

# **Nonlinear Pricing**

by Christopher May

## **Preface.**

Simultaneous understanding of 3 major trends necessary for comprehension of nonlinear pricing:

- Assumptions and associated mathematical constructs at various levels of resolution in economics. (eg. Levels of resolution illustrated by Macro- vs. Micro-economics.)
- Conceptual links, expressed in mathematics, between other disciplines and economics. (Example: genetic algorithms, math technique based on evolution ideas, created by computer scientist.)
- Environment of faster microchips, higher bandwidth in which the change in financial economics takes place.

Conclusion of the book is that we are at the beginning of a period where the computer will be transformed from enabler of clerical functions to creator of computer-based valuation techniques. Why is this happening?

- Says that nonlinear pricing is next logical step in finance, high-tech, and telecomm industries to improve efficiencies.
- Influence of high-tech and telecomm industries in finance industries is increasing.

Microprocessor speed doubling every 18 months, and price keeps going down. Bandwidth increasing even faster. All of this is creating an environment in which nonlinear pricing can flourish.

Nonlinear concepts are a qualitatively different type of info than investors are used to seeing. It's concepts like earnings and market share vs. ideas like periods of partial predictability. What makes this new approach possible is cyberspace. And since the info of traditional analysis – company financials, SEC filings, etc., is more and more living in cyberspace, then soon nonlinear pricing will start to utilize the info of traditional finance. The relationships that are currently thought to exist between these variables – financials, balance sheet stuff, etc. – will be subject to testing and verification by non-linear means. Author says that most of these relationships between these variables were thought up when the computational power was not available for serious testing of them. So now that we have such power, we can test them more rigorously.

The computers and cyberspace, etc. that allow for cost-cutting in business, also allows for challenge to old assumptions about how instruments are valued. These computers let us extract more information from every trade. This info is the 'lifblood' of Wall St., and everyone's trying to extract as much info as cheaply as possible.

Next the author makes a statement about how the new methods of nonlinear pricing are as big a threat to traditional views as was Copernicus' book. Don't know if I really agree with that. The science of complexity in general is a pretty big leap forward though, it seems ...

*(Ken: One thing I'm interested in is that he describes nonlinear pricing as an 'emergent' method of interpreting relationships in financial economics. Is this supposed to be a use of 'emergent' in Stuart Kauffman's technical sense? That is, when you have a large network of interacting automata, then you get emergent behavior: You get self-organizing behavior across the network as a whole, even though each of the individual automata is just doing its own thing.)*

There are many component technologies of nonlinear pricing:

- Hurst exponent
- genetic algorithms

- fuzzy logic
- abductive logic
- combination: fuzzy genetic algorithms

The book will present only two:

- Hurst exponent as displayed on Bloomberg,
- and a genetic algorithms analysis.

Hurst will be applied to various financial instruments, and genetic algorithms will be applied to the various components indexes of the S&P.

Hurst is the most accessible, it is available on Bloomberg, and it refutes the assumption of Brownian motion needed by CAPM and Black-Scholes. (*Ken: It's going to tell you how far off a time-series is from a random walk at each time step.*)

Question: If the assumption of Brownian motion is put on shaky ground, what other assumptions are going to fall next?

Brownian motion, however, is a rather 'local' assumption in financial economics. To get at the larger assumption of equilibrium upon which macro- and micro-economics rest requires deeper though and more powerful and more exotic techniques.

Next the author makes a statement about how nonlinear techniques and concepts will require more thought and more effort from most traditional financial types. He also makes the statement that nonlinear techniques include the passage of time, not included by traditional finance, because the solutions obtained in nonlinear pricing are obtained by iterative solutions rather than by formulas. (*Ken: I don't agree with this statement, because a simple formula can characterize a relationship as a function of time, and also the fact that a solution is iterative doesn't mean that you're evolving something through time necessarily. You could be waiting for an iterative technique to converge to the answer for a specific time  $t_0$ , for example. But, I believe the author is making the point here that, conceptually, in nonlinear pricing we think of a business or instrument as an evolving entity, so we always concerned with how it's evolving, as well as where it's at. Whereas in traditional economics, you think of an equilibrium economy, static, etc.*)

There's a table showing the distinctions between micro- and macro-economics. Micro-economics really corresponds to finance, while macro-economics is usually just what we call economics. The table shows the main philosophy/ideas in the old and new paradigms for the two.

For macro-economics, we have in the old, physics-based theory, equilibrium, which is reminiscent of Newtonian-based physics. And, in the new, nonlinear paradigm, we have nonequilibrium and complexity theory.

For micro-economics, we have the old system of linearity, which uses randomness and Brownian motion. And in the new system, which is biology- or evolution-based, we have the nonlinear concepts of fractional Brownian motion as measured by the Hurst exponent.

There's an interesting statement about the differences between micro- and macro-economics. Micro-economics applies to a narrower definition of phenomena, such as a company rather than a country. Because of this narrower focus, there is a stronger causal relationship – a more direct relationship between cause and effect.

Also: the differences between economists, analysts, investment bankers, and traders have more to do with their levels of resolution or generality rather than the tools they use to characterize financial and economic relationships.

There is a statement that, when Black-Scholes came up with their pricing model, they were expressly thinking in terms of an equilibrium economy. However, the author states, such an equilibrium economy is inconsistent with the nonlinear concepts he's going to talk about.

There is a remark that the Hurst exponent will be given as a specific example of the inconsistencies of Black-Scholes and the nonlinear world. This has to do with the assumption of a Brownian motion in B-S, which the author claims Hurst will refute.

Some remarks about how the book will draw on the work of several scholars removed from the world of finance. Biologists, mathematicians, computer scientists, etc.

In the book, the author will try to express the need for an interdisciplinary approach, utilizing

- 1) a depth of view in terms of resolution and explanatory power,
- 2) breadth across disciplines,
- 3) knowledge of the information age which is making these changes possible.

In Chapter 1 of the book, the author will give some examples of how the revolution in technology is not just allowing us to speed up old processes, but is also allowing for qualitatively new ideas to emerge.

The world's knowledge is increasing at an amazing rate. The author believes that, with this plethora of new knowledge, progress in the 21<sup>st</sup> century will have to be made using an interdisciplinary approach. So you should be a specialist in one discipline, while constantly scouting out and reading about what's going on in other disciplines, to see what ideas and concepts you can steal/use.

Bloomberg's KAOS screen: He's going to talk about this screen a lot in the book, though the book is not intended as an advertisement. He refers to it a lot, because it's the first instance of a private network widely accessible (Bloomberg, Reuters, Bridge, etc.) offering analysis in one of these nonlinear techniques.

Chapter ends off with some personal notes. Remark I need to think about more sometime:

“... we are not in the money management business in the traditional sense of the term anymore, ... we are in the *information* business as it applies to buying and selling liquid financial instruments. Ideas are the true stock-in-trade of the money manager. Money is only the commodity. Ideas are limited [*only*] by creativity and the ability to execute them. The information age has radically altered the ability to execute ideas by allowing information to be reconfigured. The creativity to see profit and risk management applications in these new information configurations is my *métier*.”