AN INTRODUCTION TO ECONOGRAPHICOLOGY

E-Book

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To: My Lord God (YHWH)

This book is to honour the memory of my wonderful parents, Graciela and José.

To: In memory of Professor Sir Clive Granger (Nobel Prize in Economics 2003).

To: Professor Hiroaki Hayakawa; Associate Professor Su Fei Yap; Professor Hideki Funatsu; Associate Professor Yeoh Kok Kheng and Lic. Edgar José Reyes Escalante.

To: All My Family Members and Relatives: thank you for your love and support.

To: Mr. Ritter N. Diaz.

CONTENTS

CHAPTER 1
INTRODUCTION

The rationale of Econographicology revolves around the efficacy of multidimensional graphs as the most effective visual tool to understand any economic phenomenon from a multidimensional view. The main motivation behind the creation of Econographicology is to evaluate multidimensional graphs evolved so far in economics and to develop new types of multidimensional graphs to facilitate the study of economics, as well as finance and business. In doing so, the mission of Econographicology is to offer academics, researchers and policy makers an alternative multidimensional graphical modeling approach for the research and teaching-learning process of economics, finance and business. Hence, this alternative multidimensional graphical modeling approach offers a set of multi-dimensional coordinate spaces to build different types of multidimensional graphs to study any economic phenomenon. The following new types of multi-dimensional coordinate spaces are presented: the pyramid coordinate space (five axes and infinite axes); the diamond coordinate space (ten axes and infinite axes); the 4-dimensional coordinate space (vertical position and horizontal position); the 5-dimensional coordinate space (vertical position and horizontal position); the infinity-dimensional coordinate space (general approach and specific approach); the inter-linkage coordinate space; the cube-wrap coordinate space; the mega-surface coordinate space. All these multi-dimensional coordinate spaces mentioned are available to graphically represent 4-dimensions, 5-dimensions, 8-dimensions, 9-dimensions, until infinity.

Organization of the Book

This book is divided into twenty chapters: The first chapter will give a short overview of each chapter. The second chapter of this book studies the history of graphical methods applied to economics, provides an introduction to multi-dimensional coordinate spaces and the basic theoretical framework of Econographicology.

Chapter 3: The Global Dimension of the Regional Integration (GDRI-Model)

The third chapter presents a new model of analysis to study the trend of regional integration from a multi-dimensional perspective. This new model is called the global dimension of the regional integration model (GDRI-Model). The rationale for the creation of this model is the overwhelming necessity to study regional integration using political, social, economic and technological analyses simultaneously. There are four basic phases in the implementation of GDRI-Model. The first phase is the design of the multi-input database table. The second phase is the measurement of individual regional global development indices (X_i), which include the regional global political development index (X_1), the regional global social development index (X_2), the regional economic political development index (X_3), and the regional global technological development index (X_4). The third phase is the measurement of the regional global development (RGD) index. The last phase is the measurement of the regional integration stage (RIS) index.

The general objective of the GDRI-Model is to offer policy-makers and researchers a new analytical tool to study the evolution and implementation stages of any regional integration process from a multidimensional analysis based on a group of indexes and graphs. The GDRI-Model is not intended to be a forecasting model in any case. However, its application is not limited to a specific group of countries or regions. It is also not constrained by issues of a region or the development stage of any member in the region that is interested in integrating into a single regional trade bloc. The GDRI-Model is, in effect, a simple and flexible scheme, which can be applied to any case of regional integration.

Chapter 4: The Trade Liberalization Monitoring Model (TLM-Model)

The fourth chapter proposes a new trade analysis model to evaluate the trend and stages of trade liberalization of any country. This new trade analysis model is entitled "the trade liberalization monitoring model (TLM-Model)". The TLM-Model will introduce new indexes and figures. There are four basic phases in the implementation of the TLM-Model. The first phase is the design of a multi-input tariff database table by production sector (agriculture, heavy industry, light industry and services). The second is the measurement of the trade liberalization index by production sector (X_i). It is divided by the agriculture trade liberalization index (X_1), heavy industry trade liberalization index (X_2), light industry trade liberalization index (X_3), and services trade liberalization index (X_4). The third phase is the measurement of the trade liberalization trend (TLT) index. The last phase is the measurement of the trade liberalization stage (TLS) index. The general objective of the TLM-Model is to offer policy-makers and researchers a new analytical tool to study the trade liberalization trend and stages of any country from a global perspective based on a group of indexes and figures.

Chapter 5: The Multi-Level Investment Flows Monitoring Model (MIF-Model)

This chapter proposes a new model to analyze the mobility of investment flows at the intra-states level, domestic level, intra-regional level and global level. This new model is entitled "the multi-level investment flow monitoring model (MIF-Model)". The MIF-model proposes five new indicators: the intra-states direct investment (ISDI); domestic direct investment (DDI); intra-regional direct investment (IDI); total investment formation (TIF); investment reception performance (IRP). These indicators are built to analyze the mobility of investment flows in any country or region from a multi-level perspective across time and space.

Chapter 6: The Openness Monitoring Methodology (OM-Methodology)

The sixth chapter presents a new methodology on the study of openness or trade liberalization. The mission of this model is to offer policy-makers and researchers new analytical tools to study the impact and trend of openness in the economy of any country from a new perspective. The OM-Methodology, in effect, is a simple and flexible scheme. The general objective of the openness monitoring methodology (OM-Methodology) is to analyze the impact of average openness growth on the average income growth in a specific period of time (in the short run). The period under study in this research is from 1995 to 2001.

The sixth chapter is divided into three parts. The first part reviews the literature on analytical methods which evaluate openness based on three different approaches: political economy, economic theory, and trade policy. The second part will present a new model of analysis to evaluate the trend, vulnerability and harmonization of openness growth. The relationship between openness growth and income growth is based on a new group of indicators and a new type of graph. This new model of analysis is entitled "the openness monitoring methodology (OM-Methodology)".

The OM-Methodology is based on a series of steps in its application to study openness growth and income growth: (i) the degree of openness by production sectors (Oi); (ii) openness average rate ($\bar{O}$); (iii) harmonization of openness (HO); (iv) average openness growth rate ($\Delta\bar{O}$); (v) per-capita gross national income (ΔY); (vi) openness diamond graph; (vii) openness/income growth rate (O:Y) sensitivity analysis chart. The third part of this chapter shows the results obtained from the application of the OM-Methodology in different countries and regions.

Chapter 7: The Gross Domestic Product Surface (GDP-Surface)

The seventh chapter focuses on the application of 5-dimensional coordinate space (vertical position) in the graphical visualization of the historical trends of gross domestic product (GDP) in any country. The main objective for using the 5-dimensional coordinate space (vertical position) is to observe all possible changes of a large number of exogenous variables that can affect the endogenous variable in the same graphical space. To observe the GDP historical trend from a multidimensional view, this chapter proposes the application of the GDP-Surface approach on the U.S.-GDP historical trend from 1928 to 2004.

Finally, to facilitate the visualization of the GDP-surface behavior over different periods of time (per decade, annually, semester, quarterly, monthly, weekly or daily) requires the construction of a large number of GDP-Surfaces. Combined, this will generate a dynamic animation of GDP-Surfaces which will show real time behavior of the GDP historical trend in constant movement from distant periods of time until today.

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This chapter proposes an alternative multi-dimensional (MD) graphical computational system to observe or simulate different macroeconomic scenarios simultaneously in real-time view. This is called "the macroeconomic graphical sensor system (MGS-System)". Therefore, the construction of this multi-dimensional graphical computational system is based on the application of Econographicology and database analysis.

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The ninth chapter introduces an alternative index to measure the external sector from different focus. Called "the external sector development index (SX_i)", this indicator is a new analytical tool for studying the external sector behavior of any country or region. The SX_i has four objectives. The first objective is to measure the vulnerability of the external sector of any country. The second objective is to evaluate the external sector performance. The third is to establish the relationship between ES_i and GDP growth rates. The fourth objective is to evaluate the external sector (SX_i) cycle based on the table of possible combinations between ES_i and GDP.

Chapter 10: Unknown Dimensions in the Study of Market Behavior

The tenth chapter will explore unknown dimensions of market behavior from a multidimensional perspective. Our basic premise is that the market keeps in a constant state of evolution across time and space. This means that the market in each period of the history can show different market structures, internalities, externalities, institutions and economic agents behavior. Hence, the study of market behavior requests alternative economic assumptions and economic models according to each specific period of the history. Additionally, this chapter studies the unexpected, irrational and trends that the market behavior can experience at any time from a multidimensional perspective. Therefore, the study of the market behavior becomes more complicated with a low accuracy as time passes.

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Chapter 12: The General Economic Structures Composition Model (GESC-Model)

The theoretical framework of the general economic structures composition model (GESC-Model) offers a set of new macroeconomic indicators: the economic base (EB) and the general economic structures (GES's). Additionally, the GESC-Model includes a new multidimensional graphical modeling to observe EB and GES composition, size and evolution under the construction of multidimensional graphs and a single prototype. The GESC-Model theoretical framework takes into consideration the use of DNA helix structure and infinity dimensional coordinate space (general approach).

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The thirteenth chapter proposes an alternative distributed lag model from a multi-dimensional perspective. It is entitled "the mega-space distributed lag model". The main objective of the mega-space distributed lag model is to study different micro and macroeconomic scenarios simultaneously in the same graphical space. It is based on the application of a multi-dimensional econometric theoretical framework and a multi-dimensional graphical modeling scheme. The multi-dimensional graphical modeling is based on the application of the infinity coordinate space (general approach).

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Chapter 19: The Graphical Visualization of GDP from a Multi-dimensional Perspective

The nineteenth chapter proposes an alternative graphical modeling to visualize and analyze GDP behavior from a multi-dimensional perspective. Firstly, the visualization of the GDP from a multidimensional perspective requests the application of multi-dimensional graphical modeling. The idea is to study unknown dimensions in the complex and dynamic behavior of all variables that are involved in the construction of the GDP in the same graphical space.

Chapter 20: Why has the Market Become More Vulnerable in the 21stCentury?

The last chapter demonstrates a new theoretical multidimensional analytical approach to observe the vulnerability of market behavior through mathematical and graphical means. It is based on the observation of the permanent inconsistency in the market performance that is always experienced across different periods in history. Market vulnerability can materialize under the shape of trade, energy or financial crisis. Basically, we assume that the market is affected by five forces: economic forces, social forces, political forces, technological forces and natural forces. All these five forces always interact simultaneously; they affect market behavior directly without any restriction or isolation.

Chapter 21: Korean Unification: A Multidimensional Analysis

Unification between two countries is not a purely economic phenomenon but a multidimensional phenomenon. We evaluate the prospects of unification between South Korea and North Korea from a multidimensional perspective encompassing the political, social, economic and technological dimensions. To do so, we use the Global Dimension of Regional Integration Model developed by Ruiz (2004). Our main finding is a wide and growing gap between the two Koreas in terms of political, social, economic and technological development as well as overall development. This suggests that inter-Korean unification is likely to be a costly and disruptive process.

Chapter 22: Beyond the Ceteris Paribus Assumption: Modeling Demand and Supply Assuming Omnia Mobilis

This chapter is concerned with the application of multi-dimensional graphs in visualizing and modeling total change in a dependent variable in response to changes in any or all of the (many) independent variables affecting it. Previous literature has used the *ceteris paribus* assumption to obtain total change as a cumulative effect of the effect of the individual parts. The multi-dimensional graph applied to demand and supply shows that under the O*mnia Mobilis* (everything is moving) assumption, the quantity sold in the market is a joint function of all the independent variables that affect supply and demand.

Chapter 23: What is Policy Modeling?

This chapter introduces a definition, a way of classifying and a method of evaluating policy modeling. An analytical tool called "Policy Modeling Consistency (PMC) Index" has been developed for the purposes of evaluating policy modeling. The PMC-Index enables policy-makers and researchers to identify the level of consistency as well as the strengths and weaknesses within any policy modeling. The implementation of the PMC-Index involves the following four basic steps: (i) the use of multi-input-output table; (ii) classification of variables and identification of parameters; (iii) measurement of the PMC-Index; (iv) construction of the PMC-Surface. Through the PMC-Index, this paper promotes multidisciplinary approach to policy modeling. It suggests that various possible effects of any economic policy can be shown using a multi-dimensional graphical means.

Chapter 24: The Minimum Food Security Quota (MFS-Quota) In Food Security Policy Modeling

This chapter proposes the construction of the Minimum Food Security Quota (MFS-Quota) using mathematical economic modeling in real time. The MFS-Quota fixes a certain amount of annual food storage to prepare a country for any natural or social disasters. Any country can construct its own MFS-Quota for "food security policy".

CHAPTER 2
AN INTRODUCTION TO ECONOGRAPHICOLOGY

2.1. The Evolution of Graphical Methods in Economics

Research leading to this chapter shows a strong link between the introduction of graphical methods in economics and the development of theories, methods and techniques in statistics and mathematics. In the 18th century, for example, several new graphical methods were developed as a result of contemporary advances in mathematics and statistics research. These graphical methods include line graphs of time series data (since 1724), curve-fitting and interpolation (1760), measurement of error as a deviation from graphed line (1765), graphical analysis of periodic variation (1779), statistical mapping (1782), bar charts (1756) and printed coordinate chapter (1794) (See Beniger and Robyn, 1978).

For the application of graphical methods on economic analysis, we have renowned economists like William Playfair (2005), Francis Ysidro Edgeworth (1888) and William Stanley Jevons (1862). According to Harro Maas (2005), William Playfair constructed a wonderful collection of plates and graphs at the end of the 18th century. In his book entitled *Commercial and Political Atlas,* Playfair focused on the study of trade cycles. This placed him far ahead of other economists at the time in terms of visualizing socio-economic data.

The development of the usage of graphical methods in economics can be classified into two distinct phases. The first phase is the *descriptive graphical method*. It is supported by simple tables, histograms, line graphs and scatter-plots. All these types of graphs are based on the visualization of a single economic variable (vertical axis = Y) through a specific period of time (horizontal axis = X) in the first quadrant in the 2-dimensional Cartesian coordinate system (See Figure 1).

The main objective of the *descriptive graphical method* in economics is to study the behavior of a single economic variable (e.g. exports, imports, unemployment, GDP, inflation rate etc.) within a time frame (per decade, annually, monthly, weekly or daily) based on time-series. In fact, William Playfair may be considered the pioneer and promoter of the *descriptive graphical method*.

