SIRI KERTAS KERJA

WORKING PAPER SERIES

An Alternative Visualization of Business Cycles in Chaos

Su Fei Yap   Mario Arturo Ruiz Estrada

**Fakulti Ekonomi dan Pentadbiran
Universiti Malaya**

http://www.fep.um.edu.my/

**Faculty of Economics and Administration
University of Malaya
50603 Kuala Lumpur
MALAYSIA**

An Alternative Visualization of
Business Cycles in Chaos

Su Fei **Yap**

Department of Economics
Faculty of Economics & Administration
University of Malaya
50603 Kuala Lumpur
Malaysia.

Email: g2yss@um.edu.my

Mario Arturo **Ruiz Estrada**

Department of Economics
Faculty of Economics & Administration
University of Malaya
50603 Kuala Lumpur
Malaysia.

Email: marioruiz@um.edu.my

August 2007

An Alternative Visualization of
Business Cycles in Chaos

Su Fei Yap[*]
Faculty of Economics and Administration (FEA)
University of Malaya
50603 Kuala Lumpur, Malaysia

Mario Arturo Ruiz Estrada[**]
Faculty of Economics and Administration (FEA)
University of Malaya
50603 Kuala Lumpur, Malaysia

1. Abstract

This paper suggests the application of multi-dimensional graphs in the study of business cycles in the context of chaos theory. The alternative multidimensional graphic method used is known as the Kite-Cartesian space (Ruiz, 2006). The Kite-Cartesian space is an alternative analytical tool for observing changes in the behavior of business cycles from a multi-dimensional perspective. We apply the Kite-Cartesian analysis to assess U.S. business cycles from 1940 to 2005 by trimester. The Kite-Cartesian approach provides optical "snapshots" of the national income make-up at any one point in time, thus revolutionizing existing methods of visualization.

- Dr. Su Fei **Yap** is associate professor at the Faculty of Economics and Administration (FEA), University of Malaya
  E-mail address: g2yss@um.edu.my
  Tel: +60173420171

- Dr. Mario Arturo **Ruiz Estrada** is lecturer and researcher at the Faculty of Economics and Administration (FEA), University of Malaya
  E-mail address: marioruiz@um.edu.my
  Website: www.econographication.com
  Tel: +60126850293

2. Chaos Theory and Business Cycles

In recent years economists have used the technique of non-linear dynamics modeling and multi-dimensional graphs (3-D) to show apparently erratic and turbulent economic phenomena. How are chaotic dynamics related to economic models of equilibrium? How can empirical methods be used to detect nonlinearities and cyclical or chaotic structures in economic models? In examining these issues, this paper discusses significant work that has been done to date in economics-based chaos theory.

Initially, we need to define the concept of chaos: According to Nagashima and Baba (1992) chaos is a state without order or a totally disorganized state, in contrast with an ordered state. For Edward Lorenz (1998) chaos is the absence of some kind of order that ought to the present. The core idea presented here is that the study of business cycles should encompass more than one isolated linear equation and to conceptually go beyond 2-D graphical analysis revolving around one specific economic problem.

We can observe the application of chaos theory to business cycles in the current literature. Using non-linear equations, random data analysis and graphs in 2-Dimensional and 3-Dimensional format, chaos theory is applied in the visualization of different scenarios. These utilize control and non-control parametric standard analysis under a dynamical system. The general system is one with a slight amount of randomness, provided that the qualitative behavior is not appreciably altered should the randomness be removed.

It is suggested that business cycles in the context of chaos theory can be studied using on of three different approaches: the butterfly theory, turbulence theory or multi-

dimensional graphical method or Econographicology (Ruiz, 2007). In this part of our research it is important to mention that work on chaos theory based on the random data analysis approach may be grouped into two large areas of study: real data and forecasting data.

Firstly, historical data reveals different stages of the business cycles under different scenarios. Secondly, it is the unpredictability of business cycles that indicate possible chaos.

