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Introduction

Modeling and Measuring Cycles, Processes, and Trends

Leonid E. Grinin and Andrey V. Korotayev

The present Yearbook (which is the fourth in the series) is subtitled *Trends & Cycles*. Already ancient historians (see, *e.g.*, the second Chapter of Book VI of Polybius' *Histories*) described rather well the cyclical component of historical dynamics, whereas new interesting analyses of such dynamics also appeared in the Medieval and Early Modern periods (see, *e.g.*, Ibn Khaldūn 1958 [1377], or Machiavelli 1996 [1531]¹). This is not surprising as the cyclical dynamics was dominant in the agrarian social systems. With modernization, the trend dynamics became much more pronounced and these are trends to which the students of modern societies pay more attention. Note that the term *trend* – as regards its contents and application – is tightly connected with a formal mathematical analysis. Trends may be described by various equations – linear, exponential, power-law, *etc.* On the other hand, the cliodynamic research has demonstrated that the cyclical historical dynamics can be also modeled mathematically in a rather effective way (see, *e.g.*, Usher 1989; Chu and Lee 1994; Turchin 2003, 2005a, 2005b; Turchin and Korotayev 2006; Turchin and Nefedov 2009; Nefedov 2004; Korotayev and Komarova 2004; Korotayev, Malkov, and Khal-tourina 2006; Korotayev and Khal-tourina 2006; Korotayev 2007; Grinin 2007), whereas the trend and cycle components of historical dynamics turn out to be of equal importance.

It is obvious that the qualitative innovative motion toward new, unknown forms, levels, and volumes, *etc.* cannot continue endlessly, linearly and smoothly. It always has limitations, accompanied by the emergence of imbalances, increasing resistance to environmental constraints, competition for resources, *etc.* These endless attempts to overcome the resistance of the environment created conditions for a more or less noticeable advance in societies. However, relatively short periods of rapid growth (which could be expressed as a linear, exponential or hyperbolic trend) tended to be followed by stagnation, different types of crises and setbacks, which created complex patterns of historical dynamics, within which trend and cyclical components were usually interwoven in rather intricate ways (see, *e.g.*, Grinin and Korotayev 2009; Grinin, Korotayev, and Malkov 2010).

¹ For interpretations of their theories (in terms of cliodynamics, cyclical dynamics *etc.*) see, *e.g.*, Turchin 2003; Korotayev and Khal-tourina 2006; Grinin 2012a.

Hence, in history we had a constant interaction of cyclical and trend dynamics, including some very long-term trends that are analyzed in *Section I* of the present Yearbook which includes contributions by **Leonid E. Grinin**, **Alexander V. Markov**, and **Andrey V. Korotayev** ('Mathematical Modeling of Biological and Social Evolutionary Macrotrends'), **Tony Harper** ('The World System Trajectory: The Reality of Constraints and the Potential for Prediction') and **William R. Thompson and Kentaro Sakuwa** ('Another, Simpler Look: Was Wealth Really Determined in 8000 BCE, 1000 BCE, 0 CE, or Even 1500 CE?').

If in a number of societies and for quite a long time we observe regular repetition of a cycle of the same type ending with grave crises and significant setbacks, this means that at a given level of development we confront such rigid and strong systemic and environmental constraints which the given society is unable to overcome.

Thus, the notion of cycle is closely related to the concept of the trap. In the language of nonlinear dynamics the concept of traps will more or less correspond to the term 'attractor'. Continuing the comparison with nonlinear dynamics, we should say that a steady escape from the trap will largely correspond to the concept of a phase transition.

In this Yearbook particular attention is paid, of course, to the Malthusian trap. The escape from the Malthusian trap in historical retrospect was incredibly difficult (see, *e.g.*, Korotayev *et al.* 2011; Grinin 2012b). Periodically, attempts were made to get out of this trap. However, for many millennia no societies managed to achieve a final steady escape from it, but those attempts in the long run led to a systematic increase in the level of technological development of the World System.

The problems of the mathematical modeling of the Malthusian trap dynamics are analyzed in the article by **Sergey A. Nefedov** ('Modeling Malthusian Dynamics in Pre-Industrial Societies: Mathematical Modeling') in *Section II* of the present issue of the Yearbook. This section also includes the article by **Sergey Gavrilets**, **David G. Anderson**, and **Peter Turchin** ('Cycling in the Complexity of Early Societies'), as well as the one by **David C. Baker** ('Demographic-Structural Theory and the Roman Dominate'). These articles deal with various cycles in the historical dynamics of pre-Modern social systems that are rather tightly connected with demographic macroprocesses. The first article of the next section also deals with the problems of the escape from the Malthusian trap.

Section III deals with Modern history and contemporary processes and includes the contribution by **Andrey V. Korotayev**, **Sergey Yu. Malkov**, and **Leonid E. Grinin** ('A Trap at the Escape from the Trap? Some Demographic Structural Factors of Political Instability in Modernizing Social Systems') continuing the discussion on the issues of the Malthusian and post-Malthusian traps. This issue is also touched upon in the contributions by **Arno Tausch**

and Almas Heshmati ('Labour Migration and "Smart Public Health"'), Anthony Howell ('Is Geography "Dead" or "Destiny" in a Globalizing World? A Network Analysis and Latent Space Modeling Approach of the World Trade Network'), Kent R. Crawford and Nicholas W. Mitiukov ('The British-Italian Performance in the Mediterranean from the Artillery Perspective'), as well as Alisa R. Shishkina, Leonid M. Issaev, Konstantin M. Truevtsev, and Andrey V. Korotayev ('The Shield of Islam? Islamic Factor of HIV Prevalence in Africa').

Articles in this section are devoted to some rather interesting aspects and events from the Second World War to the prospects for change of the age composition of the Earth's population in the coming decades. What appears valuable is that the contributors have managed to somehow formalize these processes, and to apply various mathematical techniques to the analysis of the recent historical processes.

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