The second phase in the development of graphical methods for economics is the "*analytical graphical method*". The *analytical graphical method* in economics is distinguished by the use of 2-dimensional and 3-dimensional coordinate systems. According to Harro Maas, it was William Stanley Jevons who first explored the merits of the graphical method for political economy. Jevons did this using a function called the "King-Devenant Law of Demand," which he pioneered. This is a case of the use of *analytical graphical method* in economics, where the form of the graph gives an idea of the possible class of the functions describing the relationship between X and Y variables respectively that suggest a causal interpretation of the relationship between X and Y.

Additionally, the uses of the formal graphical method are based on the 2-dimensional Cartesian plane, which was introduced in 1637 by René Descartes (Lafleur, 1960), whose contributions to different scientific disciplines, of which economics was only one, were substantial. The 2-dimensional coordinate space opened a new era in economic analysis by providing for analysis of a single economic phenomenon based on the relationship between two variables.

However, it is necessary to mention the major contribution of Antoine Augustin Cournot (1838). Cournot derived the first formula for the rule of supply and demand as a function of price on 2-dimensional view. He was also the first economist to draw supply and demand curves on a graph. Cournot believed that economists must utilize graphs only to establish probable limits and express less stable facts in more absolute terms. He further held that the practical use of mathematics in economics involves not only strict numerical precision, but also graphical visualization. Besides Cournot and Jevons, other innovator economists that contributed to the analytical graph system in economics over time were Leon Walras (with general equilibrium), Alfred Marshall (with partial equilibrium) and Joseph Schumpeter (with business cycles) (McClelland, 1975).

In the 20th century, the use and application of *the analytical graphical method* among economists were often based on sophisticated mathematical and graphical techniques introduced during the development of new economic models. In particular, calculus, trigonometry, geometry and statistical and forecasting methods started to be employed by economists in constructing their graphs during that time. In addition, 2-dimensional and 3-dimensional Cartesian coordinate systems were also a part of complex economics research (Avondo-Bodino, 1963). Consequently, the application of sophisticated mathematical and graphical techniques can be seen in the development of the following economic models and theories: welfare theory (Hicks, 1939), IS-LM curve (Hansen, 1938), development of static and dynamic analysis (Samuelson, 1947), econometrics (Klein, 1956), Phillips curve (Phillips, 1958), Okun law (Okun, 1975), economic growth theory (Solow, 1956), game theory (Nash, 1950), introduction of dynamic models and econometrics (Tinbergen, 1937), monetary theory (Friedman, 1948), and rational expectations theory (Barro, 1976).

The rapid development of the *analytical graphical method* has been facilitated by high technology and sophisticated analysis instruments such as the electronic calculator and the computer. The development of analysis instruments in economics took place in two stages. The first stage involved the "*basic computational instruments*", where electronic calculators were used to compute basic mathematical expressions (e.g. long arithmetic operations, logarithm, exponents and squares). This took place between the 1950's and 1960's. The second stage, called "*advance computational instruments,*" took place in the middle of the 1980's. This was when high speed and storage-capacity computers using sophisticated software were introduced for the first time. The use of sophisticated software enabled easy information management, application of difficult simulations as well as the creation of high resolution graphs under the 3-dimensional coordinate system. These analysis instruments undoubtedly contributed substantially to research and development in economics.

Therefore, high computational instruments, backed by sophisticated hardware and software, are utilized to create graphical representations with high resolution and accuracy. In fact, the *descriptive graphical method* and *analytical graphical method* can be categorized according to function or according to dimension. In terms of function, these two graphical methods are either descriptive or analytical. In terms of dimension, these two graphical methods can be 2-dimensional, 3-dimensional or multi-dimensional coordinate systems. The *descriptive graphical method* shows arbitrary information that is used to observe the historical behavior of data from a simple perspective. On the other hand, the *analytical graphical method* is available to generate time-series graphs, cross-section graphs and scatter diagrams to show the trends and relationships between two or more variables from a multi-dimensional and dynamic perspective.

2.2. A Short Review about Dimension and Coordinate Systems (Cartesian Plane and Coordinate Space)

Initially, I would like to review four basic definitions of dimension. According to the first definition by Poincarė (1912), dimension is a space that is divided by a large number of sub-spaces. It meant "however we please" and "partitioned". The second definition of dimension is given by Brouwer (1924). He defines dimension as "between any two disjoint compacta". Brouwer makes references about the existence of a group of sub-sets in different sets. It is based on the uses of the topological dimension of a compact metric space based on the concept of cuts (Fedorchuk, Levin, and Shchepin, 1999). The third definition of dimension is given by Urysohn and Menger (Shchepin, 1998), who define dimension as "between any compactum and a point not belonging to it". These four authors share certain common concepts in their definitions of dimension, such as the uses of spaces, subspaces, sets, subsets, and as partitioned and cut concepts. This mean that any dimension needs to be studied using the ideas of spaces/sets or sub-spaces/sub-sets or partitions/cuts.

The idea of dimension is complex and rather deep for the human mind to penetrate. This is because we need to often perform abstractions and parameterizations of time and space of any geometrical object that cannot be visualized in the real world (Inselberg and Dimsdale, 1994). Moreover, this part of my research proposes an alternative definition of dimension. According to this book, the term "dimension" can be defined "as the unique mega-space that is built by infinite general-spaces, sub-spaces and micro-spaces that are systematically inter-connected." The process of visualizing different dimensions graphically is made possible by the use of coordinate systems. These coordinate systems can generate the graphical modeling frameworks to represent different dimension(s) in the same graphical space. The coordinate systems can be divided into two types: Cartesian plane and coordinate space.

The difference between Cartesian plane and coordinate space has its origins in the number of axes. The Cartesian plane type is based on the uses of two axes; the coordinate space type is based on the use of three or more axes. Therefore, the Cartesian plane and coordinate space types are available to generate an idea about dimension(s) graphically through the optical visualization of several lines in a logical order by length, width and height. The concept of dimension can also be explained by Euclidian geometry under the uses of the Euclidian spaces. Euclidian geometry can be divided into 2-dimensional Euclidean geometry (plane geometry) and 3-dimensional Euclidean geometry (solid geometry). Additionally, the study of Euclidian geometry also involves the examination of the n-dimensional space represented by $\mathbb{R}^N$ or $\mathbf{E}^N$ under the uses of the n-dimensional space and n-vectors respectively.

2.3. How do Multi-Dimensional Coordinate Spaces work?

The main reason to apply multi-dimensional coordinate spaces is to study any economic phenomena from a multidimensional perspective. This is originated by the limitations that the 2-dimensional coordinate space shows at the moment when it comes to generating a multidimensional optical visual effect of any economic phenomena in the same graphical space.

Hence, the multidimensional coordinate spaces leads to an alternative graphical modeling which is more flexible and innovative than the current 2-dimensional coordinate space to observe multi-variable data behavior.

The study of multi-dimensional coordinate spaces requires basic knowledge about the "n-dimensional space". The idea of the n-dimensional space originated with many Greek thinkers and philosophers such as Socrates, Plato, Aristotle, Heraclitus and Euclid (father of geometry). The great contribution of Euclid to geometry was the design of plane geometry under 2-dimensional Euclidean geometry and solid geometry under 3-dimensional Euclidean geometry. However, the n-dimensional space can be defined as a mental refraction through optical visualization and brain stimulation by several lines in a logical order by length, width, height and colors. It is to represent the behavior of simple or complex phenomena in different periods of time in the same graphical space.

Usually, the study of n-dimensional space is based on the application of the "coordinate system". In fact, the coordinate spaces can be classified into 2-dimensional coordinate space, 3-dimensional coordinate space and multi-dimensional coordinate space. The main role of the coordinate system is crucial in the analysis of the relationship between two or more variables such as exogenous variable(s) and endogenous variable(s) on the same graphical space. In fact, the Euclidean space is given only the mathematical theoretical framework, but not the graphical modeling to visualize the n-dimensions according to different mathematical theoretical research works.

On the other hand, Minkowski (Einstein, 1952) introduced the idea of the 4-dimensional space or the "world". The world, according to Minkowski, is originated by the application of the 3-dimensional continuum (or space). The difference between the 4-dimensional space and the 3-dimensional space graphical model is that the first graphical model replaces (X,Y,Z) with (X_1,X_2,X_3,X_4), thus X_1 = X; X_2 = Y; X_3=Z and $X_4 = \sqrt{-1}$. X_4 is based on the application of the Lorenz transformation axiom. The 4-dimensional space by Minkowski fails to offer a specific graphical modeling or alternative Cartesian coordinate system to help visualize the 4-dimensional space; it only offers a mathematical theoretical framework to describe the idea of 4-dimensional space. Moreover, the application of multi-dimensional coordinate spaces offer a large possibility to adapt n-dimensions, sub-dimensions, micro-dimensions, nano-dimensions and ji-dimensions in the visualization of any economic phenomenon.

Basically, the use of coordinate spaces by economists are based on plotting different dots that represent the relationship between two or more variables (endogenous and exogenous) in the first and fourth quadrants in the 2-dimensional coordinate space. Afterwards, they proceed to join all these dots by straight lines until is possible to visualize histograms, line graphs and scatter-plots (see Figure 1). Hence, it is possible to observe the trend and behavior of different variables of any economic phenomenon. For example the relationship between unemployment/inflation, interest-rate/investment, prices/quantity demand and supply, and so on.

From our point of view, each dot plotted on the 2-dimensional, 3-dimensional and multi-dimensional coordinate spaces represents a single rigid point. In fact, the plotting of a single rigid point in any coordinate space requires the application of two basic assumptions: the first assumption is that two rigid points cannot occupy the same space at the same time; the second assumption is that different rigid point(s) deal in different n-dimensional spaces move under different speeds of time. The variable "time" in the case of multi-dimensional coordinate spaces needs to be classified by: general time, partial time and constant time. General time runs in general-space, but sub-spaces, micro-spaces, nano-spaces all run under different partial times. In the case of JI-spaces, these are always fixed by constant time.

Recently, a few economists have started to use the 3-dimensional coordinate space in economics by utilizing three axes: “X-coordinate“(or exogenous variable), “Y-coordinate“ (or exogenous variable) and the “Z-coordinate“ (or endogenous variable). This is based on the construction of surfaces or 3-dimensional manifolds to visualize multi-variable economic data behavior (See Figure 2). According to our research the use of the 3-dimensional coordinate space is not so popular among economists and policy makers.

Based on one thousand five hundred (1500) chapters published in twenty one (21) reputable economics journals[1] between the year 1939 and 2009 (JSTOR, 2009), it is possible to observe that the common types of graphical representations applied in the study of social sciences, especially in economics, were of the 2-dimensional coordinate space type. 99.5% of these chapters applied the 2-dimensional Cartesian coordinate system, and only 0.5% of them applied the 3-dimensional coordinate spaces. Additionally, this research will proffer several reasons as to ***why*** economists continue using the 2-dimensional coordinate space or sometimes the 3-dimensional coordinate space in the graphical representation of complex and dynamic economic phenomena. These reasons are listed below:

- The 2-dimensional graphical models have been established over a long time, since the introduction of the 2-dimensional coordinate space by Descartes (Lafleur, 1960) up till today. The application of the 2-dimensional coordinate space in the economic graphical analysis has become a t**<u>radition</u>**.

- The 2-dimensional space is **<u>easy to apply</u>** in order to visualize basic trends or values in the same graphical space. A logical explanation about the common use of the 2-dimensional coordinate space is that it can be easily used to plot, draw and visualize any economic phenomenon. Therefore, the 2-dimensional coordinate space can generate a clear visual and mental reflection to understand complex and dynamic economic phenomena graphically in the same space and time.

- It is difficult to find **<u>alternative and suitable multi-dimensional graphical models</u>** to generate the transition from 2-dimensional coordinate space graphical modeling to multi-dimensional space graphical modeling. This research found some difficulties generating this crucial visual and mental transition from 2-dimensional coordinate space to multi-dimensional coordinate space. This could be due to the difficulty of plotting, drawing and visualizing multi-dimensional graphs.

Figure 1
2-Dimensional Coordinate Space

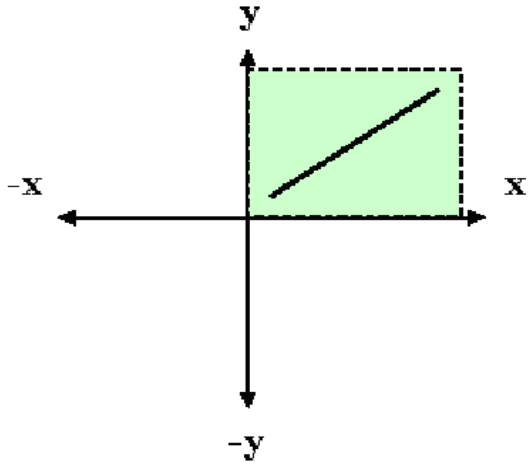
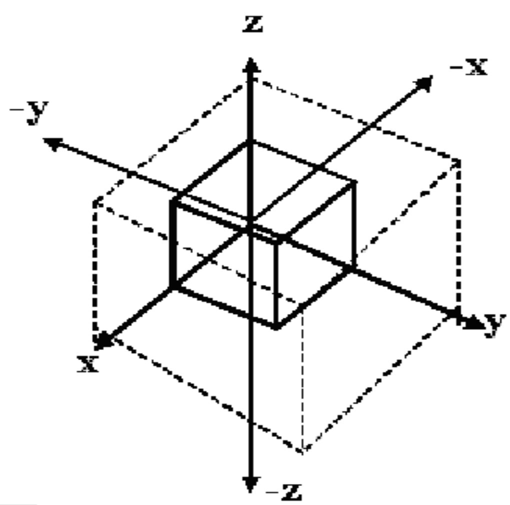


Figure 2
3-Dimensional Coordinate Space



Finally, a new set of multi-dimensional coordinate spaces is introduced in this document. The idea is to generate a new multidimensional optical visual effect to visualize complex economic phenomena. We can observe that the multidimensional coordinate spaces can incorporate a large number of exogenous variables that change constantly and directly affect the behavior of endogenous variable(s) in the same graphical space. These new types of multi-dimensional coordinate spaces are based on the pyramid coordinate space (five axes and infinite axes), the diamond coordinate space(ten axes and infinite axes), the 4-dimensional coordinate space (vertical position and horizontal position), the 5-dimensional coordinate space (vertical position and horizontal position), the infinity-dimensional coordinate space (general approach and specific approach), the inter-linkage coordinate space, the cube-wrap coordinate space, and the mega-surface coordinate space. Being multi-dimensional, it enables economists, academics and policy makers to analyze economic phenomena from multidimensional perspectives across time and space.