Many of the fundamental concepts in the behavior of real data or forecasting data in business cycles can be represented by graphs. However these graphs are not always plots of values of a single variable against values of another. Often we are interested in the simultaneous values of several variables that actually require graphs in more than two dimensions. We can observe that the classic 2-D graph used to represent business cycles is inadequate in most chaos simulations. Nevertheless, most economists do not find curves in four dimensional spaces particularly easy to visualize. We would like to suggest the use of Econographicology in the study of business cycles in the context of chaos theory. Econographicology offers a different type of Cartesian space to demonstrate chaotic patterns. Econographicology is defined as a multi-dimensional graphical method to facilitate meta-database storage and multi-variable data behavior visualization. It stems from the necessity to generate an alternative and specialized multidimensional graphical method for economics, business and finance. Therefore, Econographicology is aimed at maximizing the use of multi-dimensional graphs in order to minimize difficulties in the

3

visualization of random and meta-database storage and multi-variable data behavior. The new Cartesian space comprises of Multi-Dimensional Cartesian coordinates systems under linear and non-linear systems. In our research we consider the application of the Kite Cartesian Space. These Cartesian Spaces are constructed based on the traditional 3-D space concept, but they represent 5-D. The multiple-dimension representations are to facilitate an easier understanding of chaos in business cycles.

Based on our analysis of the literature in the application of chaos in business cycles, several pertinent points may be noted. Application of non-linear equations and 2-D graphs comprised 70% of cases, while linear equations were observed in the application of chaos under control in 30% of cases. The common models used to measure business cycles based on chaos theory include the elasticity approach (ex-ante), general equilibrium models (ex-ante), import demand regression approach (ex-ante), growth simulation and other regression approaches (ex-post), general equilibrium or dynamic models analysis are applied in 80% of cases (Source, year).

In the last 25 years, many economists have applied chaos theory to business cycle models in studying general economic behave. These different applications of chaos theory have significantly contributed to the study of business cycles. A large part of this type of work comprise GDP cross-country comparative studies to explain the link between recession and growth. Many of these studies are sensitive to initial conditions and certain initial conditions specified may be less realistic.

In the applying chaos theory to the study of business cycles, many economists have assumed that the economy has an equilibrium state, and that it would settle down to this state, without disturbances such as business cycles, if only we would stop interfering with the system, in short, if it were not subjected to variable forces. What some chaos analysts are now proposing is that, as a dynamical system, the economy is chaotic, and business cycles, at irregular intervals, are inevitable. Meddling might even suppress rather than produce cycles, but more likely it would simply shorten some recessions and lengthening others.

In a nutshell, this research maintains that the application of chaos theory to business cycles faces limitations in studying the effects of multi-variables using standard graphical approaches which represent merely one part of the complicated puzzle which is chaos. On this account, this study further maintains that the study of chaos in business cycles requires a multi-dimensional analysis (both mathematical and graphical). We suggest the introduction of the Kite-Cartesian space to apply chaos theory to the study of business cycles. The Kite-Cartesian Space offers a multi-dimensional view of business cycles.

3. Kite Cartesian Space

The Kite Cartesian space (See Ruiz, 2005) consists of five axes ($[X_{1:i}, X_{2:i}, X_{3:i}, X_{4:i}], Y_i$). The quadrant represented by "j" can be 1, 2, 3 or 4 and the axis value is any number from 0 to ∞. The Kite Cartesian space represents four independent variables "$X_{1:i}$", "$X_{2:i}$", "$X_{3:i}$" and "$X_{4:i}$" and one dependent variable "Y_i" respectively. Each "$X_{j:i}$"

variable ($X_{1:i}$, $X_{2:i}$, $X_{3:i}$, $X_{4:i}$) and "Y_i" variable has its individual axis which is a vertical line with both positive and negative range. The positive and negative values are represented by *([(X_{1:i or} -X_{1:i}), (X_{2:i or} -X_{2:i}), (X_{3:i or} -X_{3:i}) (X_{4:i or} -X_{4:i})], (Y_i or -Y_i)]* on the Kite Cartesian space (See figure 1 and 2).

