

Review Essay

Review of Andrey Korotayev, Artemy Malkov, and Daria Khaltourina, *Introduction to Social Macrodynamics* (Three Volumes)*

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This interesting work is an English translation, by the authors and in three brief volumes, of an amended and expanded version of their Russian work published in 2005. Andrey Korotayev is Director of the ‘Anthropology of the East’ Center at the Russian State University for the Humanities; Artemy Malkov is Research Fellow of the Keldysh Institute for Applied Mathematics; and Daria Khaltourina is Research Fellow of the Center for Regional Studies. By way of full disclosure, I should state that I have enjoyed not only making the acquaintance of the first and third authors at professional meetings, but also the opportunity to offer comments on earlier versions of some parts of this English translation. In terms coined recently by Peter Turchin, the first volume focuses on ‘millennial trends’, the latter two on ‘secular cycles’ a century or two in duration.

The first volume's subtitle is *Compact Models of the World System Growth* (CMWSG hereafter). Its mathematical basis is the standard hyperbolic growth model, in which a quantity's proportional (or percentage) growth is not constant, as in exponential growth, but is proportional to the quantity itself. For example, if a quantity growing initially at 1 percent per unit time triples, it will by then be growing at 3 percent per unit time. The remarkable claim that human population has grown, over the long term, ac-

According to this model was first advanced in a semi-serious paper of 1960 memorably entitled 'Doomsday: Friday, 13 November, A.D. 2026' (von Foerster, Mora and Amiot, 1960). Admitting that this curve notably fails to fit world population since 1962, chapter 1 of *CMWSG* attempts to salvage the situation by showing that the striking linearity of the declining rates since that time, considered with respect to population, can be identified as still hyperbolic, but in *inverse* form. Chapter 2 finds that the hyperbolic curve provides a very good fit to world population since 500 BCE. The authors believe this reflects the existence, from that time on, of a single, somewhat integrated World System; and they find they can closely simulate the pattern of actual population growth by assuming that although population is limited by technology (Malthus), *technology grows in proportion to population* (Kuznets and Kremer). Chapter 3 argues that world GDP has grown not hyperbolically but quadratically, and that this is because its most dynamic component contains two factors, population and per-capita surplus, each of which has grown hyperbolically. To this demographic and economic picture chapter 4 adds a 'cultural' dimension by ingeniously incorporating a literacy multiplier into the differential equation for absolute population growth (with respect to time) such that the degree to which economic surplus expresses itself as population growth depends on the proportion of the population that is literate: when almost nobody is literate, economic surplus generates population growth; when almost everybody is literate, it does not. This allows the authors' model to account nicely for the dramatic post-1962 deviation from the 'doomsday' (hyperbolic) trajectory. It also paves the way for a more specialized model stressing the importance, in the modern world, of human-capital development (chapter 5). Literacy's contribution to economic development is neatly and convincingly linked, in chapter 6, to Weber's famous thesis about Protestantism's contribution to the rise of modern capitalism. Chapter 7 cogently unravels and elucidates the complex role of literacy – male, female, and overall – in the demographic transition. In effect, the 'doomsday' population trajectory carried the seeds of its own aborting:

the maximum values of population growth rates cannot be reached without a certain level of economic development,

which cannot be achieved without literacy rates reaching substantial levels. Hence, again almost by definition the fact that the [world] system reached the maximum level of population growth rates implies that . . . literacy [had] attained such a level that the negative impact of female literacy on fertility rates would increase to such an extent that the population growth rates would start to decline (*CMWSG*: 104).

The second volume is subtitled *Secular Cycles and Millennial Trends* (*SCMT* hereafter). Chapter 1 stresses that demographic cycles are not, as often has been thought, unique to China and Europe, but are associated with complex agrarian systems in general; and it reviews previous approaches to modeling such cycles. Due to data considerations, the lengthy chapter 2 focuses on China. In the course of assessing previous work, the authors, though writing of agrarian societies in particular, characterize nicely what is, in larger view, the essential dilemma reached by every growing human population:

In agrarian society within fifty years such population growth [0.6 percent per year] leads to diminishing of per capita resources, after which population growth slows down; then either solutions to resource problems (through some innovations) are found and population growth rate increases, or (more frequently) such solutions are not found (or are not adequate), and population growth further declines (sometimes below zero) (*SCMT*: 61–62).

