[Review of the book Nonlinear Dynamical Economics and Chaotic Motion, H.W. Lorenz, 1989]

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Published in:
Journal of economics = Zeitschrift für Nationalökonomie

Publication date:
1990

Lorenz, H.-W.: *Nonlinear Dynamical Economics and Chaotic Motion.* (Lecture Notes in Economics and Mathematical Systems, Vol. 334.) 12 Tables, XI, 248 pp. Berlin – Heidelberg – New York – London – Paris – Tokyo – Hong Kong: Springer-Verlag. 1989. DM 53.—.

The two main themes of this book are, first, whether economic time series, that are difficult to explain using linear time-invariant models, can be derived from non-linear versions of these models and, second, how the existence of nonlinearities in the underlying model can be determined from these time series.

The first question is answered affirmatively and illustrated by a number of economic examples, like e. g. the Phillips model, Optimal Economic Growth models, various Business Cycle models and the Kaldor model. Though this is, from a mathematical point of view, not very surprising it probably provides for many economists new insights on time series.

The second question is only partially answered. This is directly related to the problem itself.

Since an economy is not an isolated subsystem of the society, any model of it contains noise, fluctuations and exogenous shocks. Therefore the choice for either a nonlinear model superimposed by noise or a linear model superimposed by noise is not easy. The author summarizes a number of tools to discriminate between both types of models. However, all these methods have in common that they require too many data points in order to achieve reliable results. So, the problem remains to find more appropriate statistical methods.

Since analysis of time series aims at prediction of future evolution of the system, and indirectly at controlling it, a main conclusion of the book is that a correct modeling (and thus in particular the detection of nonlinearities in time series) is a must, but is certainly not a guarantee for being able to predict it. The consequences of a misspecification of the model are clearly illustrated. It is shown that even in case we know the deterministic model, but not the exact initial state of the system, a reliable prediction of the future evolution of the system may be impossible. In other words, there exist time series we cannot predict and we consequently cannot manipulate. However, for deterministic chaotic systems the future behaviour for small time horizons usually can be predicted with an acceptable preciseness. So, the conclusion is that, generically, we may benefit from a correct modeling of time series, as long as we just stick to the short-run predictions.

The book deals with nonlinear deterministic parametric differential (difference) equations. It provides a very nice exposition of the existing theory on this subject, without going too much into analytic details. It contains many figures clarifying various notions involved (like e. g. [multiple] limit cycles, saddle loops, dissipative systems, bifurcations, attractors and chaos), and is therefore also open to readers not familiar with this theory. In fact some elementary understanding of the mathe-

matical notions limit, Taylor expansion, complex variables and eigenvalues suffice to understand the global lines of the book. The reverse of this is that sometimes existing relations between various results get lost which otherwise might have become more clear. The book contains, however, many references for a reader interested in more details.

The book starts with a nice historic review of economic science. However, what I missed in the introduction is an embedding of this theory into the general nondeterministic framework. In particular I missed references to the existing literature on (identification of) (non)linear control systems.

Concluding, I believe that this is a very nice and clearly written book which provides an elementary overview on the behaviour of nonlinear deterministic dynamical systems, contains only some minor indistinctions, and is particularly suited for readers who are interested in modeling time series and not familiar with time series generated by nonlinear models.

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