs, then continues with non-material individual needs and afterwards proceeds to community-related material needs, and finally to non-material community-related needs (such as the creation of infrastructure). This sequence might be inspired by a 'Maslow's pyramid for collectives' and by a spiral-like vision of development (as found by Graves 1970, 1974; Küstenmacher *et al.* 2010). Such an overall empirical sequence is called here a *gigatrend*.
- The apparent need is to recognize new, seemingly 'unpredictable' developments – and this could be achieved by a new type of 'non-linear futurology'. The question is: what economic structural shifts and which types of shifting social emphases will occur? This article suggests the answer: let us conceive techno-socio-economic evolution as 'blossoming evolution', which is a systemic shape shown in Figure 7. The single phases are: after an initial sleeping phase a distinctive blooming phase starts, followed by a saturation phase of great stability (Ahamer 2021). Within Figure 7, the single sequences according to a diagnosis of the global *agronomical* system are constant areas of life (reproducing, eating, doing business, eating better food, and later safeguarding increased quality of environment, health and wellness, and finally realisation of meaning in life (in energy economics, a similar sequence may be perceived).

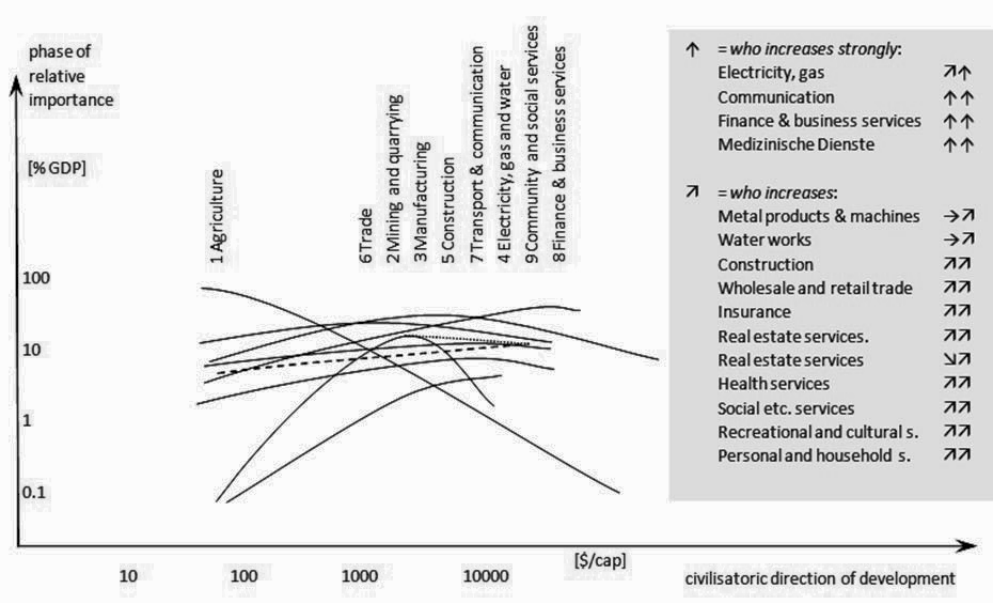


Fig. 8. Map of techno-socio-economic evolution for the nine economic sectors.
Data Source: Ahamer (2018).

As deducible from the methodologies described earlier, Figure 8 describes (= 'maps') the sequence of economic sectors using their shares in total GDP/capita in an idealized way for all nations globally. This 'Map of techno-socio-economic evolution' for the nine main sectors shows the more or less decisive peaks of relative shares of sectors and at the same time suggests their interpretation as 'collective emphasis' of an entire society.

2.3. Global deforestation as a transitory phenomenon

An additional example is Figure 9, which depicts ongoing deforestation and afforestation on the planet.

