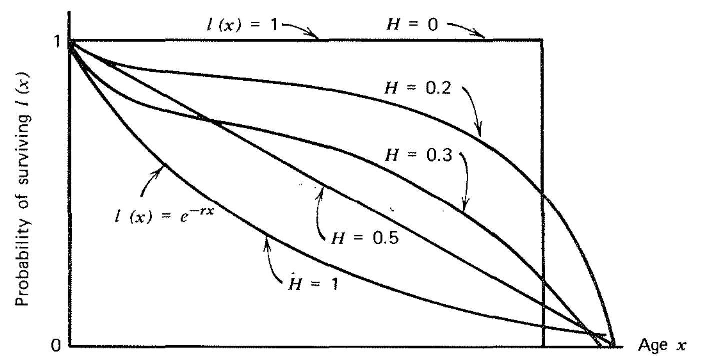
Keyfitz: Mathematical Demography

Applied Mathematical Demography
by Nathan Keyfitz
John Wiley—Interscience, 1977, xxiv + 388 pp. $19.95
Reviewed by Joel E. Cohen

From the origin of the species to 1825, the human population of the earth increased by one billion for the first time. The human population of the earth increased by one billion for the fourth time from 1960 to 1975.

If these facts and their implications were as well known to middle class Americans as the recent vagaries of the Dow Jones Index, the subject matter of Nathan Keyfitz's *Applied Mathematical Demography* would be as familiar to college undergraduates as is that of Paul Samuelson's *Economics*. Even the narrowest self-interest, coupled with the recognition that all humans share one globe, would create concern with where the rise in human numbers is taking us.

Yet, Keyfitz admits (p. 202), "our knowledge of population mechanisms is weak." It is important to improve our knowledge, including both facts and theories. Reading Keyfitz's new book is an efficient and pleasant way of becoming acquainted with some of the theories which require improvement. This clear, useful review of selected models of population mechanisms is accessible to anyone who knows elementary calculus and elementary probability theory. The book does not crusade for anything except the excitement of scholarship; its prose approaches passion only in describing the process of research.



"No model, no understanding"

A major message of the book appears as a section heading: "No model, no understanding." Keyfitz makes the point by posing practical questions about human populations which have no quantitative answers, and in some cases no qualitative answers, without the help of a model.

For example: Supposing age-specific death rates in a population to be constant over time, how would different long-run rates of increase affect the mean age of the population, or the fraction of people older than some given age, or the premium of a pension fund, or the age of promotion in a hierarchical organization governed by seniority rules?

If age-specific death rates were altered by a proportion uniform at all ages, what would be the effect on the expectation of life at birth? (For small proportions, the effect depends on a function of the life table related in form, and in some geometric properties, to an entropy-like measure proposed for age-structured populations by Demetrius in 1974.)

Can further decline in death rates be expected to provoke any substantial rise in the rate of population growth of the world as a whole, all other factors remaining constant? (No, with the principal exception of tropical Africa.)

Assuming all else equal, which of two populations will have the lower birth rate, one in which 100% of people use a contraceptive that is 50% effective or one in which 50% of people use a contraceptive that is 100% effective and 50% use none? (The latter.)

What might be the effects on the birth rate of an ability to influence the sex of offspring?

The most frequent method of analysis is that of comparative statics: a model with a long-run equilibrium is established, one parameter of the model is perturbed, and the consequent perturbation in the equilibrium is calculated. There are endless examples suitable for elementary teaching of applications of Taylor series, of the implicit function theorem, of conditional probabilities.

Joins Earlier Text

This book joins Keyfitz's earlier *Introduction to the Mathematics of Population* (1968) on the short list of books which any student of mathematical demography, or of age-structured biological populations, should master. Mathematically trained readers might find it easier first to review the formalism in the *Introduction* and then to enjoy the applications in this new book. Students and scholars outside of mathematics might first let the examples in Keyfitz's new book motivate them to grapple with the underlying mathematics in his earlier book. In spite of the considerable, and inevitable, overlap of the models in the two books, both are worth reading.

A welcome feature of this new book is the discussion of the probable limitations of each model analyzed. For example, models for the expected numbers of various kinship relations

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in a large population ignore the dependence within families in fertility and mortality. By pointing out how the models fail to incorporate features of the phenomena analyzed, Keyfitz provides many valuable pointers for future research. Thus the book not only covers what has been done but it also a guide to the unknown by one who has marked many new trails himself.

Emphasis on Models

The emphasis on models is necessary because of the "incapacity of the raw data to speak for themselves" (p. 364). Numerical data here usually illustrate rather than verify some underlying model. (Some of these data are startling in themselves: in 1965 Honduras reported 51% of its population to be under age 15, compared with, say, 31% in the U.S. now [p. 163].) But models alone do not a science make.

Keyfitz points out that a full and systematic account which brings demographic, economic, social, behavioral, genetic and physiological data to bear on the issues raised here by demographic models remains to be written. I hope he will write it, and thereby unify the tabulation of demographic statistics and the elaboration of elementary models into a science of demography.

Only a more dynamic tension between models and data can change demography from a form of accounting for a poorly understood past to a scientific foundation for understanding, predicting, and influencing a potentially hazardous future.

(Editor's note: The reviewer is professor at The Rockefeller University, New York City.) □

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