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A Planet-Wide Information System

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Abstract

Purpose – Various economic growth theories propose a view of globalisation resulting in economic convergence. However, others suggest economic divergence (i.e. a widening gap between global rich and poor) and others still, different patterns of development. Hence it is necessary to validate such globalisation hypotheses with sound quantitative data.

Design/methodology/approach – The paper proposes the "Global Change Data Base" (GCDB) that includes an analytical tool (AT) providing correlations between primary and secondary data (by country by year) from the fields of population, agriculture, economy, energy and human development.

Findings – The AT is able to first test the hypotheses on global development and globalisation and second to suggest new hypotheses on the mechanisms of globalisation. Results can be used in curricula of Global Studies worldwide.

Research limitations/implications – These data analysis has still to be complemented by sociological, political and economic theories providing insights into global restructuration processes and structural transitions through globalisation.

Practical implications – "Forward-looking" as an emerging scientific discipline is supported by the proposed detailed analytical methods, namely by providing quantitative, in-depth techno-socio-economic megatrends.

Social implications – The perception of globalisation might be rendered more inter-subjectively traceable by the GCDB.

Originality/value – Up-to-date means of forward-looking are less detailed regarding economic sectors and energy sources compared to the proposed GCDB.

Keywords Agriculture, Globalisation, Energy, Trends, Global Change Data Base (GCDB), Global Studies, Human development, Population

Paper type Conceptual paper

1. Introduction

Globalisation attracts increasing interest both on the educational level of university curricula (Anheier and Juergensmeyer, 2012; Mazour *et al.*, 2003; Bader and Zotter, 2012; Bader and Köttstorfer, 2013; Bader *et al.*, 2013a, b; Nederveen Pieterse, 2013; Ahamer *et al.*, 2011), in modelling science (IPCC, 2000; GEA, 2012) as well as in political science (Ilyin and Ursul, 2012, 2013; Grinin, 2012a, b, 2013; Chumakov, 2010). For university didactics, globalisation represents a wider and more trans-disciplinary concept (Ahamer, 2012, 2013) than the climate change boom of earlier years.

2. Need for planet-wide information on structural change and globalisation

Various types of forecast and forward-looking regarding global development on the economic, social, cultural and environmental levels are presented in literature with often divergent underlying developmental paradigms.

The following main types of future research could be discerned:

(1) Ethically oriented globalisation concepts directed towards cultural and political consensus (Rauch, 2013; Chumakov, 2013; Sayamov, 2013; Gay, 2010; Chase-Dunn, 2010; Krastev, 2011; Grinin *et al.*, 2009, 2013; Collins, 2010; Eisenstadt, 2010; Nazaretyan, 2009; Lozny, 2010; Grinin, 2010, 2011, p. 152;

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Rauch and Strigl, 2005; Grinin and Korotayev, 2011; Modelski and Perry, 2002; Laszlo, 2011; Ahamer, 2008a; Ahamer and Strobl, 2010; Ahamer *et al.*, 2010).

(2) Positive views of global development, classical development theories, exponential or over-exponential growth theories (IPCC, 2000; Johansen and Sornette, 2001, p. 474; Akaev *et al.* 2012; Kapitza, 2010, p. 1338; von Foerster *et al.*, 1960; Grinin, 2013; Mankiw *et al.*, 1992; Korotayev *et al.*, 2011b).

(3) Critical views such as dependency theory (Frank, 1966; Wallerstein, 1984; Harvey, 1989).

(4) Catastrophic theories or analyses of crises (Meadows *et al.*, 2004; Rozanov, 2012).

(5) Cyclical theories such as narrative approaches (Rodrigue and Stasko, 2010; Ibn Khaldun, 1958; Amirabedini, 2014; Spengler, 1918) or quantitative ones such as Kondratieff cycles (Grinin and Korotayev, 2011; Korotayev *et al.*, 2011a; Modelski, 2001, p. 76).

(6) Saturation paradigms, logistics curves, abatement scenarios, and post-growth concepts (Miranda and Lima, 2010, p. 700; Coccia, 2010, p. 733; Yücel and Barlas, 2010, p. 604; Akaev, 2010, p. 828; Grübler *et al.*, 1999, 2007; Riahi *et al.*, 2007; Moss *et al.*, 2010; Kates *et al.*, 2001; Ahamer, 2008b).

(7) Combined paradigms, namely integrating Kondratieff's cycles with on-going growth (Akaev *et al.*, 2012, p. 356; Devezas, 2010, p.750; Bondarenko, 2011).

(8) Complexity paradigms in narrative or quantitative style, e.g. as "big history" or macro-history (Spier, 2005; Nazaretyan, 2005; Christian, 2005; Ilyin and Ursul, 2012), self-organisation or self-creation (Snooks, 2007; Heylighen, 2007), and many more.

The variance of the mathematical appearance of above propositions reflects the variance of understandings of development as such.

