

Dynamics References (Non-linear Systems)

Challenges of Using Statistics in the Stock Market

“The Signal and the Noise: Why So Many Predictions Fail-But Some Don't”

Nate Silver

Pedigree Book/Penguin Group [September 27 2012]

Paperback, 534 pages

ISBN 978-1-59420-411-1

*Silver’s comments about stock market prediction are taken from these pages:
11, 17, 16, 118, 119, 120, 185, 333, 337, 338, 343, 371, 449, 450.*

The signal is the truth. The noise ... distracts us from the truth. Widespread failures of prediction ... dynamic systems make forecasting more difficult ... complex human interactions ... behavior of the American economy ... It's hugely difficult to forecast the business cycle ... very hard to determine cause and effect from economic statistics alone ... the economy is always changing [dynamically] ... many forecasters mistake correlation for causation, and noise for signal.

Edward N Lorenz [1963 paper, 1972 paper, book]

- 1. Dynamic systems ... behavior at one point influences future behavior.*
- 2. Nonlinear exponential relationships ["butterfly" effects are possible].*

Efficient Market Hypothesis

[Claim:] ... the movement of the stock market is unpredictable...

Two ways to disprove it [the efficient market hypothesis].

- 1. Demonstrate that some investors are consistently beating the stock market.*
- 2. Illustrate predictability in the returns.*

Prediction Topics - Dynamic Systems, Chaotic Systems, Nonlinear Systems

"Love and Math: The Heart of Hidden Reality"

Edward Frenkel

New York: Basic Books [2013]

ISBN-13: 978-0-465-05074-1 (hardback)

*Frenkel's comments about mathematics are taken from these pages:
93,135-139.*

Mathematical insight. The ability to see patterns and connections that no one had seen before ... usually the product of months, if not years, of hard work. Little by little the inkling of a new phenomenon or a theory emerges, and at first ... often ... your initial idea was wrong, and you try something else ... you can never give up ... you analyze more data, you learn from your previous mistakes, ... and every once in a while, suddenly, your idea starts to work ...

Asking the right questions ... ask ... pointed questions trying to figure out which of these data ... relevant and which ... should ... be thrown away ... mathematicians ... formulate the right questions ... and then find some non-trivial connections, or correlations, between the remaining parameters ...and then go through a cold and unbiased analysis to get the answers ... the main point ... ask the right questions.

Building a model. Learn his methodology ... follow ... decision-making process ... use this knowledge to come up with a set of rules I derived an explicit algorithm ... [that]... described in simple terms essential points of the thought process of a doctor making the decision ... In about 95 percent of the cases, it led to an accurate diagnosis.

Statistical analysis ... very often these methods cannot be applied because the data are not precise or because there are different types of data: some objective and some subjective ... or some quantitative ... and some qualitative ... very difficult ... to feed inhomogeneous data into a statistical formula.

"Newton's Clock: Chaos in the Solar System"

Ivars Peterson

New York: W.H. Freeman and Co. [1993], xiii, 317 pages.

ISBN-10: 0716723964

Prediction accuracy depends on using enough significant figures in each time step calculation. A custom computer design with the right architecture/properties may be crucial in some cases for preserving accuracy over a long series of time steps.

Deterministic Nonperiodic Flow
Edward N Lorenz
Journal of the Atmospheric Sciences
Vol 20, Issue 2, pages 130-141, March 1963

Prediction accuracy for dynamic systems depends on the number of significant figures employed in each time step.

Abstract:

"Finite systems ... deterministic ... dissipative....

[The] solutions are ... unstable ... nonperiodic....

[The] feasibility of ... prediction is examined in the light of these results."

"Predictability: Does the Flap of a Butterfly's Wings in Brazil Set Off a Tornado in Texas?"
Edward N Lorenz, Professor of Meteorology, Massachusetts Institute of Technology
Dec 29, 1972, Sheraton Park Hotel, Wilmington Room
AAAS Section on Environmental Sciences
New Approaches to Global Weather: GARP (The Global Atmospheric Research Program)

Page 2, Proposition 2.

"In more technical language, is the behavior of the atmosphere unstable with respect to perturbations of small amplitude? The connection between this question and our ability to predict the weather is evident.... Although we cannot claim to have proven that the atmosphere is unstable, the evidence that it is so is overwhelming."