2.4. An Introduction to the *Omnia Mobilis* Assumption

Basically, the idea of building an economic model is to simplify the real economic world into a graphic representation. It is based on the uses of a large number of variables that interact together in the same economic phenomenon. An economic phenomenon can be analyzed by induction (particular observations) or deduction (simple forecasting). According to my research, any economic model will try to show the interaction of different economic factors and different possible scenarios. The main problem is how to make the economic model as a whole keep up with the dynamic changes across time (period of time in analysis) and space (geographical place in analysis).

For long time, economists and academics have applied the *Ceteris Paribus* assumption to build economic models, especially in old and established economic models such as the supply and demand model that explain the basic relationship between two variables: endogenous variable (quantity) and exogenous variable (price) into a precise period of time and space. In other words, we leave the rest of variables out for the present until we can get the final result from these two specific variables in analysis.

The *Ceteris Paribus* assumption also can be considered the most common assumption that is learned and applied by economists to understand different economic phenomena. This assumption translated from Latin means "all other things [being] the same". It facilitates the description of how a variable of interest changes in response to changes in other variables by examining the effect of one variable at a time. An extremely important contribution from Alfred Marshall, the *Ceteris Paribus* assumption is crucial in its application to economic models. According to Marshall (1890, v.v.10):

> "The element of time is a chief cause of those difficulties in economic investigations which make it necessary for man with his limited powers to go step by step; breaking up a complex question, studying one bit at a time, and at last combining his partial solutions into a more or less complete solution of the whole riddle. In breaking it up, he segregates those disturbing causes, whose wanderings happen to be inconvenient, for the time in a pound called *Ceteris Paribus.* The study of some group of tendencies is isolated by the assumption *other things being equal:* the existence of other tendencies is not denied, but their disturbing effect is neglected for a time. The more the issue is thus narrowed, the more exactly can it be handled: but also the less closely does it correspond to real life. Each exact and firm handling of a narrow issue, however, helps towards treating broader issues, in which that narrow issue is contained, more exactly than would otherwise have been possible."

Marshall's approach thus allows the analyses of complex economic phenomena by examining it in parts where each part of the economic model can be joined to generate an approximation of the real world. This approach can be termed the Isolation Approach and according to Marshall (Schlicht, 1985) originates from two possible isolation clauses. First, the

Ceteris Paribus assumption allows some variables to be considered unimportant. This clause is called Substantive Isolation.

The Substantive Isolation clause considers that some unimportant variables cannot significantly affect the final result of the economic model. Second, the *Ceteris Paribus* assumption allows for the influence of some important factors to be disregarded. The application of the *Ceteris Paribus* assumption in this case is purely hypothetical; therefore, the second clause is called Hypothetical Isolation. It allows parts of the model to be managed more easily.

In other words, to explain a complex economic phenomenon, the *Ceteris Paribus* approach considers the partial effect of each variable in a set of m variables (termed usually independent variables, X_j , j = 1, 2, . . ., m) upon a variable of interest (usually termed the dependent variable, Y). From a mathematical point of view, the *Ceteris Paribus* assumption in an economic model is equivalent to the partial derivative, which explains how one exogenous variable, say X_k, in a set of exogenous variables can directly affect the endogenous variable Y while the other exogenous variables are held constant. From a graphical point of view, the *Ceteris Paribus* assumption supports the elaboration of scenarios that can be visualized on a 2-dimensional coordinate space.

More precisely, if "Y" is a function of, say, X_1 and X_2, the (partial) relationship between Y and X_1 can be visualized in the 2-dimensional space describing Y and X_1, assuming X_2 is held constant. In order to approximate the real world, Marshall (1890, v.v.10) goes on to propose that "[w]ith each step more things can be let out of the pound; exact discussions can be made less abstract, realistic discussions can be made less inexact than was possible at an earlier stage." The real-world scenario is thus approximated by the cumulative effect of the partial effects of the X variables on Y. After reviewing the *Ceteris Paribus* assumption, this research finds that part of the problem in suggesting the application of the *Ceteris Paribus* assumption has its origins in three basic reasons:

- First, the historical momentum that this assumption was built in order to help explain an economic phenomenon does not allow for the fact that the number of variables taken into account was far less before than in our days.

- Second, the *Ceteris Paribus* assumption can be considered the basic and classic tool for teaching-learning in economics.

- Third, its graphical modeling is based on the application of 2-dimensional coordinate space (X,Y) that has been used for a long time. According to my research, the 2-dimensional coordinate space cannot be used to visualize multi-variable economic modeling into the same graphical space. Thus, the 2-dimensional coordinate space is only able to visualize two variables: an endogenous variable and an exogenous variable simultaneously within the same graphical space.

The idea to introduce the *Omnia Mobilis* assumption -everything is moving- (Ruiz Estrada, Yap and Nagaraj, 2008) is to reduce the dependency and fewer uses of the *Ceteris*

Paribus assumption in economic modeling. We propose the openness of substantive isolation through the application of the *Omnia Mobilis* assumption. It is based on generating the relaxation of all variables without restrictions or limitations that the *Ceteris Paribus* assumption generates into economic modeling. To generate this relaxation of a large number of variables in any economic modeling, we suggest the application of multi-dimensional coordinate spaces that is offered by Econographicology (Ruiz Estrada, 2007). The idea is that drawing multidimensional graphs can help in visualizing all changes of several numbers of variables in the same graphical space. Additionally, the multidimensional graphs provide an alternative graphical approach to the Marshall view of step-by-step cumulative partial approach to economic modeling. The main objective of applying multidimensional graphs is to visualize, graphically, all changes of the endogenous variable in response to the changes of several exogenous variables simultaneously. These Multi-dimensional graphs can also be used to show the dynamic behavior of different variables in any economic model without any restriction. The application of the *Omnia Mobilis* assumption is to capture all possible economic actors and consider different possible scenarios into the same picture. Therefore, this chapter proposes that the use of the *Ceteris Paribus* assumption is not necessary when economists have the opportunity to use the *Omnia Mobilis* assumption and multidimensional graphs instead.

The *Omnia Mobilis* assumption also suggests the application of economic modeling in real time to observe the changes of all variables in real time. It is to demonstrate that economic modeling does not request the application of the *Ceteris Paribus* assumption in the study of dynamic and complex economic phenomena, because according to our research, any economic phenomenon is always still alive and never maintains constant behavior. The difference between the *Ceteris Paribus* assumption and the *Omnia Mobilis* assumption is that the *Ceteris Paribus* assumption only takes a photo of a specific historical moment in some economic phenomenon while the *Omnia Mobilis* assumption displays a video that runs in real time. Moreover, the multidimensional graphs play a crucial role in understanding the application of the *Omnia Mobilis* assumption in economic modeling. In fact, these multidimensional graphs are available to visualize the changes of all exogenous variables and their simultaneous effects on a single variable or endogenous variable in the same time and space. Finally, the *Omnia Mobilis* assumption opens a new era in economic modeling under the application of multidimensional graphs and economic modeling in real time. It is safe to say that the contribution of the *Ceteris Paribus* assumption in economic modeling has been useful in the past, but today this assumption is not enough to explain the complexity and dynamic nature of different economic phenomena as a whole.

2.5. The Classification of Multi-dimensional Coordinate Space

Multi-dimensional coordinate spaces can be classified by the pyramidal coordinate space (five axes and infinite axes), the diamond coordinate space (ten axes and infinite axes), the 4-dimensional coordinate space (vertical position and horizontal position), the 5-dimensional coordinate space (vertical position and horizontal position), the infinity-dimensional coordinate space (general approach and specific approach), the inter-linkage coordinate space, the cube-wrap coordinate space, and the mega-surface coordinate space.

2.5.1.1. The Pyramid Coordinate Space with Five Axes

The pyramid coordinate space with five axes consists of four independent axes (X_1, X_2, X_3, X_4) and one dependent axis (Y^*). The Y^* axis is positioned in the center part of this coordinate space among of the other four axes: X_1, X_2, X_3, X_4. The function used by the pyramidal coordinate space with five axes is fixed by $Y^* = f(X_1, X_2, X_3, X_4)$, where X_1, X_2, X_3, X_4, Y^* axes use only real positive numbers $\boldsymbol{R}_+$ under the condition $0 \geq \boldsymbol{R}_+ \leq +\infty$. The positive axes in the pyramidal coordinate space with five axes require the use of absolute values. The use of absolute values in each axis is based on the application of the non-negative property.

Hence, all axes $/X_1/$, $/X_2/$, $/X_3/$, $/X_4/$, $/Y^*/$ always use values larger than or equal to zero. The pyramid coordinate space with five axes show clearly, within the same graphical space, any possible change(s) of any or all values plotted on each or all X_1, X_2, X_3, X_4 axes that can directly affect the behavior of the Y^* axis value. In order to plot different values in each axis into the pyramid coordinate space with five axes, we need to plot each value directly on its axis line. At the same time, all values plotted on each axis line need to be joined together by straight lines until a pyramid-shaped figure with five faces can be visualized (see Figure 3 and Prototype 1).

Therefore, we have two possible graphical scenarios. The first graphical scenario: if all or any X_1, X_2, X_3, X_4 axes values move from outside to inside, then the Y^* axis values move down. The second graphical scenario: if all or any X_1, X_2, X_3, X_4 axes values move from inside to outside, then the Y^* axis values move up. Basically, the pyramid coordinate system with five axes is represented by this diagram:

$$(1.)\quad ([X_1, X_2, X_3, X_4], Y^*)$$

Prototype 1
The Pyramid Coordinate Space (P-Coordinate Space) Prototype

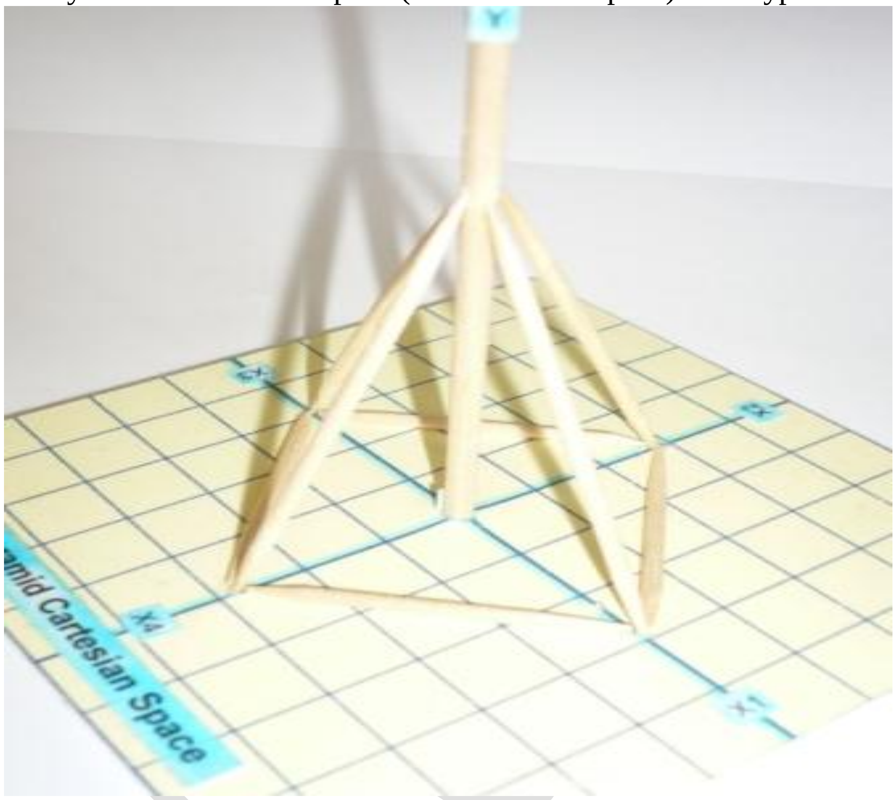
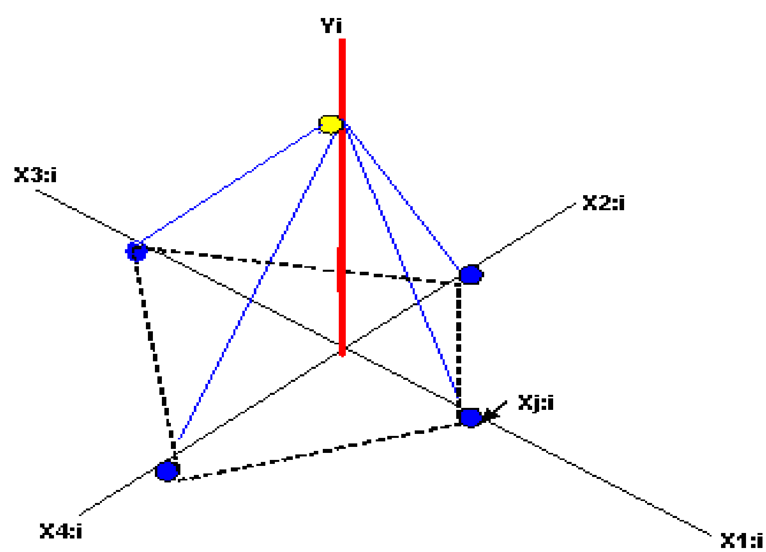
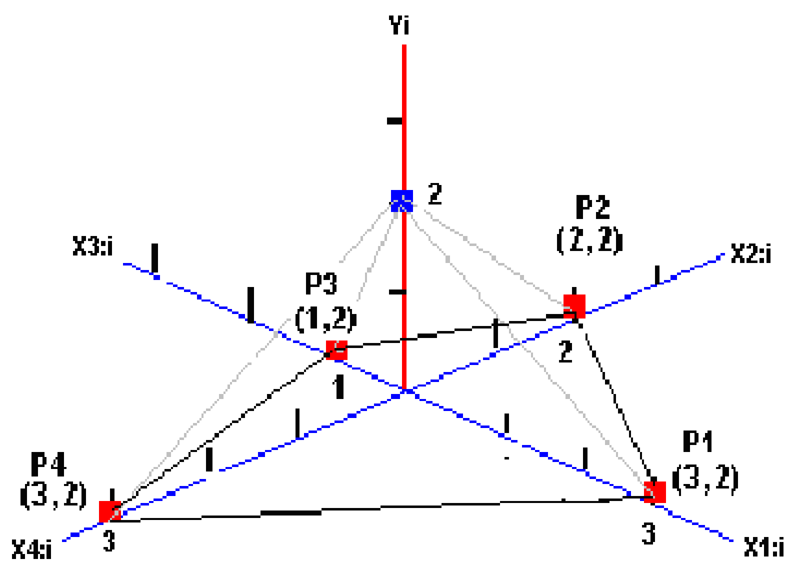


Figure 3
Pyramid Coordinate Space



(Xj:i , Yi)	X1:i	X2:i	X3:i	X4:i
Yi	P1 = (3,2)	P2 = (2,2)	P3 = (1,2)	P4 = (3,2)



2.5.1.2. The Pyramid Coordinate Space with Infinite Axes

The pyramid coordinate space with infinite axes consists of an infinite number of independent axes (X_1, X_2, X_3,…,X_∞) and one dependent axis (Y^*). The Y^* axis is positioned in the center part of this coordinate space among the other infinite axes: X_1, X_2, X_3,..., X_∞. The function used by the pyramid coordinate space with infinite axes is fixed by $Y^* = f(X_1, X_2, X_3, \ldots, X_\infty)$, where X_1, X_2, X_3,…, X_∞, Y^* axes use only real positive numbers $\boldsymbol{R}_+$ under the condition $0 \geq \boldsymbol{R}_+ \leq +\infty$.