3. Technical design of the proposed information system

The proposed Global Change Data Base (GCDB) should envisage compiling over two thousand data sets from the fields of:

- agriculture, land use (FAO, 2013);
- economy, gross national product (UNSTAT, 2013);
- energy supply on global (IEA, 2013) and (if possible) local (Müller *et al.*, 2013; Duraković *et al.*, 2012) levels; and
- population and social sciences, Human Development Indicators (HDI, 2013), World Development Indicators (WDI, 2013), Penn World Tables (PWT, 2013) or other indicators of development and globalisation (cf. Zinkina and Korotayev, 2013).

The GCDB should analyse these data numerically and graphically by means of regressions and correlations. Given the above-mentioned partly contradictory paradigms, it might be helpful to first concentrate on a consistent sub-period within a Kondratieff wave, namely the 1960s through 1980s.

Depending on data availability, for each country in recent decades (mostly 1960-1991), data should be compatible to standard international data sources, such as UNSTAT, FAO, IEA, HDI, WDI, and PWT (at left in Figure 1).

Diagrams will be provided on a per country basis, per continent, and for 11 world regions common to most global modelling (Figure 2), as used in energy economics (IPCC, 2000; GEA, 2012; Ahamer, 1994). A detailed overview of the data set should be available as a variable list.

Furthermore, the GCDB shall have a macro-driven "AT", which is designed for graphical and quantitative representation of global trends.

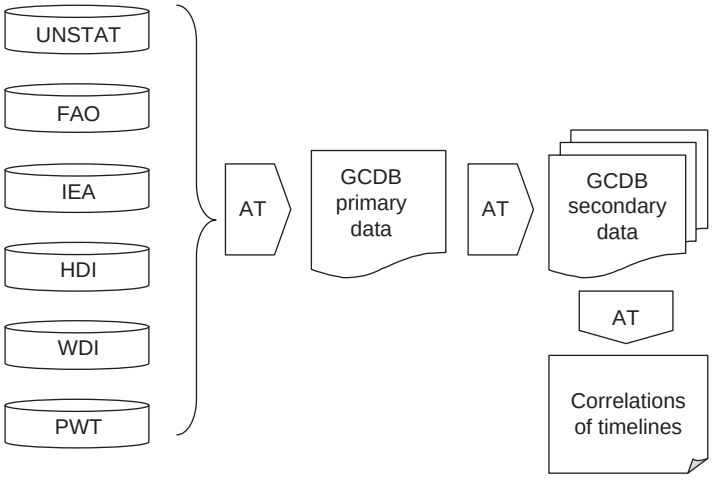
The AT has two main tasks (compare data flow in Figure 1, from left to right):

(1) It combines any existing (primary) GCDB data on new (derived, secondary) data; by addition, subtraction, multiplication, division, differentiation to individually selectable (secondary) data.

(2) It correlates any (primary or secondary) data. The quantitatively specified correlation factors and parameters can also be illustrated graphically (by the "pathfinder", as a third macro task).

The menu system will be structured accordingly:

(1) The main menu (at far left in Figure 3) is planned to branch out to the specified tasks and provides an overview of the possibilities.



Notes: At left: internationally compatible data sources such as UNSTAT, United Nations Statistical Office; FAO, Food and Agricultural Organisation; IEA, International Energy Agency; HDI, Human Development Indicators; WDI, World Development Indicators; and PWT, Penn World Tables. These data are topographically harmonised by the analytical tool (AT) of the GCDB which yields the GCDB's thousands of primary data. By their mathematical combination, the AT computes a greater multitude of secondary data that are able to be correlated and then displayed graphically in order to detect so-called "paths of development" as hypothesised by some growth theories

Figure 1.
Data flow scheme for the "Global Change Data Base" (GCDB)

(2) The menu "generate *derived* variables" (at near left in Figure 3) is planned to allow the mathematical operator applied to the selectable (e.g. primary) data, the names and units for the result and the weight function necessary to aggregate geographically the result derived (i.e. the secondary data), to be chosen.

(3) The menu "creating *correlations*" (at near right in Figure 3) is the planned choice for the two variable sets to be linked; the type of correlation (linear, exponential, logarithmic, potential) and the name for the result file.

(4) As an additional option, the planned menu "pathfinder" (at far right in Figure 3) will provide previously created correlations with interpolated trend lines.

4. Possible applications for the proposed information system

As examples, the following themes can be covered by the GCDB:

- land use change;
- CO_2 emissions from energy supply; and
- water demand and supply.

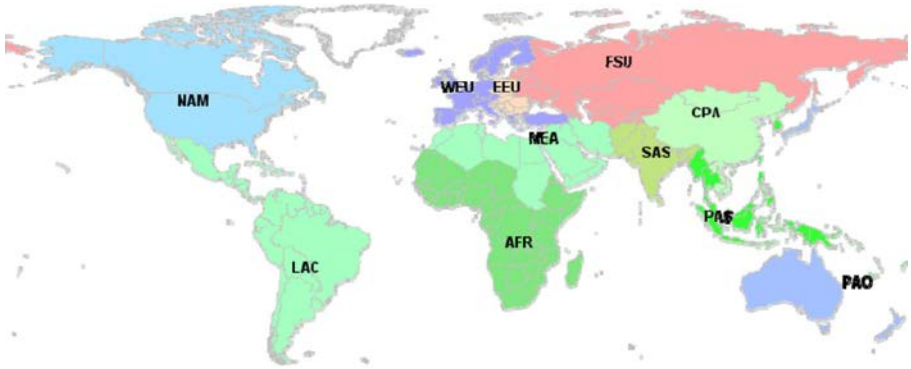
First applications will be reported in other articles (e.g. Ahamer and Mayer, 2013).