Page 3.

"The most significant results are ...

1. Small errors in the coarser structure ... tend to double in about three days...

2. Small errors in the finer structure ... tend to grow much more rapidly...

3. Errors in the finer structure ... tend to induce errors in the coarser structure ..."

"Adaptive & Digital Signal Processing with Digital Filtering Applications"
Claude S Lindquist
Miami FL: Steward & Sons, 1989
ISBN-10: 0917144031

Frequency response of systems. Separation of information and noise from a time series. Examination of component behavior, in detail. FIR filter design methods. DFT/FFT methods. Adaptive prediction. Derivatives of Fourier Transforms. Cepstrum analysis. Phase unwrapping. Modulus.

“Engineering Applications of Correlation and Spectral Analysis,” 2nd edition
Julius S Bendat and Allan G. Piersol
New York: Wiley/Wiley-Interscience, 1980
ISBN-10: 0471058874

Engineering analysis of time series in the frequency domain. Power spectral density, magnitude, coherence, and covariance. Calculation of variance directly in the frequency domain, etc.

“Digital Filters,” 1st edition
R W Hamming
Prentice-Hall, Inc., Englewood Cliffs, NJ, 1977
ISBN-10: 0132125714 / ISBN-13: 978-0132125710

Concepts of FIR filter design. Frequency response of digital filter designs, numerical integration designs, and numerical differentiation designs. Filter synthesis in time domain, and in frequency domain.

Human Dynamics in Markets (Nonlinear Systems)

“Business Cycles: From John Law to Chaos Theory,” 1st edition
Lars Tvede
Routledge, February 1, 1997
ISBN-10: 9057020661
ISBN-13: 978-9057020667

Author was a professional futures trader. Refreshing ideas.

“From Efficient Markets Theory to Behavioral Finance”
Robert J. Shiller
The Journal of Economic Perspectives
Vol. 17, No. 1 (winter, 2003), pp. 83-104 (22 pages)
Published by: American Economic Association

On page 86, Figure 1, the real price of S&P 500 is wiggly, which visually illustrates the volatility concept. The other lines in the graph are smooth, representing expected values for a rational market.

Behavioral Finance: https://en.wikipedia.org/wiki/Robert_J._Shiller

System Dynamics

Jay Forrester, Professor, Sloan School of Management (MIT)

Various publications, 1950s to 1970s

Available on the Internet

The phrase "system dynamics" refers to a school of thought. Control systems theory. Engineering. Feedback effects. Humans can create chaos, based on incomplete information. Today, Forrester's ideas are demonstrated to MBA students in an exercise known as "The Beer Game," a micro- stock market simulation. The participants crash the market.

The Cobweb Theorem

Mordecai Ezekiel

Paper (1938)

(On the Internet)

Describes the dynamic (herd-like) behavior of human beings, often in response to a perceived phenomenon, or a perceived truth. Humans often create inelastic "over-supply" or "shortage" conditions by their own actions.

"Studies in Tape Reading"

Rollo Tape [pseudonym for Richard D Wyckoff]

Noble Offset Printers, Inc.

New York 3, NY, Copyright 1910

Available on the Internet (Google Scholar).

Some traders watch group behavior to anticipate near-term future price movements. A shop might watch 30 or 40 displays, and day trade, based on watching herd dynamics. No mathematics.

Selected Examples of Nonlinear Systems Dynamics

Lorenz System (Animation) https://en.wikipedia.org/wiki/Lorenz_system

An animated simulation is shown in the figure (top right of page). The orientation changes to show certain dynamic ideas. The web page provides computer codes in different languages.

List of Chaotic Systems https://en.wikipedia.org/wiki/List_of_chaotic_maps

Chaos from Euler Solution of ODEs <http://sprott.physics.wisc.edu/chaos/eulermap.htm>

Shows convincingly that when discrete step solutions are too large, or if the equations are too coarse, then chaotic behavior results in the output.

The Dance of Earth and Venus (Animated Demonstration)

https://www.marksmath.org/visualization/earth_venus_dance/

The animation draws, then stops. A 5-leaf "star" pattern is in the center. From Mark McClure, Professor of Calculus and Complex Dynamics at University of North Carolina, Asheville.