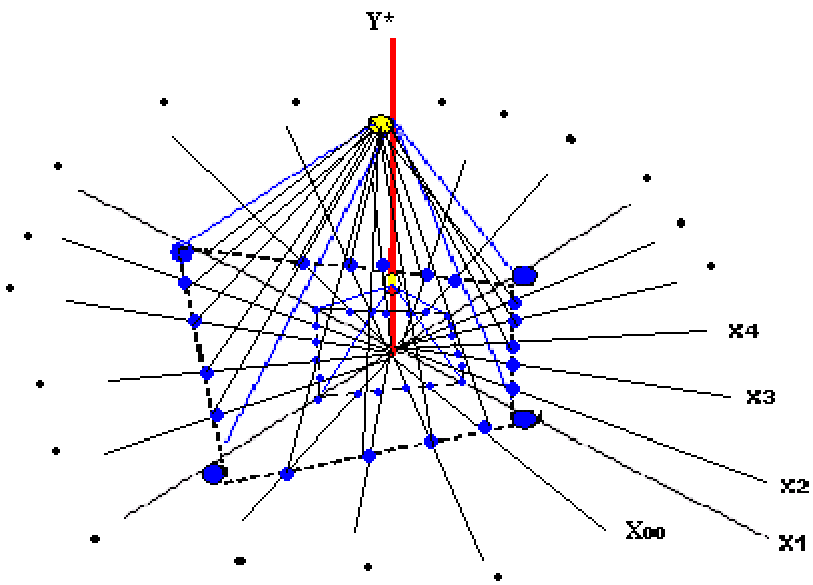
The use of positive axes in the pyramidal coordinate space with infinite axes requires the use of absolute values. The use of absolute values in each axis is based on the application of the non-negative property. Hence, all axes $/X_1/$, $/X_2/$, $/X_3/$, $/X_4/$, $/Y^*/$ always use values larger than or equal to zero. The pyramid coordinate space with infinite axes show clearly, within the same graphical space, any possible change(s) of any or all values plotted on each or all X_1, X_2, X_3,…, X_∞ axes that can directly affect the behavior of the Y^* axis value.

In order to plot different values in each axis into the pyramid coordinate space with infinite axes, each value must be plotted directly on its axis line. At the same time, all values plotted on each axis line need to be joined together by straight lines until a pyramid-shaped figure with infinite faces is built (see Figure 4).

Therefore, we have two possible graphical scenarios: first, if all or any X_1, X_2, X_3,…, X_∞ axes values move from outside to inside, then the Y^* axis values move down; second, if all or any X_1, X_2, X_3,…, X_∞ axes values move from inside to outside, then the Y^* axis values move up. The pyramid coordinate system with infinite axes is represented by:

(2.) $([X_1, X_2, X_3, \ldots, X_\infty], Y^*)$

Figure 4: *The Pyramid Coordinate Space with Infinite Axes*



2.5.2.1. ***The Diamond Coordinate Space with Ten Axes***

The diamond coordinate space with ten axes has two levels of analysis and ten axes. Each level of analysis is represented by $(X_{L:i}, Y_{L:i})$, where "L" represents the level of analysis, in this case either level one (L_1) or level two (L_2); "i" represents the quadrant level of analysis (in this case, quadrant 1, 2, 3 or 4). In order to plot different values in each axis into the diamond coordinate space with ten axes, each value is plotted directly on its respective axis line. At the same time, all values plotted on each axis line need to be joined together by straight lines until a diamond-shaped figure with eight faces is built (see Figure 5 and Prototype 2). It is important to mention at this juncture that the first level (L_1) has five axes represented by $X_{1:1}$, $X_{1:2}$, $X_{1:3}$, $X_{1:4}$, $Y_{1:}$ four independent axes represented by $X_{1:1}$, $X_{1:2}$, $X_{1:3}$, $X_{1:4}$ and one dependent axis fixed by Y_1 respectively. The second level (L_2) has five axes represented by $X_{2:1}$, $X_{2:2}$, $X_{2:3}$, $X_{2:4}$, Y_2. We assume that no relationship exists between level one (L_1) and level two (L_2) of analysis. The common issue between these two levels of analysis is that both levels use the same $X_{L:i}$ axes in the diamond coordinate space. However, level one (L_1) of the analysis cannot affect level two (L_2) of the analysis, and vice versa. If different levels of analysis are drawn in the diamond coordinate space, two different scenarios can be visualized and compared in the same diamond coordinate space at the same time (see Figure 5). It is crucial to mention at this point that the fifth and tenth axes (Y_1 *and* Y_2) are positioned in the center part of the diamond coordinate space among the other eight axes: $X_{1:1}$, $X_{1:2}$, $X_{1:3}$, $X_{1:4}$, $X_{2:1}$, $X_{2:2}$, $X_{2:3}$, $X_{2:4}$.

We assume that both Y_L (Y_1, Y_2) use only real positive numbers $\mathbf{R}_+$. Therefore, in the diamond coordinate space, all $X_{1:1}$, $X_{1:2}$, $X_{1:3}$, $X_{1:4}$, Y_1, $X_{2:1}$, $X_{2:2}$, $X_{2:3}$, $X_{2:4}$, Y_2 axes are grouped together on the positive side of their respective axes. The only use of positive axes in the diamond coordinate space requires the use of absolute values. The use of absolute values in each axis is based on the application of the non-negative properties. Hence, all axes $/X_{1:1}/$, $/X_{1:2}/$, $/X_{1:3}/$, $/X_{1:4}/$, $/Y_{1}/$, $/X_{2:1}/$, $/X_{2:2}/$, $/X_{2:3}/$, $/X_{2:4}/$, $/Y_{2}/$ always use values larger than or equal to zero. The final result is that, if the two levels of analysis are joined, it is possible to visualize a diamond-shaped figure. The diamond coordinate system is represented by:

$$(3.1.) \quad ([X_{1:1}, X_{1:2}, X_{1:3}, X_{1:4}], Y_{1})$$

$$(3.2.) \quad ([X_{2:1}, X_{2:2}, X_{2:3}, X_{2:4}], Y_{2})$$

Prototype 2: Diamond Coordinate Space Prototype

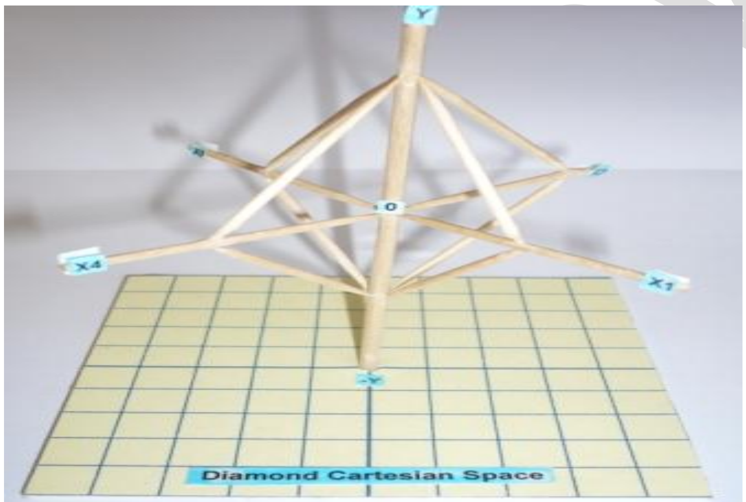
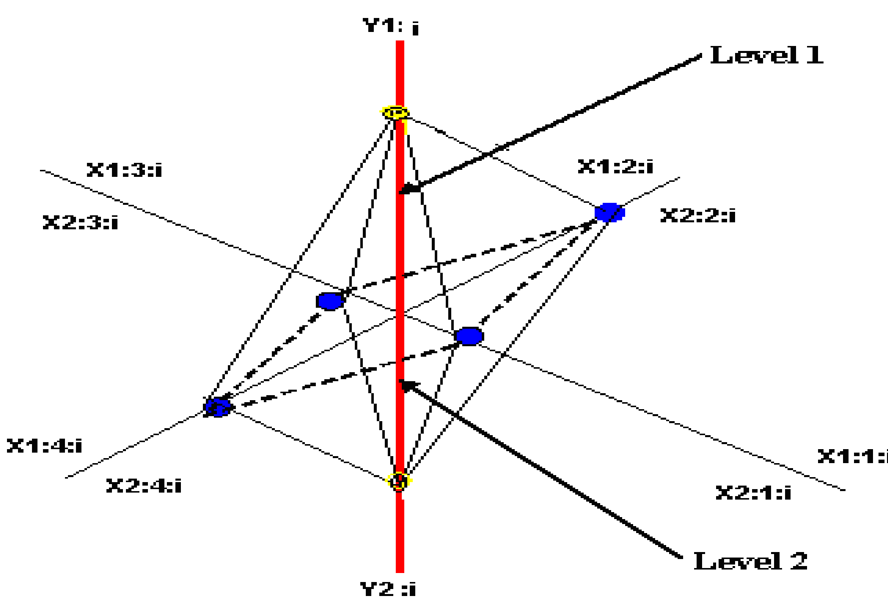
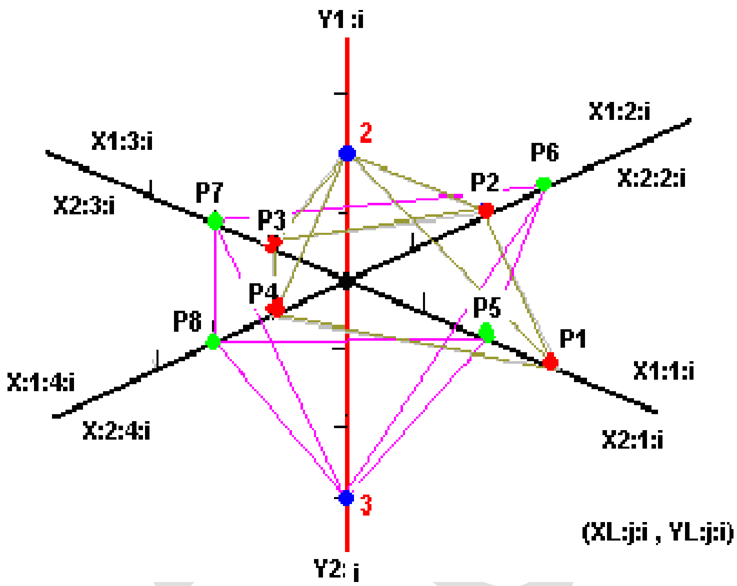


Figure 5
Diamond ***Coordinate Space***



$(X_{L:i}, Y_{L:i})$	X1:1 = 3	X1:2 = 2	X1:3 = 1	X1:4 = 1
Y1: i = 2	P1 = (3,2)	P2= (2,2)	P3= (1,2)	P4= (1,2)
	X2:1 = 2	X2:2 = 3	X2:3 = 2	X2:4 = 2
Y2: i = 3	P5 = (2,3)	P6 = (3,3)	P7 = (2,3)	P8 = (2,3)



2.5.2.2. ***The Diamond Coordinate Space with Infinite Axes***

The diamond coordinate space with infinite axes has two levels of analysis and infinite axes. Each level of analysis is represented by $(X_{L:i}\ ,\ Y^{*}_{L:i})$, where "*L*" represents the level of analysis, in this case either level one (L_1) or level two (L_2); "*i*" represents the quadrant level of analysis (in this case, quadrant 1, 2, 3,…, ∞). In order to plot different values in each axis into the diamond coordinate space with infinite axes, each value is plotted directly on its respective axis line. At the same time, all values plotted on each axis line need to be joined together by straight lines until it forms a diamond-shaped figure with infinite faces (see Figure 6). It is important to mention at this juncture that the first level (L_1) has infinite axes represented by $X_{1:1}$, $X_{1:2}$, $X_{1:3}$,…, $X_{1:\infty}$,$Y^{*}_{1:}$ infinite independent axes represented by $X_{1:1}$, $X_{1:2}$, $X_{1:3}$,…,$X_{1:\infty}$ and one dependent axis fixed by Y^{*}_{1} respectively. The second level (L_2) has infinite axes represented by $X_{2:1}$, $X_{2:2}$, $X_{2:3}$,…, $X_{2:\infty}$,Y^{*}_{2}. We assume that no relationship exists between level one (L_1) and level two (L_2) of analysis.

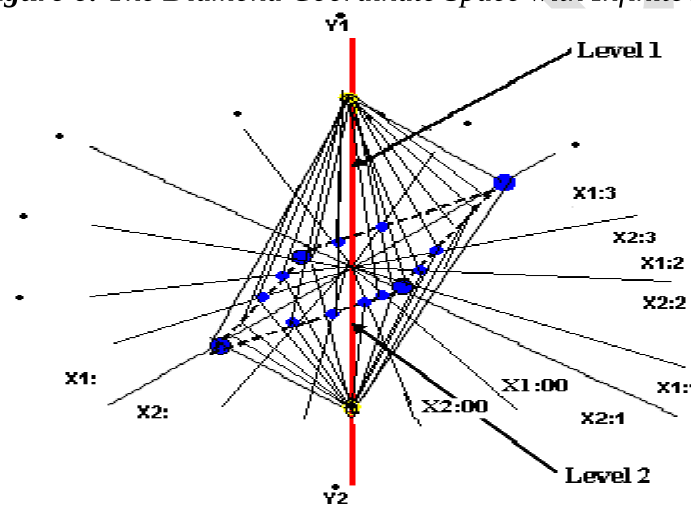
The common factor between these two levels of analysis is that both levels use the same $X_{L:i}$ axes in the diamond coordinate space with infinite axes. However, level one (L_1) of the analysis cannot affect level two (L_2) of the analysis, and vice versa. If we draw different levels of analysis in the diamond coordinate space with infinite axes, we can visualize and compare two different scenarios in the same diamond coordinate space at the same time. It is crucial to mention at this point that the Y^*_1-axis *and* Y^*_2-axis is positioned in the center part of the diamond coordinate space with infinite axes (among the other infinite axes $X_{L:i}$).