Here it is extremely important to think "outside of the box" and not to constrain the vertical axis to the representation of only the standard Y variable. The key argument is that we must necessarily work within a 3-dimensional system yet attempt to represent multidimensional structures. What this system posits is that the x-axes are also represented by vertical lines that stand upright at some point along the horizontal spokes (similar to the spokes of an imaginary horizontal wheel). Given a particular xi value, the point in question will be positioned at a distance ! xi ! either above or below the horizontal plane depending on whether x is positive or negative. We suggest that the given x-vertical line be placed at a distance ! xi ! from the core- Y axis.

Representing the dependent variable, the fifth axis, *"Y_i"* is positioned in the center of the graph (among the other four axes). *"Y_i"* has a positive range and negative range. It is the convergent point of all the other four spokes *($X_{1:i}$, $X_{2:i}$, $X_{3:i}$ and $X_{4:i}$)*. In other words, all *"$X_{j:i}$"* spokes converge at the *"Y_i"* axis. The result is a figure represented by a structure with 5 vertices. The function to be used by the Kite-Cartesian space is equal to *$Y_{i} = f(X_{j:i})$, where $X_{j:i} < +\infty$ and $-\infty < Y_i < +\infty$.*

Figure 1
The Kite Cartesian Space (Kite-Cartesian Space)

Figure 2

The Kite Cartesian Space (Kite-Cartesian Space) Plotting Example

(Xj:i , Y :i)	(X1:i or -X1:i)	(X2:i or -X2:i)	(X3:i , -X3:i)	(X4:i , -X4:i)
(Y1:i or -Y1:i)	(5,1)	(-2,1)	(6,1)	(-5,1)

Source: Econographication Virtual Laboratory (EVL), 2007

4. Application of the Kite Cartesian plane

In this study, the concept of Kite Cartesian space is applied to the analysis of the national income "Y" accounts which stems from four broad categories of spending. In particular, the GDP is the sum of consumption, investment, government and net trade, represented by "C = X_1", "I = X_2", "G = X_3" and "NT = (X-M) = X_4" respectively in the expressions below. In Figure 1, these four broad categories of spending of GDP are independent variables represented by X_1, X_2, X_3 and X_4 respectively, while the national income is represented by "Y". For demonstration purposes, the following data are used: U.S. consumption (C); investment (I); government (G); net trade (X-M) from 1940 to 2005 by trimester (see Figure 3). Steps involved in the application of Kite Cartesian space are as follows.

First step - to define national income: Expression (1)

$$(1.) \quad Y = GDP = C+I+G+(X-M).$$

Second step – The construction of the "***GDP Kite***" (Ruiz, 2005) is based on connecting GDP (Y) and the four broad categories of spending of C = X_1, I = X_2, G = X_3 and NT = X_4. We join all the four broad categories of spending (C, I, G and NT) plus the GDP in order to build the "***GDP Kite***" to study the overall behavior of the economy. With the advent of more sophisticated computers, the traditional focus on GDP in the context of business cycles can be seen in a new perspective. The Kite –Cartesian approach provides optical "snapshots" of the national income make-up at any one point in time, thus revolutionizing existing methods of visualization.

Third Step – GDP-Kite Classification (Ruiz, 2005)

Level 1: Good Performance

The GDP-Kite is located in the positive quadrant

Level 2: ChaoticPerformance

The GDP-Kite is located between the positive and

negative quadrant

Level 3: Poor Performance

The GDP-Kite is located in the negative quadrant or closed

to 0

9

In the analysis based on the GDP kite we apply the concept of the attractor. This consists of an infinite number of surfaces or higher-dimension manifolds –generalizations of surfaces to multi-dimensional space- often occurring in parallel sets, with a gap between any two surfaces of the set called a "strange attractor". The name was introduced in the early 1970's by David Ruelle and Floris Takensin in a paper in which they proposed that turbulence is an example of what we now call chaos. We assume that the strange attractor in the GDP-kite in the initial stage is the zero plane. In the study with the GDP kite we apply the Lorenz attractor under the assumption that the system never exactly repeats itself, the trajectory never intersects space; as the system changes, the motion of the point represent the continuously changing variables. In our case the GDP kite never exactly repeats itself, the changes between the initial and final points in the business cycle never intersects surfaces within the same Cartesian space.