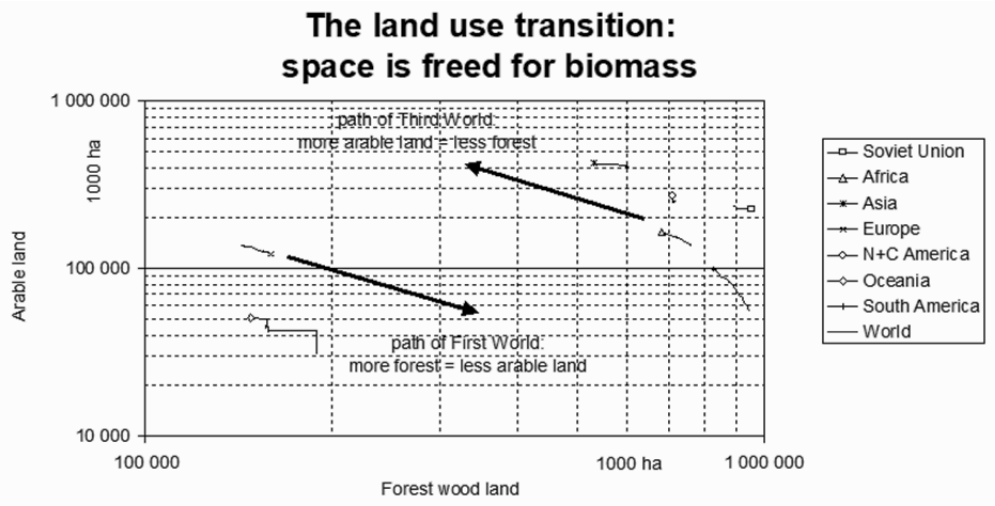


Fig. 9. The 'land use transition': afforestation is already taking place in the First World, while the Third World is still being cleared by deforestation. *Data source*: Ahamer (2019).

Figure 9 offers a graphic with unusual axis descriptors (arable land versus forest land) but offers quick insight into the global dynamics of land use change: in Europe, North America and Russia (Öttl *et al.* 2014, Ahamer and Kumpfmüller 2013), during recent decades, afforestation is already taking place, while on other continents deforestation is happening – visible from the time series moving in different directions: towards bottom right for decreasing forest land, moving upwards left for increasing forest land.

3. Can Collective Values be Made Visible in Statistics?

Is this an erratic headline? Mentally and philosophically, the economic and the material were meticulously separated for centuries, and this step was indeed considered a scientific achievement (Descartes 1997 [1632]), after the putatively dark medieval times. However, the general approach in futurology and scenario writing (Akaev *et al.* 2012; Korotayev and Zinkina 2014; Altmann 2013) with their 'business as usual' scenarios (that merely continue existing trends) offers a more than simple option to include collective values as an agent which then changes business as usual trends. The very basic analogy is Newtonian physics: consider a space rocket heading to the moon, and take into account its perseverance on a linear path where outside forces are zero: if you want to steer it, you ignite a small lateral rocket which causes deviation from the earlier course. By the simple formula F = m*a, we understand that acceleration is proportional to the applied force.

In scenario writing, let us just name the deviation from the business as usual path a 'value' in the sense of heuristic collective ethics. When thinking in the context of ana-

lytical mechanics, the second derivative of a location is proportional to the acceleration, hence a change in direction.

3.1. Values are necessarily reversed

Based on the above deliberations, we can now logically deduce:

Having a value = society pays for the achievements of an economic sector.

Social values in a past decade do not necessarily have to be values in a coming decade. Especially if some targets have already been achieved, these may be sliding out of public attention in the future.

The general view by the founder of 'ecological economics,' Herman Daly (former World Bank Senior Economist) amounts to: A mature economy shifts (while P = production, B = stock, see Daly 1973, 1996, 2005) in the view of the author

- from a system of *growth efficiency* (maximize P / B = production per unit of inventory (*e.g.*, biomass stock);
- towards a system of *conservation efficiency* (maximize the reciprocal P / B = the amount of stocks received per unit of new production).

Production in general represents the maintenance costs of the stock and should be minimized.

This distinction between two phases having opposite directions for optimization means a complete reversal of values and paradigms, as compared to a classical economic view.

We can see now very clearly: any growth procedure creates other, even opposite values (if we perceive values as 'optimization targets'). Life's values are therefore *principally* context-dependent and phase-dependent.

A quick example is: material growth = product = GDP is sought first in any economy or by any individual but it may then become a burden (historic buildings need enormous care), when the house becomes too large after the children have grown up, and the car becomes too expensive.

Expressed in a very decisive manner (⇔ meaning: is opposed to):

Values in the growth phase ⇔ Values in the maturity phase

Thesis of this article: The world now moves from an era in which the capital produced by human is the limiting factor towards an era in which the remaining natural capital is the limiting factor.

This is the structural importance of environmental protection along evolution, and especially the target of climate protection.

3.2. Turning towards a 'Society of Sense'

After the transition from the industrial society to the information society, another transition step will come to the foreground, namely, how we get from information to knowledge, further on to wisdom and then towards meaning.