We assume that both Y^*_L (Y^*_1,Y^*_2) use only real positive numbers $\mathbb{R}_+$. Therefore, in the diamond coordinate space, all $X_{1:1}$, $X_{1:2}$, $X_{1:3}$,…, $X_{1:\infty}$,Y^*_1, $X_{2:1}$, $X_{2:2}$, $X_{2:3}$,…, $X_{2:\infty}$,Y^*_2 axes are grouped together on the positive side of their respective axes. The only use of positive axes in the diamond coordinate space with infinite axes requires the use of absolute values. The use of absolute values in each axis is based on the application of the non-negative properties. Hence, all axes $/X_{1:1}/$, $/X_{1:2}/$, $/X_{1:3}/$,…, $/X_{1:\infty}/$, $/Y^*_1/$, $/X_{2:1}/$, $/X_{2:2}/$, $/X_{2:3}/$,…, $/X_{2:\infty}/$, $/Y^*_2/$ always use values larger than or equal to zero. The final result is that if the two levels of analysis are joined, it is possible to visualize a diamond-shaped figure. The diamond coordinate system is represented by:

(4.1.) $([X_{1:1}, X_{1:2}, X_{1:3}, \ldots, X_{1:\infty}], Y^*_1)$

(4.2.) $([X_{2:1}, X_{2:2}, X_{2:3}, \ldots, X_{2:\infty}], Y^*_2)$

Figure 6: *The Diamond Coordinate Space with Infinite Axes*



2.5.3.1. The 4-Dimensional Coordinate Space: Vertical Position

The 4-dimensional coordinate space in vertical position offers four axes: Xv_1, Xv_2, Xv_3, Yv. All these four axes are distributed by three independent axes: Xv_1, Xv_2, Xv_3 and one dependent axis: Yv. The Xv_1, Xv_2, Xv_3, Yv axes fix positive and negative real numbers $\mathbb{R}_{+/-}$.

In order to plot different values in each axis into the 4-dimensional coordinate space in vertical position, each value is plotted directly on its axis line. All values plotted on each axis line need to be joined together by straight lines until a pyramid-shaped figure is formed, with four faces in vertical position (see Figure 7 and Prototype 3).

Additionally, the Yv axis is positioned in the center part of the 4-dimensional coordinate space in vertical position (among the other three axes). It is the convergent point of all the other three axes: Xv_1, Xv_2, Xv_3. In other words, all Xv_1, Xv_2, Xv_3 axes always converge in the Yv axis. The 4-dimensional coordinate system in vertical position is represented by:

(5.) $([Xv_1, Xv_2, Xv_3], Yv)$

Prototype 3: ***The 4-Dimensional Coordinate Space: Vertical Position***

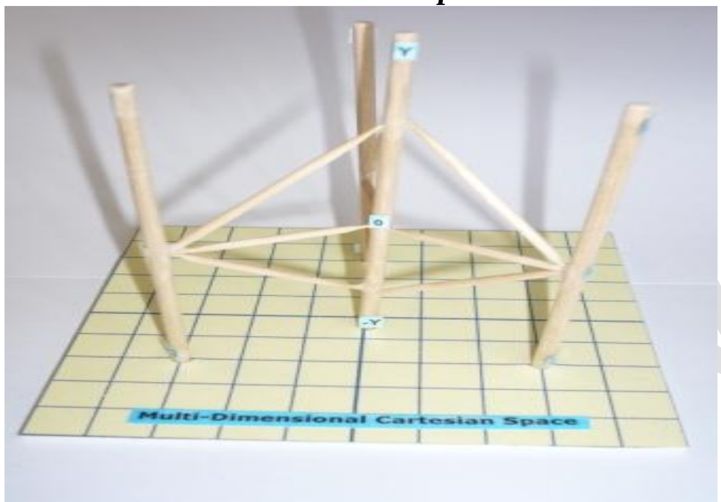
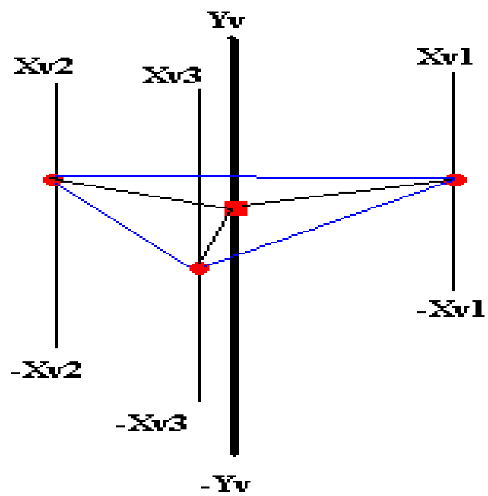


Figure 7: The 4-Dimensional Coordinate Space in Vertical Position



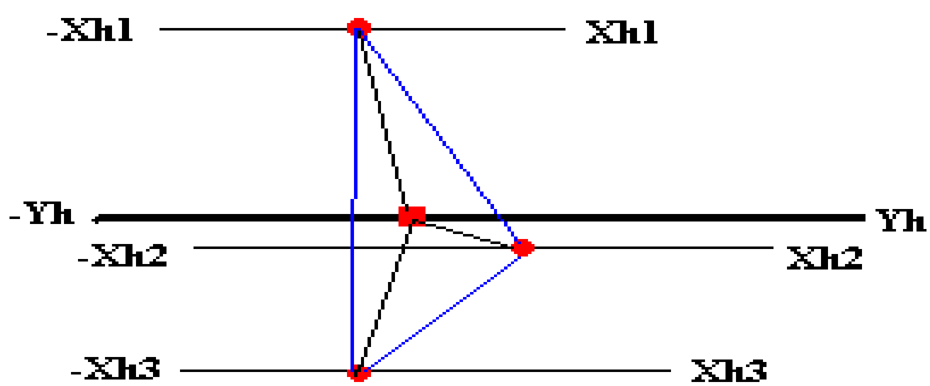
2.5.3.2. The 4-Dimensional Coordinate Space in Horizontal Position

The 4-dimensional coordinate space in horizontal position offers four axes: Xh_1, Xh_2, Xh_3, *Yh*. All these four axes are distributed by three independent axes: Xh_1, Xh_2, Xh_3 and one dependent axis: *Yh*. The Xh_1, Xh_2, Xh_3, *Yh* axes are fix positive and negative real numbers $\mathbb{R}_{+/-}$. In order to plot different values in each axis into the 4-dimensional coordinate space in horizontal position, each value is plotted directly on its axis line. All values plotted on each axis line need to be joined together by straight lines until a pyramid-shaped figure is built, with four faces in horizontal position (see Figure 8).

Additionally, the *Yh* axis is positioned in the center part of the 4-dimensional coordinate space in horizontal position (among the other three axes). It is the convergent point of all the other three axes: Xh_1, Xh_2, Xh_3. In other words, all Xh_1, Xh_2, Xh_3 axes always converge in the *Yh* axis. The 4-dimensional coordinate system in horizontal position is represented by:

(6.) $([Xh_1, Xh_2, Xh_3], Yh)$

Figure 8: The 4-Dimensional Coordinate Space in Horizontal Position



2.5.4.1. The 5-Dimensional Coordinate Space in Vertical Position

The 5-dimensional coordinate space in vertical position consists of five vertical axes: Xv_1, Xv_2, Xv_3, Xv_4, *Yv*. All these five axes are distributed by four independent axes: Xv_1, Xv_2, Xv_3, Xv_4 and one dependent axis *Yv*. The Xv_1, Xv_2, Xv_3, Xv_4, *Yv* axes fix positive and negative real numbers $\mathbb{R}_{+/-}$. In order to plot different values in each axis into the 5-dimensional coordinate space in vertical position, each value is plotted directly on its axis line. All values plotted on each axis line need to be joined together by straight lines until a pyramid-shaped figure is built, with five faces in vertical position (see Figure 9 and Prototype 4).

Therefore, the *Yv* axis is positioned in the center of the 5-dimensional coordinate space in vertical position (among the other four vertical axes). The *Yv* axis is the convergent axis of all the other four vertical axes: Xv_1, Xv_2, Xv_3, Xv_4. The 5-dimensional coordinate system in horizontal position is represented by:

(7.) $([Xv_1, Xv_2, Xv_3, Xv_4], Yv)$

Prototype 4: The 5-Dimensional Coordinate Space: Vertical Position

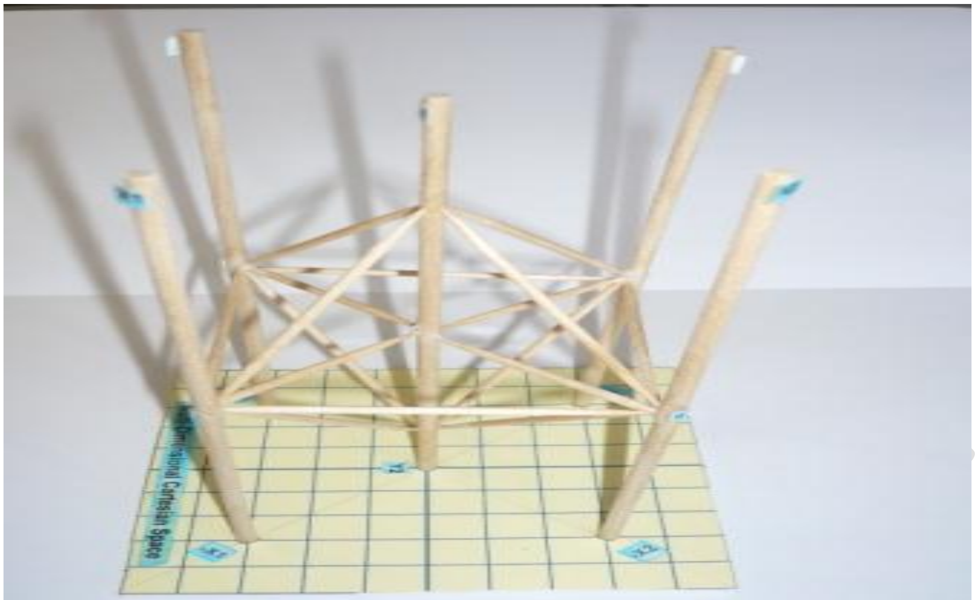
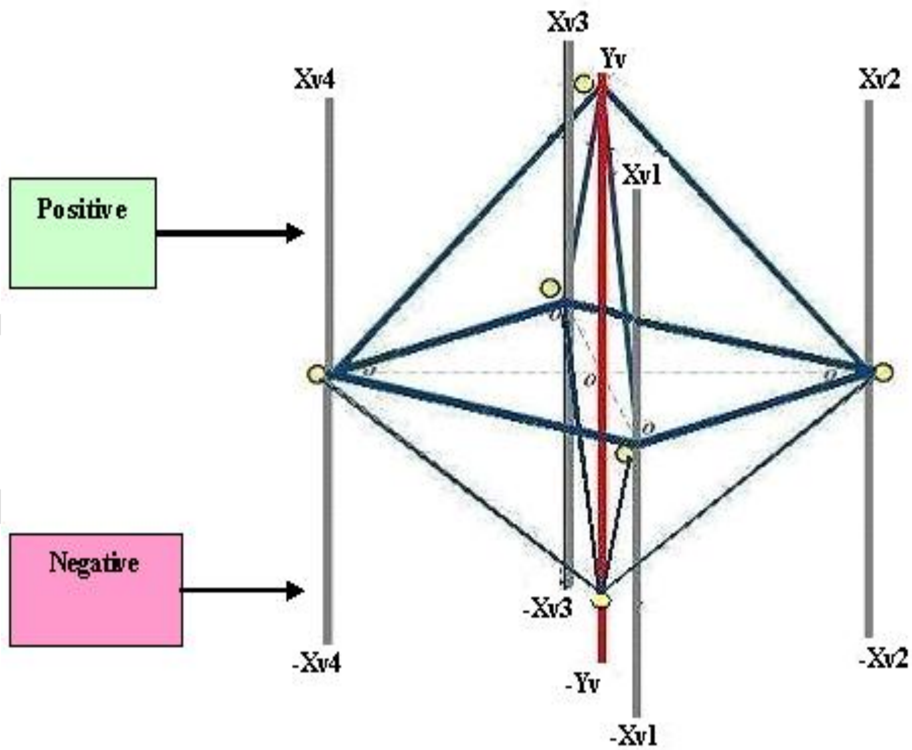
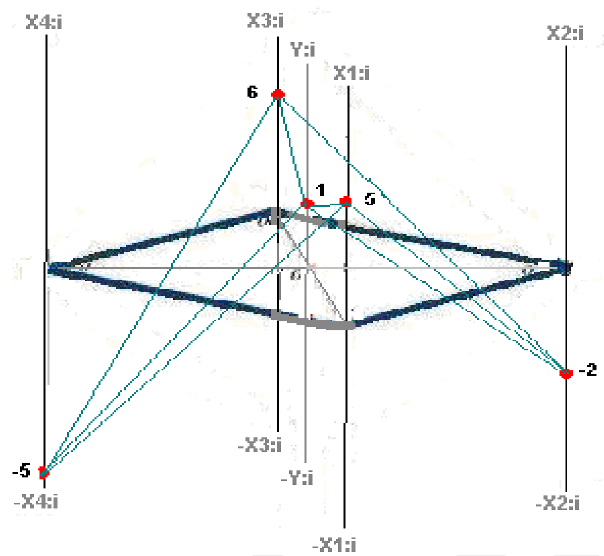


Figure 9: The 5-Dimensional Coordinate Space in Vertical Position



(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)



2.5.4.2. The 5-Dimensional Coordinate Space in Horizontal Position

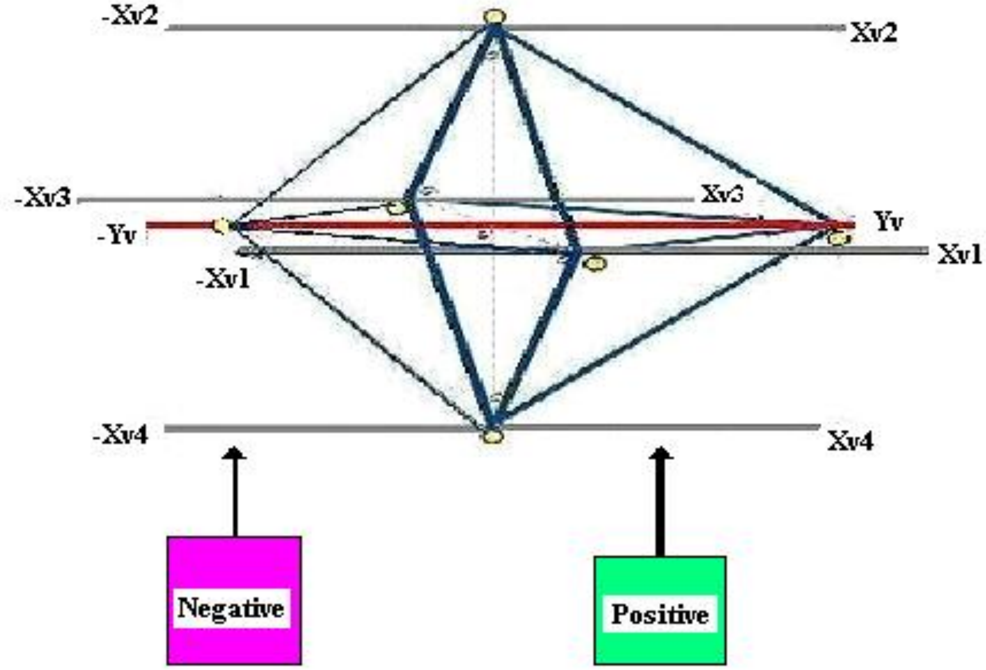
The 5-dimensional coordinate space in horizontal position consists of five vertical axes: Xh_1, Xh_2, Xh_3, Xh_4, Yh. All these five axes are distributed by four independent axes: Xh_1, Xh_2, Xh_3, Xh_4 and one dependent axis Yh. The Xh_1, Xh_2, Xh_3, Xh_4, Yh axes fix positive and negative real numbers $\mathbb{R}_{+/-}$.