The rapid changes of the GDP kite in different stages originates from the fluctuations or "economic winds". These economics winds stem from the market based on speculation (economics turbulences) and non-regulation. The GDP kite is only partially controlled by strong participations of the government applying apt fiscal, monetary, trade and social policies. High wind intensity can result in poor or chaotic performances of the economy in any country. On the other hand a relatively low wind intensity can produce better and more stable performances according to GDP kite analysis.

The GDP kite shows the national income from a new visual perspective. This feature in the GDP kite gives the multi-dimensional view of the national income to reveal the movement of one or all variables (X_1, X_2, X_3, X_4) along their respective axes simultaneously within the same Cartesian space. It also shows how changes in one or all "X_i" may affect "Y". We applied concept of the GDP- Kite to the study of the Gross Domestic Product (GDP) of U.S. from 1940 to 2005 (see Figure 3). The GDP Kite shows how U.S. Consumption (C), Investment (I), Government (G) and Net Trade (X-M) are move in different directions simultaneously within the same GDP-Kite providing a quick visual imprint of the U.S. economy.

If we observe the U.S. GDP kite trimester by trimester (from 1940 to 2005), we have a total of 232 simulations with the GDP kite showing different displacements within the Kite Cartesian space. From 1940 to 2005, the U.S. GDP kite yields 58 simulations or 25% l of the cases in the study which are in Level 1 or good performance. Good performance is characterized by the positive results in all four broad categories of spending (C, I, G and NT) and GDP. In this study chaotic performance is shown in 150 simulations or 65% of cases in studied characterized by non proportional changes. Poor performance is shown in 23 simulations or 10% of total cases (see figure 3). Poor performance is characterized by negative growth in all four broad categories of spending (C, I, G and NT) and GDP. If we generate a successive slide show based on the use of each GDP kite by trimester then we can observe how the GDP kite constantly changes within the same Cartesian space. We can clearly observe that business cycles are fundamentally chaotic.

Figure 3:
United States GDP Kite from 1940 to 2005

GDP/U.S.-1940 **GDP/U.S.-1945** **GDP/U.S.-1950** **GDP/U.S.-1955**

GDP/U.S.-1960 **GDP/U.S.-1965** **GDP/U.S.-1970** **GDP/U.S.-1975**

GDP/U.S.-1980 **GDP/U.S.-1985** **GDP/U.S.-1990** **GDP/U.S.-1995**

GDP/U.S.-2000 **GDP/U.S.-2005**

Source: Bureau of Economic Analysis U.S. Department of Commerce (2005)

12

Conclusion

The GDP kite is a different analytical tool compared to the conventional 2-D and 3-D Cartesian planes applied in the analysis of chaos in business cycles. The GDP kite shows the global picture of an economic phenomena; Hence it allows for focus on macroeconomics analysis. It is a simple yet efficient analytical tool to explain complex economic phenomena. The new Cartesian Space offers an alternative tool to visualize the correlation between the independent variables (X_1, X_2, X_3 and X_4) and dependent variable (Y). As such, the GDP kite provides a good basis for the design of new types of graphs to analyze chaos in business cycles. It is suggested that business cycles are basically chaotic and generates by market turbulences owing to speculation and poor macroeconomics policies.

References

Gleick, James.1987. Chaos: Making a New Sciences. Penguin books press. pp.1-350.

JSTOR. Journals in Economics Section, http://www.jstor.org (accessed April 2006).

Lorenz, Edward.1998. The Essence of Chaos. UCL press. pp.1-230.

Nagashima N. and Baba Y. 1992. Introduction to Chaos. IOP Press. pp. 1-170.

Ruiz Estrada, Mario. 2005. "New Visual Perspective for Economic Analysis: The Multi-Dimension (MD) Cartesian Plane", Faculty of Economics and Administration – University of Malaya. FEA-Working Paper: No.2005-1.

Ruiz Estrada, Mario. 2007. "Econographicology" International Journal of Economic Research, Volume 4-1.