People principally work to make sense and even to 'create sense and meaning': in a future society, the employees will be strengthened and will be able to afford to se-

lect institutions for their work which largely correspond to their own targets about life (Horx 1997, 2002; Ahamer and Jekel 2010).

Therefore, it seems reasonable to assume that humanity increasingly pays tribute to meaning and 'making sense.' This will presumably be mirrored by future 'evolutionary maps of economy' in Figure 8.

4. Paradigmatic Changes are a Common Effect in History

Understanding history as being embedded into long-term techno-socio-economic evolution also removes the widely accepted control optimism, according to which future developments could be controlled by the so-called 'measures' of people. The word '*steering optimism'* means the same: politicians believe they are able to steer reality; but in reality, they only moderate ongoing evolution. Thinking back to one's childhood, we might visualise the image of a small girl sitting on a carousel and happily turning back and forth the steering wheel of the red car mounted on the revolving carousel: she might be proud of steering her car, while in reality it follows only its eternal route around.

As a consequence of the different societal and political standpoints they are representing, different networks of institutions tend to have different preconceived understandings, different '*precognitive visions*,' to use Schumpeter's vocabulary (Dugger and Sherman 2003: 253). From this obviousness comes the virulence of our theoretical-perspective of the topic '*What is "development"* in my understanding?'

4.1. Paradigms originating from developmentally optimistic approaches

Research or policy-oriented institutions drawing their resources from a positive or even euphoretic view on economic development (such as IIASA, Marchetti and Nakićenović 1979) or financial institutions in the tradition of Bretton Woods (Williamson 1985) according to Daly's perception (1999: 128–135), emphasise external control: targeted interventions from outside are undertaken in order to promote (a) regional developments and (b) global development in 'unfavourable situations' (Ahamer 2019).

4.2. Paradigms originating from developmental dependency-oriented approaches

Research or policy-oriented institutions with a critical view on development (*e.g.* Jäger and Springler 2012; Meadows *et al.* 1992; Lovelock 1988; Sayamov 2013; Ahamer 2012; Fischer *et al.* 2016) emphasise self-control and impulses for independent growth.

4.3. Paradigms offering a synthesis, stemming from an evolutionary approach

It is already becoming clear what the target of reasoning is here, namely that an evolutionary world view is able to reconcile seemingly irreconcilable ideologies:

- A 'discursive and dialogical' basic attitude between particular views (Ahamer 2012) carries in itself both elements, namely the development-related positive and the development-related negative approach, between which it establishes a discursive relationship. This 'scientific method' of establishing a discourse goes back to Galileo Galilei himself, who is seen by many as the actual founder of modern empirically based astronomy, especially when he suffered interference with daily power politics. He took refuge to write a 'dialogue between the two main world models, the Ptolemaic and the Copernican' (Galilei 1632).

- Strengthening of 'civil society' has hopefully applied error-reducing structure formation.
- The formation of institutions in the face of 'global change' as a pendulum movement between UNFCCC ⇔ IPCC (world = real ⇔ world = ideal). These two domains of (social and natural) science and related world understandings with their domain names '.gov' and '.edu' each contain a different professional concept of truth similar to distinct hemispheres of ethical fundaments: legitimacy <=> factuality.
- True learning (= actual change of behaviour) is usually only possible in life after repeated reversals of roles, triggering real dialogue between different domains of consciousness (as it is, *e.g.*, facilitated by the negotiation game 'Surfing Global Change'). Let us dare to enter and transcend previous understanding through a synthesised world view (Hegel 1807)!

As a summary of the above-mentioned, the crucial question 'is global economy converging or drifting apart?' can ultimately be answered in the sense of the situation-dependent logic by the motto: 'everything has its particular value at its particular, transient (development) time.' Even the factors that contribute most to (economic) development can change depending on the self-controlled development phase. Along these phases, the degree of relevance of different factors promoting growth changes, and consequently so does the efficacy of political methods to enhance growth. In the same manner, the public perception of what is important also changes along the logical chain of development.

4.4. Synthesising opposing positions in science

Likewise, the sigma curve of the 'blossoming evolution' (see Fig. 7; and Ahamer 2021) offers room for differently accentuated notions of growth. Close to the state of the 'empty world' (according to Daly 1999: 74), the appropriate mathematical function seems to be the growth curve that arises when rates of increase are proportional to stock (*d/dt x ~ x; the sign ~ here meaning "is proportional to"*). However, in the vicinity of the 'full world' (*Ibid.*: 74–76) the rates of increase become increasingly proportional to the distance to the maximum limit: *d/dt x ~ (1–x)*, where '*1*' symbolises the principal upper limit value for parameter *x*. These two 'ranges of validity' flow together in an uncomplicated way along the sigma curve. Thus, a sigma curve is *the* iconic symbol for how to *reconcile* seemingly irreconcilable worldviews, namely by hypothesising different phases with different validities of both views.