In order to plot different values in each axis into the 5-dimensional coordinate space in horizontal position, each value is plotted directly on its axis line. All values plotted on each axis line need to be joined together by straight lines until a pyramid-shaped figure with five faces in horizontal position is formed (see Figure 10).

Therefore, the Yh axis is positioned in the center of the 5-dimensional coordinate space in horizontal position (among the other four horizontal axes). The Yh axis is the convergent axis of all the other four vertical axes: Xh_1, Xh_2, Xh_3, Xh_4. The 5-dimensional coordinate system in horizontal position is represented by:

$$(8.)\quad ([Xh_1, Xh_2, Xh_3, Xh_4], Yh)$$

Figure 10: The 5-Dimensional Coordinate Space in Horizontal Position



2.5.5.1. The Infinity Dimensional Coordinate Space under the General Approach

The infinity dimensional coordinate space under the general approach shows a series of n-number of sub-cylinders "*C*" located in the same general cylinder; each sub-cylinder in the same general cylinder is fixed by its Level "*L*" respectively, where *L = {1, 2, 3,...,k}, k → ∞...*Plotting values into the different sub-cylinders in the same general cylinder is based on the sub-cylinder location, axis position and ratio. $X_{C:L}$ is the independent variable in sub-cylinder "*C*" at level "*L*" lying in position $P_{C:L}$ with value $R_{C:L.}$ The position is based on $P_{C:L}$ by $0^{\circ} \leq P_{C:L} \leq 360^{\circ}$, the position of $X_{C:L}$ in cylinder "*C"* at level "*L"*. And finally the ratios location under the $R_{C:L}$ is the radius corresponding to the $X_{C:L}$ in cylinder "*C*" at level "*L*". Finally, the $Y_{C:L}$ is the dependent variable at level "*L*". The values of the independent axes $X_{C:L}$ affect $Y_{C:L}$ simultaneously. The infinity dimensional coordinates space under the general approach; its function is given below:

$$(9.) \quad Y_{C:L} = f(X_{C:L,} P_{C:L} , R_{C:L})$$

For example, the value of a specific independent axis at time point 1, say $X_{1:1:1}$ is plotted as $R_{1:1:1;}$the radius pictured lying on a flat surface at angle $P_{1:1:1}$ is measured from 0° line used for its reference line. The points from the end of the radii are joined to meet in a single point on the top of each sub-cylinder at height $Y_{1:1}$, the level "L". The diameter of the sub-cylinder is twice the maximum radius. In order to plot different values in each axis into the infinity dimensional coordinate space under the general approach, each value needs to be plotted directly on its axis line. All values plotted on each axis line need to be joined together by straight lines until a cone-shaped figure in vertical position is formed (see Figure 11 and Prototype 5).

Prototype 5: The Infinity Dimensional Coordinate Space (General Approach)

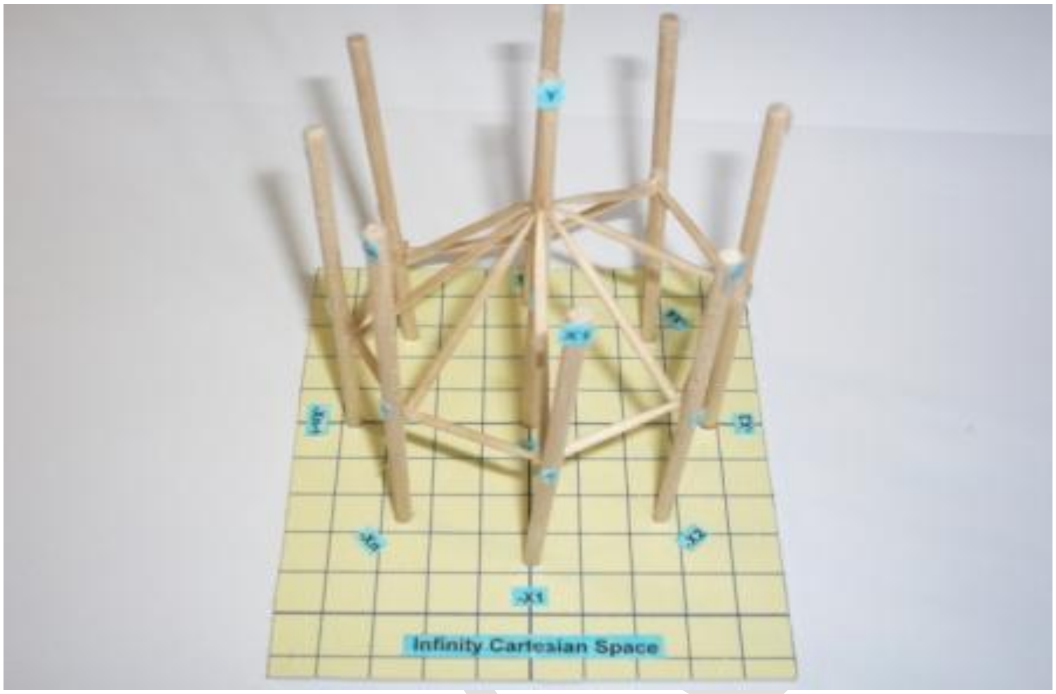
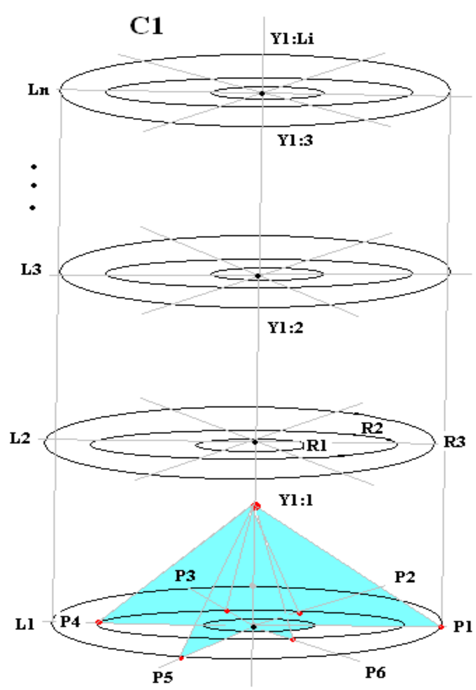


Figure 11: The Infinity Dimensional Coordinate Space (General Approach)



2.5.5.2. The Infinity Dimensional Coordinate Space under the Specific Approach

Basically, the infinity dimensional coordinate space under the specific approach offers a new coordinate system according to expression 10. The basic coordinate space system is formed by three levels of analysis: general-space (i); sub-space (j); micro-space (k). In the case of plotting into this coordinate space, start with defining the specific general-space (i), sub-space (j), micro-space (k), alpha-space (α) and beta-space (β) respectively.

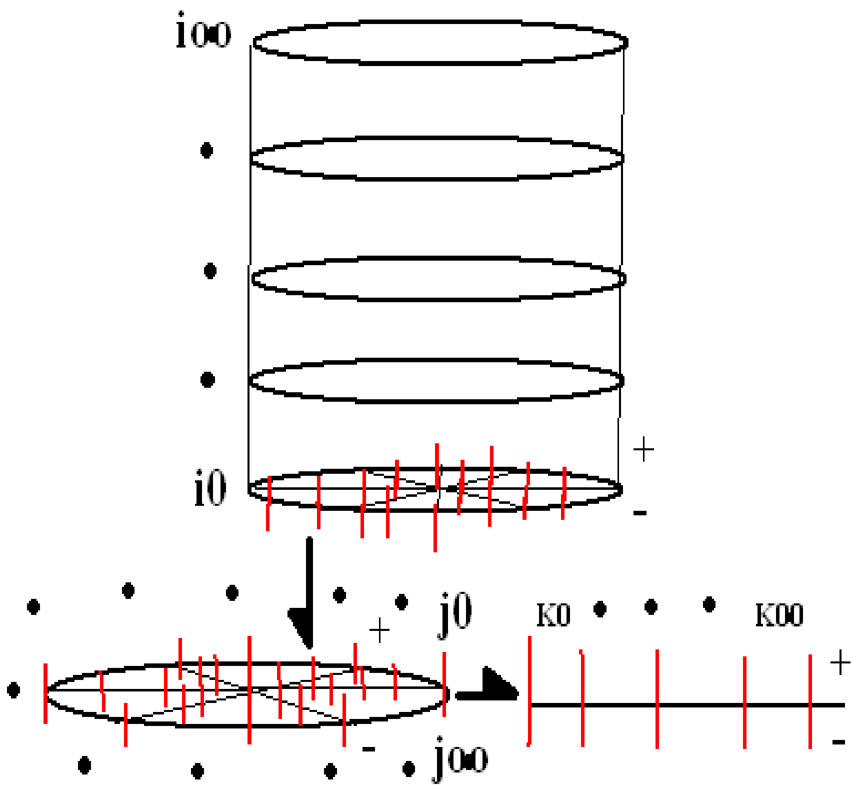
$$(10.)\qquad (\alpha_{<i:j:k>}\ ,\ \beta_{<i:j:k>})$$

The infinity dimensional coordinate space under the specific approach is able to show different dimensions that cannot be observed in the classic 2-dimensional Cartesian coordinate plane and 3-dimensional coordinate space. Hence, the 2-dimensional Cartesian coordinate plane and 3-dimensional coordinate space can be considered as sub-axes systems within the infinity dimensional coordinate space under the specific approach. The structure of the infinity dimensional coordinate space under the specific approach is formed by infinite general-spaces (i), sub-spaces (j) and micro-spaces (k). These are distributed into different places along the general cylinder (see Figure 12). Therefore, the infinity coordinate space under the specific approach starts from the general space zero (i_0) until the general space infinity (i_∞). And each sub-space starts from sub-space zero (j_0) until sub-space infinity (j_∞). Finally, the micro-space starts from micro-space zero (K_0) until micro-space infinity (K_∞) (see Expression 11). The infinity dimensional coordinate space under the specific approach can connect a large number of micro-spaces (k) distributed into the same sub-space (j) and general space (i) by the application of the inter-linkage connectivity of micro-spaces (╦). At the same time, the infinity dimensional coordinate space under the specific approach can also connect a large number of general spaces in the same coordinate space. It is based on the application of the inter-linkage connectivity of general-spaces (╬).

(11.)

$$\begin{array}{c}
(\alpha_{<0:0:0>}, \beta_{<0:0:0>}) \text{╦} (\alpha_{<0:0:1>}, \beta_{<0:0:1>}) \text{╦} \cdots \text{╦} (\alpha_{<0:0:\infty>}, \beta_{<0:0:\infty>}) \\
\text{╬} \\
(\alpha_{<0:1:0>}, \beta_{<0:1:0>}) \text{╦} (\alpha_{<0:1:1>}, \beta_{<0:1:1>}) \text{╦} \cdots \text{╦} (\alpha_{<0:1:\infty>}, \beta_{<0:1:\infty>}) \\
\text{╬} \\
(\alpha_{<0:2:0>}, \beta_{<0:2:0>}) \text{╦} (\alpha_{<0:2:1>}, \beta_{<0:2:1>}) \text{╦} \cdots \text{╦} (\alpha_{<0:2:\infty>}, \beta_{<0:2:\infty>}) \\
\vdots \\
\text{╬} \\
(\alpha_{<0:\infty:0>}, \beta_{<0:\infty:0>}) \text{╦} (\alpha_{<0:\infty:1>}, \beta_{<0:\infty:1>}) \text{╦} \cdots \text{╦} (\alpha_{<0:\infty:\infty>}, \beta_{<0:\infty:\infty>}) \\
\text{╬} \\
(\alpha_{<\infty:0:0>}, \beta_{<\infty:0:0>}) \text{╦} (\alpha_{<\infty:0:1>}, \beta_{<\infty:0:1>}) \text{╦} \cdots \text{╦} (\alpha_{<\infty:0:\infty>}, \beta_{<\infty:0:\infty>}) \\
\text{╬} \\
(\alpha_{<\infty:1:0>}, \beta_{<\infty:1:0>}) \text{╦} (\alpha_{<\infty:1:1>}, \beta_{<\infty:1:1>}) \text{╦} \cdots \text{╦} (\alpha_{<\infty:1:\infty>}, \beta_{<\infty:1:\infty>}) \\
\text{╬} \\
(\alpha_{<\infty:2:0>}, \beta_{<\infty:2:0>}) \text{╦} (\alpha_{<\infty:2:1>}, \beta_{<\infty:2:1>}) \text{╦} \cdots \text{╦} (\alpha_{<\infty:2:\infty>}, \beta_{<\infty:2:\infty>}) \\
\text{╬} \\
\vdots \\
\text{╬} \\
(\alpha_{<\infty:\infty:0>}, \beta_{<\infty:\infty:0>}) \text{╦} (\alpha_{<\infty:\infty:1>}, \beta_{<\infty:\infty:1>}) \text{╦} \cdots \text{╦} (\alpha_{<\infty:\infty:\infty>}, \beta_{<\infty:\infty:\infty>})
\end{array}$$

Figure 12: The Infinity Dimensional Coordinate Space under the Specific Approach



2.5.6. The Inter-Linkage Coordinate Space

The inter-linkage coordinate space is formed by an infinite number of general axes ($A_0, A_1, \ldots, A_n \ldots$), perimeter levels ($L_0, L_1, \ldots, L_n \ldots$) and windows refraction ($W_0, W_{1,\ldots,}W_{n\ldots}$) (see Figure 13 and Prototype 6). Each window refraction is based on joining its sub-x axis ($X_{A\text{-}L}$) with its sub-y axis ($Y_{A\text{-}L}$) respectively. Therefore, the window refraction ($W_0, W_{1\ldots}W_{n\ldots}$) is followed by the coordinate space ($X_{A\text{-}L},Y_{A\text{-}L}$).

