philippine studies

Ateneo de Manila University • Loyola Heights, Quezon City • 1108 Philippines

Dance of Chaos: : The Application of Chaos Theory in the Philippine Foreign Exchange Market by Marites A. Khanser

Review Author: Queena N. Lee-Chua

Philippine Studies vol. 47, no. 3 (1999): 430–434

Book Reviews

Dance of Chaos: The Application of Chaos Theory in the Philippine Foreign Exchange Market. By Marites A. Khanser. Cagayan de Oro City: Khanser Publishing House, 1999.

Chaos is an oft-repeated word these days. For more than two decades, mostly in the United States and Europe, mathematicians, computer scientists, biologists, doctors, meteorologists, physicists, chemists, artists, and others have been studying systems which on the surface appear random (chaotic in the ordinary sense of the word), yet have an underlying order (chaotic in the scientific sense). The Philippines has finally caught up—chaos theory is now being applied in some contexts, primarily in physics and chemistry.

I first wrote about chaos in 1991 (Lee 1991), when the Metropolitan Museum of Manila invited me to give a popular talk on the topic to mark the opening of Goethe Institut's gorgeous chaos exhibit, which has been touring the globe since 1985. In university math departments, local science museums and public art galleries, in the US, UK, France, Belgium, Canada, Brazil, Israel, Japan, the Philippines, "Beauty of Chaos" has generated the same response: the universal human delight in the beautiful. The beetle-like double blob of the Mandelbrot set, the sea-horse swirls of the Julia sets, the abstract vortices produced by Newton's algorithm—all these and more stand out in blazing, vivid color.

These amazing computer-generated pictures of chaos are called fractals which have an underlying geometric regularity known as self-similarity. When examined with stronger magnification, they reveal finer levels of detail similar to the large-scale form. A part is thus a smaller replica of the whole.

Chaos has been discovered in weather systems, in the human body, in coastlines, in drops of water dripping from a tap. I next came into contact with chaos when the Nobel Prize-winning chemist Ilya Prigogine visited the Philippines, and I had the great fortune to interview him (Lee 1992a). Specifically, Prigogine won the Nobel for widening the scope of thermodynam-

ics by applying those principles to open systems (unlike the closed classical ones of old) that are more reminiscent of those in real life. Instead of just calculating the amount of work a steam engine under ideal conditions can extract from a given quantity of fuel, his equations deal with more realistic situations—what he terms "dissipative structures." In summarizing his work, the Royal Swedish Academy of Sciences says, "It is possible in principle to distinguish between two types of structures: equilibrium structures which can exist as isolated systems; and dissipative systems which only exist in symbiosis with their surroundings. Dissipative structures display two types of behavior: close to equilibrium their order tends to be destroyed; but far from equilibrium, order can be maintained and new structures formed. The probability for order to arise out of disorder is infinitesimal according to the laws of chance. The formation of ordered, dissipative systems demonstrates, however, that it is possible to create order from disorder."

That is as good a description of chaos as any. I was also thrilled when Prigogine advised me on a chaotic model of the mind I was working on at that time for my masteral thesis (Lee 1992b). Working on the supposition that the brain is a chaotic system and that neurons can be modeled as fractals, I was able to link these findings to the premise that as the mind evolves (from small organisms to complex human beings), it is capable of producing order out of disorder—chaos again! Later, I joined some physics colleagues in attending chaos lectures given by a visiting professor at the Ateneo de Manila University, and was even invited to talk about applications of chaos in medicine in a Juan Salcedo Memorial Lecture at an annual conference of the Philippine College of Physicians. All these activities reveal that, indeed, chaos is fast becoming an intriguing topic of discussion in the Philippines.

The newest study of chaos locally, *Dance of Chaos*, is "the popular version of the D.B.A. dissertation of Dr. Marites A. Khanser, entitled, Fractal Dimensions and the Lyapunov Exponents in the Philippine Foreign Exchange Market'" (inside front cover). By wedding chaos theory to the behavior of financial markets, Khanser "proposes that financial systems are nonlinear, dynamical systems—complex and open—always changing, often abruptly and turbulently" (inside front cover).

Dr. Marites Khanser holds a Doctor of Business Administration degree from the Graduate School of Business, De La Salle University, in 1998. She majored in Finance, in particular, advanced financial technologies. She also holds a Master of Business Administration Degree from the MBA Program, Xavier University, Ateneo de Cagayan, in 1989. In 1991, she finished a Master of Arts in English Studies from the University of the Philippines, Diliman. She graduated summa cum laude in her undergraduate degree, also at Xavier University in 1979. Her interests are diverse (writing, mathematics, business) and in the future, she plans to join the Santa Fe Institute in New Mexico, US, and be actively involved in global research on chaos theory.

In this book, Khanser's goal is three-fold: to "describe the behavior of the currency market within the framework of chaotic dynamics . . . to ascertain the fundamental equations of motion driving the movements of the Philippine peso-US dollar exchange rate and the trading volume of the US dollars in the local currency market . . . to develop a forecasting model that can predict the future evolution of the Philippine foreign exchange market" (p. 8).

Have her goals been met?

In Chapter One, Khanser gives a brief history of chaos theory, and outlines the conceptual framework, focusing two characteristics of deterministic chaos: fractal dimensions or strange attractors and sensitivity to initial conditions or a large positive Lyapunov exponent. In Chapter Two, she describes the behavior of financial markets, refuting the popular CAPM (capital asset pricing model) and the controversial random walk hypothesis so beloved of many economists and policy-makers. She lists a few empirical studies done by other international researchers that have applied chaos theory to financial markets elsewhere (e.g., Scheinkman and LeBaron's [1989] discovery of nonlinear dependence or fractal dimensions in CRSP weekly stock returns, Rubio, Rodriguez and Rivero's [1992] study of chaos in the time series of the peseta-US dollar exchange rates).