(Indeed, for humans, technological solutions that raise carrying capacity are always a presumptive alternative to demographic collapse; therefore, asserting – or even proving – that a particular population ‘exceeded its carrying capacity’ is not sufficient to account logically for the collapse of either a political system or an entire civilization.) Interestingly, the authors find evidence that China's demographic cycles, instead of simply repeating themselves, tended to increase both in duration and in maximum pre-collapse population. In a brief chapter 3 the authors present a detailed mathematical model which, while not simulating these trends, does simulate (1) the S-shaped logistic growth of population (with the effects of fluctuating annual harvests smoothed by the state's functioning as a tax collector and famine-relief agency); (2) demographic collapse due to increase in banditry and internal

warfare; and (3) an 'intercycle' due to lingering effects of internal warfare. Chapter 4 offers a most creative rebuttal of recent arguments against population pressure's role in generating pre-industrial warfare, arguing that a slight negative correlation, in synchronic cross-cultural data, is precisely what such a causal role would be expected to produce (due to time lags) when warfare frequency and population density are modeled as predator and prey, respectively, using the classic Lotka-Volterra equations. Chapter 4 also offers the authors' ambitious attempt to directly articulate secular cycles and millennial trends. Ultimately they produce a model that, unlike the basic one in chapter 3, simulates key trends observed in the Chinese data in chapter 2:

the later cycles are characterized by a higher technology, and, thus, higher carrying capacity and population, which, according to Kremer's technological development equation embedded into our model, produces higher rates of technological (and, thus, carrying capacity) growth. Thus, with every new cycle it takes the population more and more time to approach the carrying capacity ceiling to a critical extent; finally it 'fails' to do so, the technological growth rates begin to exceed systematically the population growth rates, and population escapes from the 'Malthusian trap' (*SCMT*: 130).

The third volume is subtitled *Secular Cycles and Millennial Trends in Africa* (*SCMTA* hereafter). It is divided into two parts, the first of which is devoted to Egypt in the 1st through 18th centuries CE (chapters 1–6); the second, to postcolonial tropical Africa (chapters 7–8). The first part argues that while Egypt's population probably increased over the period in question, the increase was modest compared to that of other agrarian societies. This modesty the authors ascribe to the remarkable brevity of Egypt's political-demographic cycles, which they estimate at averaging around ninety years – little more than half as long as China's. With such brief cycles, collapse repeatedly occurred long before carrying capacities were approached. Strongly inspired by Peter Turchin's work but hewing more closely to insights of the anachronistic 14th-century cultural evolutionist Ibn Khaldun, the authors find that these brief cycles can be modeled by including climatic fluctuation and, especially, the rapid reproduction of high-consumption elites due to polygyny. They estimate the annual growth rate for Egypt

tian elites at 4 percent per year, the rate for commoners (monogamous) at only 1 percent per year – a recipe for rapid political-demographic crisis and collapse, since elites of course depend on the taxation of commoners!

The second part of *SCMTA* describes the impact of modernization on political-demographic cycles. The authors find that low nutrition predicts political instability and civil war in African nations; for prevention, they recommend especially the diversification of national economies, and the fostering of education to promote economic development. Concerning the underlying causes of historical events, they quote John Maynard Keynes writing in 1920:

The great events of history are often due to secular changes in the growth of population and other fundamental economic causes, which, escaping by their gradual character the notice of contemporary observers, are attributed to the follies of statesmen or the fanaticism of atheists (quoted in *SCMTA*: 113).