All windows refraction on the same general axis ($A_0, A_1, \ldots, A_n \ldots$) will be joined together under the application of the inter-linkage connectivity of windows refraction represented by "®". The inter-linkage connectivity of windows refraction is represented by the symbol "®". The inter-linkage connectivity of windows refraction "®" will inter-connect all windows refraction ($W_0, W_1, \ldots, W_n \ldots$) on the same general axis ($A_0, A_1, \ldots, A_n \ldots$) but at different perimeter levels ($L_0, L_1, \ldots, L_n \ldots$). Moreover, the inter-linkage coordinate system is represented by (see Expression 12):

(12.) Perimeter level P_0 ® Perimeter level P_1 ® … ® Perimeter level P_n

General Axis 0 (A_0): $W_{0\text{-}0} = (x_{0\text{-}0},y_{0\text{-}0})$ ® $W_{0\text{-}1} = (x_{0\text{-}1},y_{0\text{-}1})$ ®…® $W_{0\text{-}\infty} = (x_{0\text{-}\infty}, y_{0\text{-}\infty})$

General Axis 1 (A_1): $W_{1\text{-}0} = (x_{1\text{-}0},y_{1\text{-}0})$ ® $W_{1\text{-}1} = (x_{1\text{-}1},y_{1\text{-}1})$ ®…® $W_{1\text{-}\infty} = (x_{1\text{-}\infty}, y_{1\text{-}\infty})$

General Axis 2 (A_2): $W_{2\text{-}0} = (x_{2\text{-}0},y_{2\text{-}0})$ ® $W_{2\text{-}1} = (x_{2\text{-}1},y_{2\text{-}1})$ ®…® $W_{2\text{-}\infty} = (x_{2\text{-}\infty}, y_{2\text{-}\infty})$

General Axis 3 (A_3): $W_{3-0} = (x_{3-0}, y_{3-0})$ ® $W_{3-1} = (x_{3-1}, y_{3-1})$ ®…® $W_{3-\infty} = (x_{3-\infty}, y_{3-\infty})$
General Axis 4 (A_4): $W_{4-0} = (x_{4-0}, y_{4-0})$ ® $W_{4-1} = (x_{4-1}, y_{4-1})$ ®… ® $W_{4-\infty} = (x_{4-\infty}, y_{4-\infty})$
General Axis 5 (A_5): $W_{5-0} = (x_{5-0}, y_{5-0})$ ® $W_{5-1} = (x_{5-1}, y_{5-1})$®… ® $W_{5-\infty} = (x_{5-\infty}, y_{5-\infty})$

. . . .

. . . .

General Axis n (A_∞): $W_{\infty-0} = (x_{\infty-0}, y_{\infty-0})$ ® ……………………………® $W_{\infty-\infty} = (x_{\infty-\infty}, y_{\infty-\infty})$

Finally, the inter-linkage coordinate space is able to fix a large number of different functions located in different windows refraction ($W_0, W_1, \ldots, W_n \ldots$), perimeter levels ($L_1, L_2, \ldots, L_n \ldots$) and general axes ($A_1, A_2, \ldots, A_n \ldots$) (see Expression 13):

(13.) Perimeter level P_0 ® Perimeter level P_1 ® … ® Perimeter level P_n
General Axis 0 (A_0): $y_{0-0} = f(x_{0-0})$ ® $y_{0-1} = f(x_{0-1})$ ®…….® $y_{0-\infty} = f(x_{0-\infty})$
General Axis 1 (A_1): $y_{1-0} = f(x_{1-0})$ ® $y_{1-1} = f(x_{1-1})$ ®…….® $y_{1-\infty} = f(x_{1-\infty})$
General Axis 2 (A_2): $y_{2-0} = f(x_{2-0})$ ® $y_{2-1} = f(x_{2-1})$ ®………® $y_{2-\infty} = f(x_{2-\infty})$
General Axis 3 (A_3): $y_{3-0} = f(x_{3-0})$ ® $y_{3-1} = f(x_{3-1})$ ®……® $y_{3-\infty} = f(x_{3-\infty})$
General Axis 4 (A_4): $y_{4-0} = f(x_{4-0})$ ® $y_{4-1} = f(x_{4-1})$ ®……. ® $y_{4-\infty} = f(x_{4-\infty})$
General Axis 5 (A_5): $y_{5-0} = f(x_{5-0})$ ® $y_{5-1} = f(x_{5-1})$®……..® $y_{5-\infty} = f(x_{5-\infty})$

. . . .

. . . .

. . . .

General Axis n (A_∞): $y_{\infty-0} = f(x_{\infty-0})$ ® ………………………® $y_{\infty-\infty} = f(x_{\infty-\infty})$

Prototype *6:* The Inter-Linkage Coordinate Space

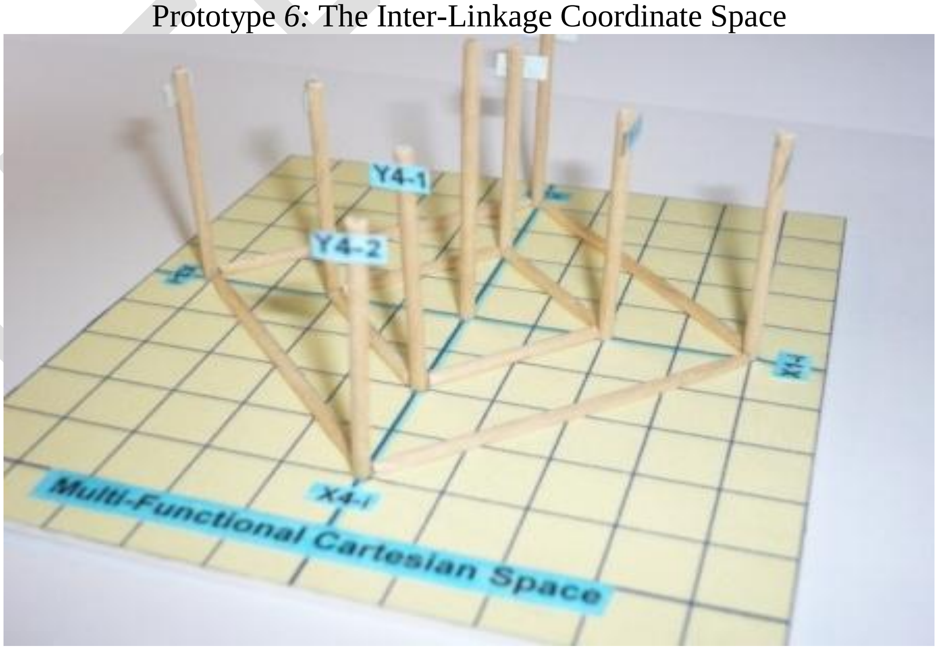
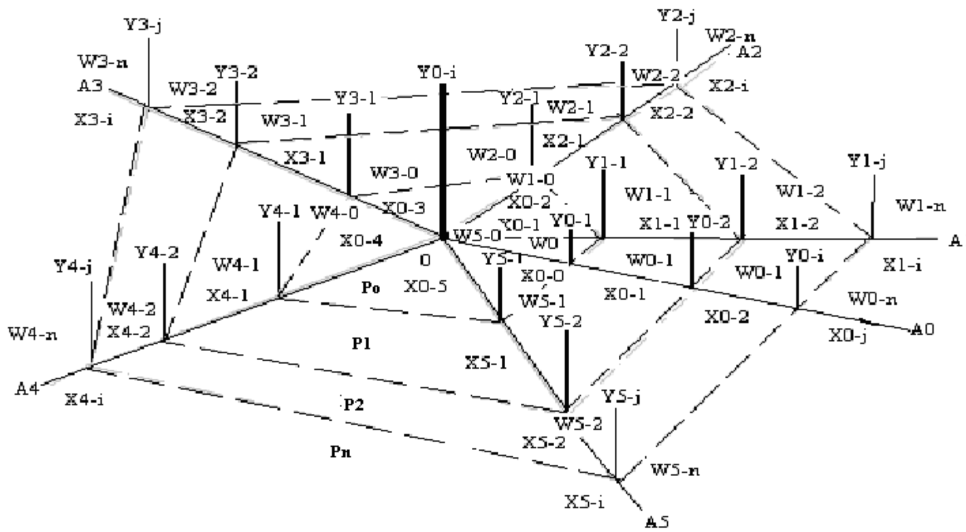


Figure 13: The Inter-Linkage Coordinate Space



2.5.7. The Cube-Wrap Coordinate Space

The cube-wrap coordinate space offers an alternative coordinate space. The main objective of the cube-wrap coordinate space is to show unknown dimensions that cannot be visualized by the 2-dimensional Cartesian plane and 3-dimensional coordinate space.

Initially, the cube-wrap coordinate space is divided into two quadrants. The first quadrant is located on the top of the cube-wrap coordinate space; this represents all $/X_i/$-axes. The second quadrant is located under the button of the cube-wrap coordinate space; this represents all $/Y_j/$-axes (see Figure 14).

In the process to plot values on this coordinate space, start by plotting each value on its respective axis line. The space that exists between $/X_i/$-axes and $/Y_j/$-axes will be called the "quadratic-space refraction" because each $/X_i/$-axis has its respective $/Y_j/$-axis. The construction of the quadratic space refraction is based on two basic steps. The first step is to plot each value on the $/X_i/$-axis line and $/Y_j/$-axis line, for which we suggest the application of the inter-linkage connectivity of micro-spaces (╥) (see Expression 14). The second step is to join the values located on $/X_i/$-axis and $/Y_j/$-axis by a single straight vertical line.

(14.) ($/X_i/$ ╤ $/Y_j/$)

We assume that between X_i–axes and Y_j–axes exists a common single straight vertical line that joins both set of axes. This common single straight line is called the zero space. Hence, the cube-wrap coordinate space starts from the quadratic space refraction zero (L_0) and extends to the quadratic space refraction infinity (L_∞). The cube wrap coordinate space requires the application of absolute values $/\mathbf{R}_{+/-}/$ because the cube wrap coordinate space only works with positive real numbers $\mathbb{R}_+$. The final coordinate system to build the cube-wrap coordinate space is represented by expression 15.

(15.)

$$CW = \left[(S_0) = (/X_{00}/ \mp /Y_{00}/) \, ╬ \, (S_1) = (/X_{01}/ \mp /Y_{01}/) \, ╬ \ldots ╬ \, (S_\infty) = (/X_{\infty\infty}/ \mp /Y_{\infty\infty}/) \right]$$

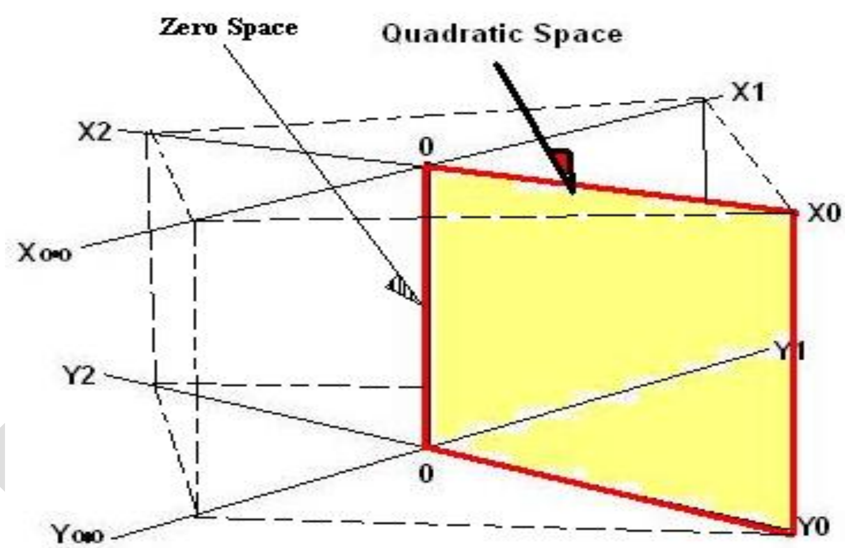
The final stage of analysis in the cube-wrap space is based on its size. There are three possible stages that the cube-wrap space can experience at any time:

(16.) If all values are growing constantly in $/X_i/$ and $/Y_j/$ then the cube-wrap is experiencing an expansion stage

(17.) If all values are decreasing constantly in $/X_i/$ and $/Y_j/$ then the cube-wrap is experiencing a contraction stage

(18.) If all values are keeping constant in $/X_i/$ and $/Y_j/$ then the cube-wrap is experiencing a static stage

Figure 14: The Cube-Wrap Coordinate Space and the Cube-Wrap Space



2.5.8. The Mega-Space Coordinate Space

The mega-space coordinate space is formed by an infinite number of axes in vertical position. Each vertical axis (X_{ij}) shows positive integer numbers on the top and negative integer numbers on the bottom in the same vertical axis. At the same time, all the vertical axes can be located by row number (i) and column number (j) in the mega-space coordinate space (See Expression 19).

The idea to apply the mega-surface coordinate space is to build the mega-surface. The mega-surface shows how a large number of variables behave together in the same graphical space. Initially, the construction of the mega-surface is started by joining each vertical axis value by straight lines with its neighboring vertical axis: front side; left side; right side; back (see Figure

15). It is necessary to join all the axes in order to apply the inter-linkage connectivity condition (╬) on all vertical axes simultaneously.