In the natural sciences, such a gradual migration from one domain of theory validity to another is nothing unusual. We may take the historically well-known examples of (1st) *classical* mechanics, (2nd) *relativity* theory and (3rd) *quantum* mechanics:

- The first example: the transition from

1. the free fall of a body in a vacuum is described by Galileo's famous seventeenth-century law of falling bodies, in which velocity increases linearly. Only gravity (constant *g*) is relevant.
2. in a viscous medium such as oil or honey, however, the internal frictional forces predominate, which (only in the nineteenth century by Navier and Stokes [Landau and Lifschitz 1991] led to a law with constant falling speed.

Epistemologically, the following two (historically more recent) 'validity transitions' of natural laws had a strong effect:

- the second example: the transition from

1. 'law 1' of classical mechanics for 'usual' velocities to
2. 'law 2' of relativistic mechanics in the case of approaching the speed of light.

- The third example: the transition from

1. 'law 1' of continuous states at 'normal', macroscopic length situations to
2. 'law 2' of quantised, *i.e.* non-continuous states in cases of very small atomic length.

While a paradigmatic change as a *mental* event resides in the sphere of *perceptions*, transitions are actually documentable by statistically observable *physical* parameters. The next chapter provides some examples.

5. Historically Known Transitions

At the *International Institute for Applied Systems Analysis* (IIASA) situated in a former Habsburg hunting and leisure castle at the small village of Laxenburg south of Vienna, surrounded by a large park and connected to the main Schönbrunn Palace by a 20km driveway, all the main themes of global interests were implemented as main departments for outstanding research. The foundational idea of IIASA was to create a free space of cooperation between scientists and academicians of the formerly antagonistic Eastern and Western blocks in the neutral Republic of Austria. The constitutive idea was to have the Academies of Sciences of participating countries as contributors of human resources to IIASA. To date, IIASA is the leading scientific institution in Austria and enjoys worldwide credibility.

For us here, it is interesting that each of the coming 'transitions' was and is mirrored by a department at IIASA – illustrating the importance of mentioned scientific areas for the peaceful future of humanity.

5.1. Population transition

The population transition (or demographic transition) has already taken place in many countries that consider themselves to be 'developed' and hence is studied thoroughly (Landry 1934).

The subject was formerly known to newspaper readers as the 'population explosion' and was still considered a prime cause of war in Europe (through the idea of 'colonisation space' with the unspeakable consequences of many millions of victims) as late as the twentieth century. This 'explosion' has already slowed down in many countries; and in Central Europe it has already turned into the problem of 'population shrinkage and securing pensions for citizens of old-age' (Davis 2018).

5.2. The current land use transition

Linked to the above global and globalistics-related theme of population is the idea of 'sufficient farmland for the humanity,' which is clearly and drastically in the foreground of perception in areas of global disfavour. The question of how to provide sufficient food to all is the key to the peaceful development of political systems, especially in the Third World.

However, as a contrast, in some countries the trend has already reversed and the main concern of agronomic policy making is the set-aside areas which already necessitate large financial resources (see Fig. 9).

5.3. The presumed future energy transition

Energy as a key global theme also carries within itself the potential for triggering wars. Thus, it is necessary to switch to renewables available locally.

Now, we look at the per capita energy demand and at its change rates over time (Ahamer 2018), but for better visibility of actual trends we plot the same as a function of GDP/capita (see Fig. 10). It is noticeable that the rates of increase in the economically less developed economies are firstly bundled and secondly are decreasing; indeed, in some cases they appear to be heading in the negative in the near future.