FEA Working Paper Series

2007-1   Chris Fook Sheng NG, Lucy Chai See LUM, NOOR AZINA Ismail, Lian Huat TAN and Christina Phoay Lay TAN, "Clinicians' Diagnostic Practice of Dengue Infections", January 2007.

2007-2   Chris Fook Sheng NG and NOOR AZINA Ismail, "Analysis of Factors Affecting Malaysian Students' Achievement in Mathematics Using TIMSS", January 2007.

2007-3   Mario Arturo RUIZ ESTRADA, "Econographicology", January 2007.

2007-4   Chris Fook Sheng NG and NOOR AZINA Ismail, "Adoption of Technology in Malaysian Educational System", January 2007.

2007-5   Mario Arturo RUIZ ESTRADA, "New Optical Visualization of Demand & Supply Curves: A Multi-Dimensional Perspective", January 2007.

2007-6   Mario Arturo RUIZ ESTRADA and PARK Donghyun, "Korean Unification: A Multidimensional Analysis", January 2007.

2007-7   Evelyn DEVADASON and CHAN Wai Meng, "Globalization of the Malaysian Manufacturing Sector: An Agenda for Social Protection Enhancement", January 2007.

2007-8   CHAN Wai Meng and Evelyn DEVADASON, "Social Security in a Globalizing World: The Malaysian Case", January 2007.

2007-9   NIK ROSNAH Wan Abdullah, "Eradicating Corruption in Malaysia: 'Small Fish' and 'Big Fish'", March 2007.

2007-10   Evelyn DEVADASON, "Producer-Driven versus Buyer-Driven Network Trade in Manufactures: Evidence from Malaysia", April 2007.

2007-11   ABDILLAH Noh, "Institutions and Change: The Case of Malaysia's New Economic Policy", April 2007.

2007-12   TAN Tok Shiong, "Effects of Foreign Workers On the Employment Opportunities For Local Citizens", June 2007.

2007-13   FATIMAH Said and AZLINA Azmi, "Kepentingan Industri Telekomunikasi dalam Ekonomi Malaysia", July 2007.

2007-14   Su Fei YAP and Mario Arturo RUIZ ESTRADA, "An Alternative Visualization of Business Cycles in Chaos", August 2007.

FEA Working Paper Series

Objective and Scope:

The Faculty of Economics and Administration (FEA) Working Paper Series is published to encourage the dissemination and facilitate discussion of research findings related to economics, development, public policies, administration and statistics. Both empirical and theoretical studies will be considered. The FEA Working Paper Series serves mainly as an outlet for research on Malaysia and other ASEAN countries. However, works on other regions that bear important implications or policy lessons for countries in this region are also acceptable.

Information to Paper Contributors:

1)   Two copies of the manuscript should be submitted to:
            Chairperson
            Publications Committee
            Faculty of Economics and Administration
            University of Malaya
            50603 Kuala Lumpur
            MALAYSIA

2)   The manuscript must be typed in double spacing throughout on one side of the paper only, and should preferably not exceed 30 pages of A4 size paper, including tables, diagrams, footnotes and references.

3)   The first page of the manuscript should contain
            (i) the title,
            (ii) the name(s) and institutional affiliation(s) of the author(s), and
            (iii) the postal and email address of the corresponding author.
        This cover page will be part of the working paper document.

4)   The electronic file of the manuscript must be submitted. The file can be a Word, Word Perfect, pdf or post-script document. This will be posted at the Faculty's website (http://www.fep.um.edu.my/) for public access.

5)   Contents of the manuscript shall be the sole responsibility of the authors and publication does not imply the concurrence of the FEA or any of its agents. Manuscripts must be carefully edited for language by the authors. Manuscripts are vetted and edited, if necessary, but not refereed. The author is, in fact, encouraged to submit a concise version for publication in academic journals.

6)   When published, the copyright of the manuscript remains with the authors. Submission of the manuscript will be taken to imply permission accorded by the authors for FEA to publicize and distribute the manuscript as a FEA Working Paper, in its hardcopy as well as electronic form.