Chapter Three goes mathematical: here Khanser outlines the steps to test for chaos—using 50 years of exchange rate data (1946–1997) totaling 13,713 spot prices of the Philippine peso against the US dollar and 10 years of volume trading data (1988–1997) totaling 2,102 daily sales volume of US dollars. Khanser first detrends the time series using natural logarithmic differencing, then she reconstructs the phase space, measures the correlation dimension, estimates the Lyapunov exponents, and finally calculates other chaos-related tests (power spectrum, capacity dimension, correlation matrix, phase space plots)—often with the help of the software program Chaos Data Analyzer. I went through the calculations, and was impressed by their range and accuracy. What pleasantly surprised me the most was that Khanser was able to derive a strange attractor in the shape of a "dancing star" (something I have not come across in any of my studies on chaos) viewed in the phase space plot of the volume trading time series data. This figure is an indicator of chaos, a premise confirmed by measuring the correlation dimension and Lyapunov exponents.

In Chapter Four, Khanser elaborates on chaos in the Philippine foreign exchange market, dividing her analyses into three periods: the fixed exchange rate regime (1946–1970), the floating exchange-rate regime (1971–1984), and the present free exchange-rate regime (1985–1997). After running a series of chaos tests, it is not surprising that she comes up with the following behavior: steady or fixed state for the first period, periodic or limit cycle for the second, chaotic for the third.

In Chapter Five, Khanser draws from the previous analyses and comes up with a chaos-based forecasting model for our market. Using some so-

phisticated linear algebra (including time series, M-dimensional vectors, correlation matrices,autocorrelation functions, among others), Khanser was able to come up with three equations to model market behavior. Back-testing also reveals that the model is quite robust, with estimated predictive power in the range of 98 – 99+%. However, lest people start speculating, Khanser is careful to list the limitations of the model. It is worth quoting her reflections in full (pp. 58–59):

> The major strength of my chaos-based forecasting model is that it defines the exact mathematical rules in terms of differential equations that describe the behavior of the Philippine foreign exchange market. The model can accurately predict price and volume movements, at least over the short term, provided that the initial conditions are specified.
>
> The model's predictability only in the short term is an essential feature of my chaos-based forecasting model. Nevertheless, the information in the short term can be very useful for risk control, currency hedging and trading.
>
> However, there is a caveat in using my model for predictive purposes. Because of the sensitivity to initial conditions of the model's equations, long-term predictability is not possible. Even when short-term predictions can be made, there is no guarantee that the model can precisely predict tomorrow's value all the time. As in any forecasting model, its predictive power is subject to forecast errors: the predicted value can only approximate the actual spot price.
>
> While it is true that the model can tell us how many variables are driving the movements of both the volume and spot price, we can not know for certain what exactly these three dynamic variables are. It is incapable of identifying the market forces that are at work, since it operates under the concept of a "black box"—an operation that processes input and gives its outputs without specifying variables determining the process. We can only surmise by monitoring and tracking the significant variables influencing the market, particularly interest rates, interbank call loan rates, and trade deficits.
>
> If you wish to make use of my chaos-based forecasting model, then it should be in conjunction with other advanced financial technologies, such as the artificial neural networks models that can handle long-term predictions. In this manner, you can exploit both the short-term predictive power of my model, as well as the long-term predictive power of neural nets.
>
> My chaos-based model only applies to the Philippine currency market. There are many other areas where chaos-based modeling are applicable, notably, other Asian currencies, stocks and other financial assets.

Consider yourself fairly warned. In Chapter Six, Khanser concludes by describing chaos as a dance, and reflecting on the implications of this theory

on financial management. A glossary of technical terms and three appendices on mathematical derivations complete the text.

I believe that Khanser has achieved the three goals she set out to achieve. Mathematicians and business professors alike will delight in how their respective fields are combined in such an engaging way. Most of the shortcomings of the text are minor: some typographical errors here and there, grammatical lapses in some places. Perhaps the biggest drawback of the book is its tone—supposed to be a popular text, it still sounds and looks like a doctoral dissertation (from which it was culled). Finer rewriting and editing (maybe with the aid of someone versed in popular science writing versus technical research writing) may help. Because of my math background, I had no problem following the technical computations, but when I gave the text to a professor in the humanities, he could only understand (and not too much at that) the first chapter, and finally had to throw up his hands in surrender. This is quite a pity, since the subject of the book is fascinating, and should be brought to the level of the common man—including policy-makers.

I also lent this book to a trader in one of the Philippines' major banks. After acknowledging that the work is indeed a good contribution to local knowledge of financial markets, he commented, "It would be more interesting and more useful for us if this model also held for 1998 prices, which are a lot more volatile than at any other time in history." This is the challenge Khanser now faces: to use her model to analyze the present Asian economic crisis, which has drastically affected the Philippines, too.

References

Lee, Queena N. 1991. Beauty from chaos. *Sunday Inquirer Magazine,* 2 June .

———. 1992a. Ilya Prigogine: Producing order out of chaos. *Philippine Daily Inquirer,* 12 September.

———. 1992b. Presence: An evolutionary and interdisciplinary model of mind. Masteral thesis, Ateneo de Manila University.

Rubio, Rodriguez and Rivera. 1992. Chaotic behavior in exchange rate series: First results for the peseta-US dollar case. *Economics Letters* 39:199–211.

Scheinkman, J. A. and B. LeBaron. 1989. Nonlinear dynamics and stock returns. *Journal of Business* 62 (3).

Queena N. Lee-Chua
Mathematics Department
Ateneo de Manila University