5. Formalism for the example of energy supply

In general notation it is already visible that the fundamental formalism recurs to intensity parameters, i.e. quotients of extensity parameters. Thus, structural properties can be described independently from a country's area or population. Such chains of quotients were earlier often called "Kaya identities" and are widely used, e.g. by the Special Report on Emissions Scenarios SRES (IPCC, 2000) and differ by their degree of differentiation into single chain elements along the logical chain from demand to supply and emissions. The GCDB might use the following equation:

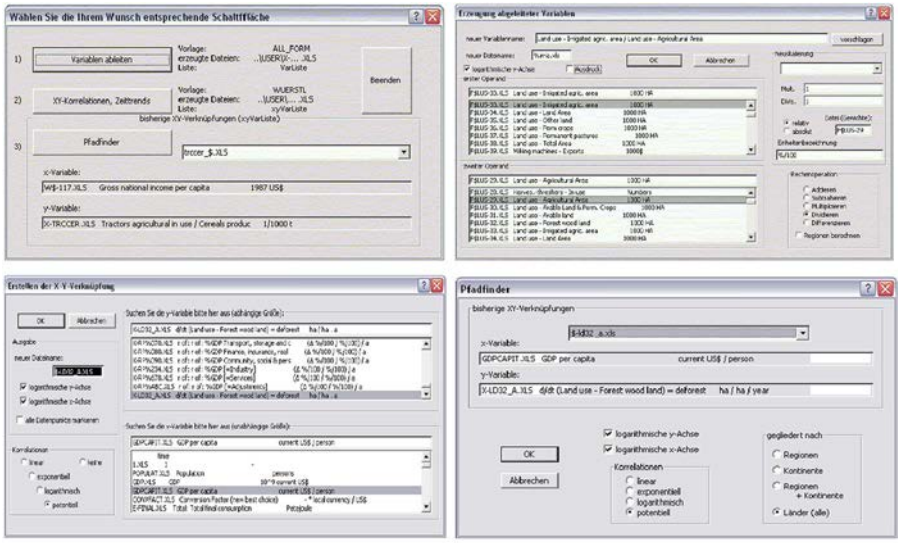
$$CO_2 = (CO_2/E_\mathrm{p}) \times (E_\mathrm{p}/E_\mathrm{f}) \times (E_\mathrm{f}/GNP) \times (GNP/\mathrm{capita}) \times Population$$

where CO_2 is the level of CO_2 emissions; E_p is the demand for primary energy (for a specific energy carrier); E_f is the demand for final energy (for a specific energy carrier); GNP is the gross national product (in a specific economic sector); P is population.



Source: database of Grübler et al. (2012)

Figure 2.
The proposed 11-model regions for the scenarios used in the Global Energy Assessment (GEA, 2012) are compatible with those in the IPCC report on emission scenarios (IPCC, 2000)



Note: From left to right: main menu, menu for deriving primary variables, menu for correlations, and menu for path finder (trend scout)

Figure 3.
Examples for planned macro menu control windows for the analytical tool to the "Global Change Data Base" (GCDB)

In detailed notation, the same equation reads:

$$
\begin{aligned}
CO_2(c,y) = \sum_{f,s} CO_2(c,y,f,s) = \\
= [CO_2(c,y,f,s)/E_{\mathrm{p}}(c,y,f,s)]\times \\
\times[E_{\mathrm{p}}(c,y,f,s)/E_{\mathrm{f}}(c,y,f,s)]\times \\
\times[E_{\mathrm{f}}(c,y,f,s)/GNP(c,y,s)]\times \\
\times[GNP(c,y,s)/P(c,y)]\times \\
\times P(c,y)
\end{aligned}
$$

where c is the country, y is the year, f is fuel, s is economic sector, Σ is the sum.

6. Conclusions

The proposed GCDB seems to be able to test hypotheses and to create new hypotheses in a quantitative manner on global development and globalisation.

Because earlier modelling exercises are highly dependent on underlying economic, social, philosophical and developmental paradigms, a rather paradigm-free analytical tool seems suitable and promising. Often, the choice of mathematical modes of correlation (linear, exponential, logarithmic, and potential) might influence the interpretability of results and their match with previously adopted paradigms of development.

Also, the degree of differentiation of the planned GCDB (number of economic sectors and fuel types) might be higher than in earlier exercises of global modelling.

The proposed Planet-Wide Information System can hence contribute to closing the gap between qualitatively oriented humanities and social sciences on the one hand, and quantitatively oriented natural sciences and engineering on the other.

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