Some aspects of this work are easy to criticize. The reporting of probabilities with sixteen zeros to the right of the decimal point will strike as gratuitous those readers who consider .001, .01, or even .05 sufficient to render randomness an implausible explanation for a result, especially when, as here, the danger of erroneously rejecting the null hypothesis (alpha or Type I error) is clearly preferable to the premature truncation of inquiry that could result from erroneous *failure* to reject the null (beta or Type II error). More importantly, one would like to have seen more attention given to the problems that attend using regression with time-series data. Values in a variable's time series tend to be affected by adjacent values ('autocorrelation'), a condition that violates one of the assumptions underlying the ordinary-least-squares model and that regularly results, for regressions on time itself (*e.g.*, population plotted against time), in exaggerated *R*-squared magnitudes and significance levels; similar exaggeration results for regressions of a time-trending variable on one or more other time-trending variables (*e.g.*, population growth rate plotted against population). The frequent appearance, in the book's graphs, of long runs of data points on the same side of a theoretical line or curve is a symptom of autocorrelation; and the book's regressions of trending variables on other trending variables do not appear to have been protected

from this source of spuriousness by inclusion of time itself as an independent variable in the regression equations. The hyperbolic curve, moreover, is not systematically compared here with serious competitors. For these reasons the hyperbolic curve's superiority, as a description of human population history, remains by no means beyond question (cf. Cohen 1995: chapter 5 and appendix 6).

Important questions remain, too, about the tenability of the Kuznets-Kremer assumptions – appealing as they are to some of us – offered to theoretically account for the hyperbolic model's applicability to human population history. For example, the key assumption that technological growth tends to keep pace with population growth appears problematic enough to warrant perhaps greater caution than the authors express. Also, one would like to see a better fit between the abstract global model on the one hand, and what we know about the growth rates for particular populations on the other. Since particular populations seldom sustain even exponential growth for very long, explaining sustained hyperbolic growth globally apparently requires invoking the spread, from population to population, of the demographic transition's first phase (cf. *CMWSG*: 92–93; *SCMTA*: 116–117). This is for recent centuries only; to cover the pre-industrial period, the authors posit five somewhat intricate and interrelated mechanisms, one of which again relies on diffusion (the ‘innovation diffusion’ mechanism) (*SCMTA*: 140–141). It seems somewhat awkward, however, to rely so much on diffusion from donor to recipient regional populations, sometimes over considerable time periods, given that the Kuznets-Kremer assumptions appear to ascribe the (apparently) hyperbolic shape of long-term global population growth to direct and continuous interaction, within a single world-system population, between a single technological base and a single inventive potential (both seen as proportional, quantitatively, to population itself).

While the translation's English is often less than felicitous, it is quite clear; the few typographical errors I noted were not of a kind to create misunderstanding. The authors are to be commended, I think, for putting most of the mathematics ‘up front’ rather than tucked away in appendices, as publishers are wont to urge. (There are technical appendices – three in *CMWSG*, two in *SCMT*, and one in *SCMTA*; but their function is by no means to keep the text itself free of math.) Cultural evolutionism is still near the beginning of the long process of becoming a mathematical science; to

that extent, the medium of this book is, if perhaps not *the* message, certainly *a* message (Carneiro 2003: 285–286)!

Even more generally, this work vigorously asserts the value of studying social and cultural evolution as such. Noting the 'almost total disenchantment with the evolutionary approach in the social sciences as a whole' (*SCMT*: 140), the authors perspicuously compare the resulting stultification to the fate that 'would have stricken physicists if a few centuries ago they had decided that there is no real thing such as gas, that gas is a mental construction, and that one should start with such a "simple" thing as a mathematical model of a few free-floating molecules in a closed vessel' (*SCMT*: 140, note 6).

Thirty years ago, Mark Nathan Cohen wrote, 'It has been my observation that simple hypotheses boldly defended are often the best teaching tools and the best spurs to research' (Cohen 1977: ix). Aside from the difficulties we all encounter, sooner or later, comprehending mathematics (we differ only in when, not in whether, the difficulties begin), this book's theses are simple; and they are nothing if not 'boldly defended'! In sum, this work deserves attention from anyone interested in cultural evolutionism's scientific prospects, and close study indeed by anyone hoping to contribute to this field's development from a mathematical point of view.

NOTES

* The all three volumes are published in 2006 in Editorial URSS, Moscow.

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