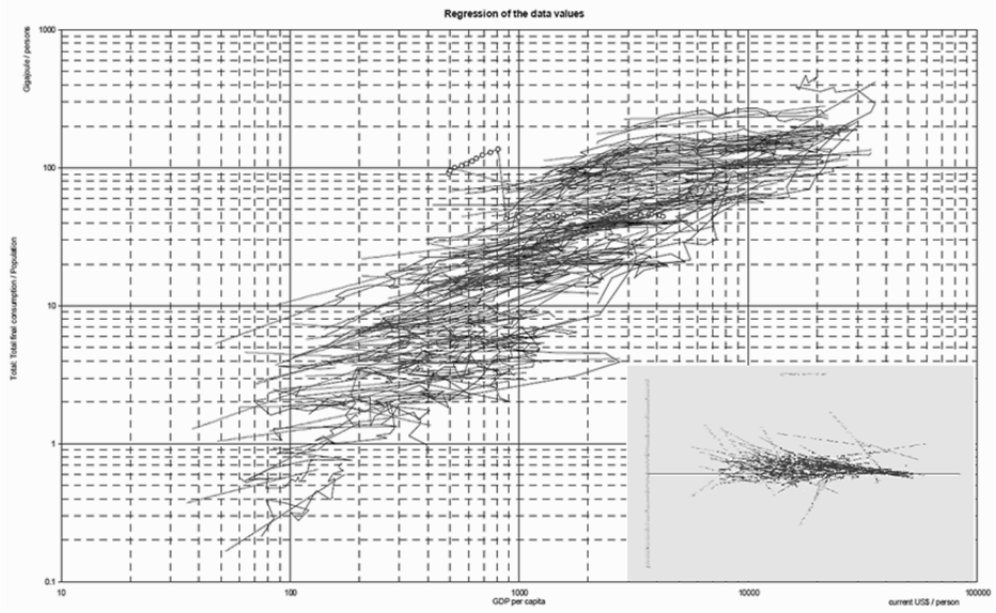


Fig. 10. Illustration of the final energy consumption per capita as a function of economic level (measures as GDP/cap). In the insert: the same, only for the rate of change of the final energy consumption per capita. *Source:* World Bank, IEA, GCDB.

If we now continue the development in our thoughts, a presumption of 'negative growth in energy demand,' that is an expected decrease in some industrialized nations, becomes apparent for the coming decades. The topic 'Peak Oil' (2020) is co-creative and has multiple causes which are at least not contradictory to each other – cause and effect are often indistinguishable in complex systems – both in Big History and in quantum mechanics.

A fundamental strategy (on the meta-level) would therefore be to press ahead with appropriate evolutionary changes; that is to speed up the 'civilizational timeframe,' in order to promote precisely those evolutionary processes and structural developments

which actually promote sustainability and global justice (although here too, at present, it is not yet possible to provide simple, practical selection rules for this).

Thus, in a nutshell, evolutionary time should be speeded up as opposed to astronomical, physical time.

5.4. Transitions are the building law of techno-socio-economic evolution

As a mathematical detail, it should be noted that the proportionality of the second derivative with the capacity remainder is structurally similar to the pendulum equation. A practical example may help: (environmental) warnings are analogous to the volume of the car parking assist pilot, which beeps louder the closer you get to the wall. Any evolution builds on feedbacks and coupling within network-like logical relationships (Hannon and Ruth 2001; Zawadzka 2010; Vester 1980; Sterman 2000).

It is possible that the mathematics to be applied is therefore no longer that of an exponential function, but that of combinatorics (terms such as 'n over k' or 'n factorial' n!), which describes the density of interaction of independent actors (Ahamer 2019).

In a series of ever more complex case studies for 'mapping global dynamics,' Ahamer (2019) displays deforestation (see Fig. 9), economic shift (see Fig. 8) and energy supply (see Fig. 10) as further case studies for transitions.

This approach also seems to correspond to the attitude of several Moscow-based conferences. Existing knowledge is networked and new knowledge is produced in order to achieve an integrated view of development that perceives the economic logic of growth and the scientific logic of the environment as part of the same dynamics of world development. To see the world as a contradictory entity takes both its complexity and its interconnectedness seriously (Novy 2008: 2).

6. The Energy-Economic Quotient Chain Symbolizes Paradigm Change

6.1. A factor decomposition

Now we boldly go one step further: In which direction is evolution developing in general? Also, the 'goal' and target of evolution (can be understood here in all senses of the world, while avoiding a teleological worldview) is subject to an evolutionary change, as the coming deliberation will show.

A fundamental remark is made here: in the energy consulting industry, the search for 'the target function' of primary energy use has intensified since the energy crisis in the 1970s. *Demand Side Management* (DSM, *i.e.* the orientation towards meeting the actually intended need for energy services) was discovered and since then has represented the more modern paradigm, as opposed to supply side management which remains oriented towards available (fossil) energy resources.

The formal connection to this theme opens up after the energy conversion chain – a 'red thread' written in quotient form – is presented as a (tautological) 'factor formula', which has often been used in the literature for global scenarios (Kaya 1990); hence is also widely known as Kaya identity. The known conversion steps are presented in a simplifying linear combination:

$$CO_2 = (CO_2 / E_p) \times (E_p / E_f) \times (E_f / GNP) \times (GNP / QL) \times (QL / capita) \times population$$

Legend in short form: CO_2 = CO_2 emissions, E = (primary or final) energy, GNP = gross national product, QL = quality of life, P = population. *Source:* Ahamer 2019.

Logically, this (admittedly oversimplified, but nevertheless widely used) notation is nothing more than the division of the overall topic 'CO_2 emissions' into several logically independent sub-themes, each described by simple aggregating quotients.

Do we already see here, with an interpretative view, how the focus – that is the magnitude (*i.e.*, parameter) to be optimized in each case, thus the respective virulent development aspect (furthermore also the telescopic sight of the topic perception) – *shifts* from left to right?

- 'Chimneys must smoke' (beginning of industrialisation, component 'CO_2');
- (cheap) energy sources must be available in a secure way (as film, where James Bond as 'Agent 007' tries to crudely secure crude oil supply in Kazakhstan);
- promote efficient energy conversion (Amory Lovins [1989, 1990] invents the 'NegaWatt');
- (additionally: by DSM insertion of the newly invented variable 'energy service');
- economic growth does not require energy demand growth ('decoupling');
- 'Quality of Life': life fulfilment even outside of gainful employment. Working with one's own potential, not necessarily in the monetary employment cycle;
- stabilization of the global population number.

6.2. Some practical steps and examples of target transitions

(1) In this formula's appearance, the ultimate *target* function is always placed at far right, just before the final 'P'. What is not yet 'seen' and perceived (*i.e.* symbolically, what is not yet written as a quotient) cannot yet be a goal at a given point in history, which is actually a history of world perceptions.

For example, the author has *already* inserted here *additionally* the *quality of life* (QL) into the chain of quotients known from literature, because this dimension is usually missing in purely technical-economic considerations (Nakićenović 1997).

(2) The following is a recent example concerning the parameters of final and primary energy: decades ago, 'demand side management' (DSM, Lovins 1989, 1990) was not yet an objective; the business objectives of energy suppliers were just 'to sell energy' (*e.g.,* heating oil). Modern restructured utilities are now already acting as 'energy service utilities' that ensure warm homes and implement insulation measures in their own area of activity when appropriate. The materialization of this new paradigm in the formula is the addition of both primary and final energy within the series of quotients (not only of primary energy).

(3) Following the term 'energy service' (the introduction of which was revolutionary in that it was only with the linguistic designation of this term that it became possible to optimize the efficiency of its achievement) we now use the newly invented word 'economic service'. Previous usage of the term GDP is now understood in a completely new way, namely no longer as a desirable goal per se, but as a necessary effort to achieve the life goal 'quality of life' QL (second factor from right). Intellectually and mathematically, 'GDP' thus moves from the numerator to the denominator of the objective function. This changes the direction in which the extent of economic activity is optimised: no longer 'as much as possible' as an end in itself, but 'as little as possible' in order to achieve the underlying goal 'QL'; that is the expenditure of material resources is done as efficiently as possible. In this example, material growth (= GDP) becomes

the first goal to be striven for and, after its approximate attainment, the means, the effort and the burden. Daly shows similar formula structures (Daly 1999: 121–124).

7. Summary and Conclusions

This article suggests viewing time series of systemic variables (such as sectoral GDP, population change, energy supply and demand, *etc.*) on a per-country basis as a function of GDP/capita and detects several regularities along techno-socio-economic evolution:

- These graphical representations are called 'maps of techno-socio-economic evolution.'
- There appears a successively 'blooming' sequence with several development parameters and this gives rise to thinking of a regular sequence of societal needs to be fulfilled.
- Having a value means that a society pays for the achievements of an economic sector.
- Any society evolves from a system of growth efficiency towards a system of conservation efficiency.
- As a consequence, collective preferences (~ ethical 'values' in a traditional sense) in the growth phase may be regularly opposed to 'values' in the maturity phase of a societal system.

While the deforestation and population transitions already occur(red) historically, the energy transition seems to be the next to come. Its imminent arrival will additionally mitigate the global warming issue.

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