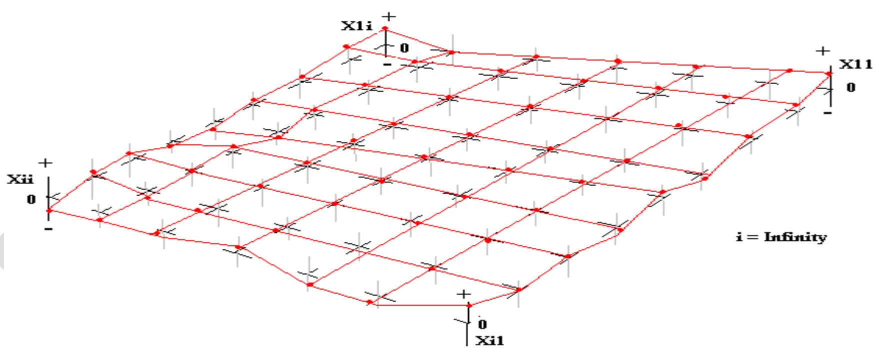
(19.)

$$\text{╬}\, X_{ij} \Rightarrow \begin{pmatrix} \text{╬} X_{11} & \text{╬} X_{12} & \text{╬} \ldots\ldots\ldots\ldots & \text{╬} X_{1\infty} \\ \text{╬} X_{21} & \text{╬} X_{22} & \text{╬} \ldots\ldots\ldots\ldots & \text{╬} X_{2\infty} \\ \text{╬} X_{31} & \text{╬} X_{32} & \text{╬} \ldots\ldots\ldots\ldots & \text{╬} X_{3\infty} \\ \text{╬} X_{\infty:1} & \text{╬} X_{\infty:2} & \text{╬} \ldots\ldots\ldots\ldots & \text{╬} X_{\infty\infty} \end{pmatrix}$$

The final analysis of the mega-surface is based on its location within the mega-space coordinate space. These are the possible stages that the mega-surface can experience:

(20.) If all X_{ij} values > 0 then the mega-surface shows an expansion stage
(21.) If all X_{ij} values = 0 then the mega-surface shows a stagnation stage
(22.) If X_{ij} values < 0 then the mega-surface shows a contraction stage
(23.) If some X_{ij} shares positive, negative or zero values in different vertical axes, then the mega-surface shows an unstable performance stage

Figure 15: The Mega-Space Coordinate Space and the Mega-Surface



2.5.9. The Cubes Coordinate Space

The cubes coordinate space is formed by an infinite number of general axes ($A_0, A_1, \ldots, A_n$), where each axis shows different levels ($L_0, L_1, \ldots, L_n$), perimeters ($P_0, P_1, P_2 \ldots P_n$), and cubes with different sizes and colors ($C_{0/\beta}, C_{1/\beta \ldots} C_{n/\beta}$). Therefore, the coordinate system of the cubes-coordinate space is represented by $S_{A:L:P:C} = (A_i, L_j, P_k, C_{s/\beta})$ respectively, where *i, j, k* and *s* represent different values between 0 and ∞…. and β represents the different colors of each cube at different levels ($L_0, L_1, \ldots, L_n$). All the cubes with different sizes and colors in the same axis under the same level ($L_0, L_1, \ldots, L_n$) and different perimeters ($P_0, P_1, P_2 \ldots P_n$) will be joined together, based on the application of the concept called "macroeconomics links structures" represented by the symbol **"@"**. Moreover, the cubes-coordinate space coordinate system is expressed by the following (See Expression 24 and Figure 16):

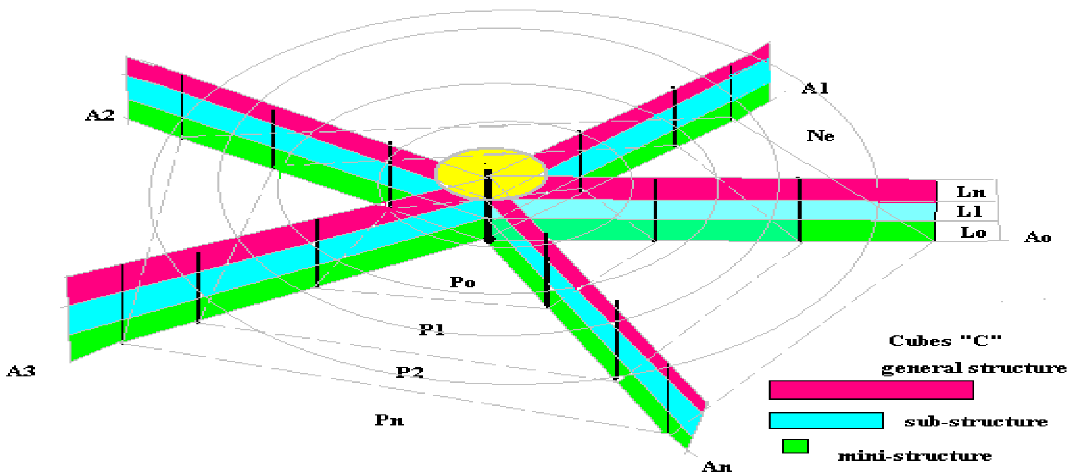
(24.) Level P_0 @………………@ Level P_n

$$\mathbf{A_0:}\; S_{0:0:0:C(\alpha/\beta)} = (A_0, L_0, P_0, C_{\alpha/\beta}) \;@\; \ldots\ldots \;@\; S_{0:0:\lambda:C(\alpha/\beta)} = (A_0, L_0, P_\lambda, C_{\alpha/\beta})$$
$$@ \qquad\qquad\qquad\qquad @$$
$$S_{0:1:0:C(\alpha/\beta)} = (A_0, L_1, P_0, C_{\alpha/\beta}) \;@\; \ldots\ldots \;@\; S_{0:1:\lambda:C(\alpha/\beta)} = (A_0, L_1, P_\lambda, C_{\alpha/\beta})$$
$$@ \qquad\qquad\qquad\qquad @$$
$$. \qquad\qquad\qquad\qquad .$$
$$@ \qquad\qquad\qquad\qquad @$$
$$S_{0:\theta:\lambda:C(\alpha/\beta)} = (A_0, L_\theta, P_\lambda, C_{\alpha/\beta}) \;@\; \ldots\ldots \;@\; S_{0:1:\lambda:C(\alpha/\beta)} = (A_0, L_1, P_\lambda, C_{\alpha/\beta})$$
$$@ \qquad\qquad\qquad\qquad @$$
$$\mathbf{A_1:}\; S_{1:0:0:C(\alpha/\beta)} = (A_1, L_0, P_0, C_{\alpha/\beta}) \;@\; \ldots\ldots \;@\; S_{1:0:\lambda:C(\alpha/\beta)} = (A_1, L_0, P_\lambda, C_{\alpha/\beta})$$
$$@ \qquad\qquad\qquad\qquad @$$
$$S_{1:1:1:C(\alpha/\beta)} = (A_1, L_1, P_0, C_{\alpha/\beta}) \;@\; \ldots\ldots \;@\; S_{1:\theta:\lambda:C(\alpha/\beta)} = (A_1, L_1, P_\lambda, C_{\alpha/\beta})$$
$$@ \qquad\qquad\qquad\qquad @$$
$$. \qquad\qquad\qquad\qquad .$$
$$@ \qquad\qquad\qquad\qquad @$$
$$S_{1:\theta:\lambda:C(\alpha/\beta)} = (A_1, L_\theta, P_\lambda, C_{\alpha/\beta}) \;@\; \ldots\ldots \;@\; S_{1:\theta:\lambda:C(\alpha/\beta)} = (A_1, L_\theta, P_\lambda, C_{\alpha/\beta})$$
$$@ \qquad\qquad\qquad\qquad @$$
$$\mathbf{A_n:}\; S_{n:0:0:C(\alpha/\beta)} = (A_n, L_0, P_0, C_{\alpha/\beta}) \;@\; \ldots\ldots \;@\; S_{n:0:\lambda:C(\alpha/\beta)} = (A_n, L_0, P_\lambda, C_{\alpha/\beta})$$
$$@ \qquad\qquad\qquad\qquad @$$
$$S_{n:1:1:C(\alpha/\beta)} = (A_n, L_1, P_0, C_{\alpha/\beta}) \;@\; \ldots\ldots \;@\; S_{n:1:\lambda:C(\alpha/\beta)} = (A_n, L_1, P_\lambda, C_{\alpha/\beta})$$
$$@ \qquad\qquad\qquad\qquad @$$
$$. \qquad\qquad\qquad\qquad .$$
$$@ \qquad\qquad\qquad\qquad @$$
$$S_{\theta:\,\lambda:\,C:\,\alpha/\beta} = (A_n, L_\theta, P_\lambda, C_{\alpha/\beta}) \;@\; \ldots\ldots \;@\; S_{n+1:\theta+1:\lambda+1:C:\alpha+1/\beta} = (A_{n+1}, L_{\theta+1}, P_{\lambda+1}, C_{\alpha+1/\beta})$$

Finally, the cubes-coordinate space shows a general function where the dependent variable is identified by the national economy base "N_e" . N_e is the final result from ten macroeconomic structures. It is based on the linking of all macroeconomics structures (S_0, S_1 ,…, S_n) under different axes (A_1, A_2 ,…, A_n), levels (L_1, L_2 ,…, L_n), perimeters (P_0, P_1, P_2…P_n) and cubes with different sizes and colors ($C_{0/\beta}$, $C_{1/\beta}$… $C_{n/\beta}$) in the same sub-coordinate space respectively. It is expressed by the following: (See Expression 25)

$$\textbf{(25.)} \quad /\Delta N_e/ = [/\Delta A_o/ \;@\; /\Delta A_1/ \;@\; \ldots @\; /\Delta A_n/]$$

Figure 16:
The Cubes-Coordinate ***Coordinate Space***



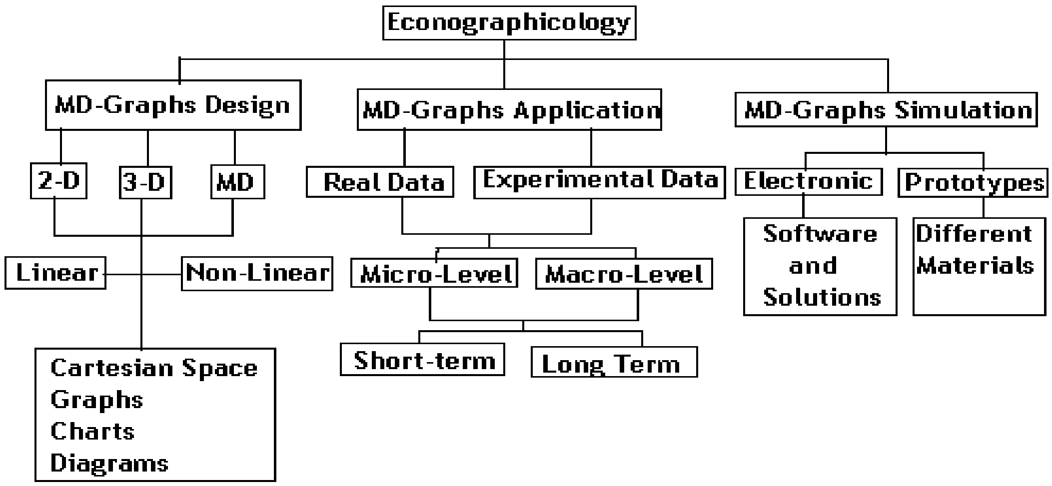
2.6. Introduction to Econographicology

Econographicology is originated by the necessity to generate an alternative and specialized multidimensional graphical modeling for economics, business and finance. In fact, Econographicology's main objective is focused on the research, development and application of multidimensional coordinate spaces to generate different types of multi-dimensional graphs. Therefore, Econographicology will maximize the uses of multi-dimensional graphs to minimize difficulties in the process of meta-database storage and multi-variable data behavior visualization. Hence, Econographicology is defined as *"a multi-dimensional graphical theoretical framework [that] can be applied [towards] economics, as well as finance and business.*"

Additionally, Econographicology is divided into three large research areas: multidimensional graphs design, multidimensional graphs application and multidimensional graphs simulation. The multidimensional graphs design research area can be 2-dimensional, 3-dimensional and multi-dimensional coordinate spaces under linear and non-linear graph systems,; the same section is divided into four sub-sections: coordinate spaces, graphs, charts and diagrams design. The multidimensional graphs application research area use two types of data; real as well as experimental data under micro and macro-level analysis in the short and long term (see Diagram 1).

The last section is the multidimensional graphs simulations research area, divided into two sections, i.e. electronic and prototype. The electronic area is based on the application and use of software and solutions. The idea of including prototypes in the multidimensional graphs simulation is to facilitate ease of comprehension in the teaching-learning-research process of multi-variable data visualization (see Diagram 1).

Diagram 1
Econographicology Research Areas



Source: Design by the author

2.7. Concluding Remarks

Firstly, this research concludes that the 2-dimensional space shows certain limitations when it comes to visualizing complex economic phenomena simultaneously in the same graphical space and time. Therefore, multi-dimensional coordinate spaces are available to expand a multidimensional optical effect to visualize different complex economic phenomena in the same graphical space and time, according to this research.

Secondly, Econographicology attempts to become an alternative graphical method focus to support the meta-database storage and visualization of multi-variables data behavior, as well as finance and business. The main idea behind Econographicology is to offer new multi-dimensional graphs based on the application of alternative multi-dimensional coordinate spaces that can facilitate the study of any economic, finance and business phenomena under macro-level and micro-level of analysis in the short and long term. In summation, Econographicology plays an important role in the research and teaching-learning process of economics through a series of new graph methods and techniques that can be profitably used by academics, researchers, economists and policy makers.

CHAPTER 3

THE GLOBAL DIMENSION OF THE REGIONAL INTEGRATION MODEL (GDRI-MODEL)

3.1. Introduction

Over the past 70 years, the field of research on regional integration has changed dramatically, with the discovery and implementation of new theories, models and techniques. In this thesis, the study of regional integration is approached from a few different perspectives, namely, economic, political, social and technological analysis. In addition, the orientation of these perspectives in the context of regional integration is also accounted for. Evaluating regional integration and its benefits is not an easy task. The nature of the subject matter constitutes part of the problem in this regard (Devlin and Ffrench-Davis, 1998). Much of the study related to regional integration has so far been done from the economic perspective. According to Winters (1999), the study of regional integration from the economic perspective is typically evaluated in light of the probable scenario in the absence of such an approach to the study. Also, as pointed out by Winters, with complications in defining and measuring changes in economic welfare for a particular sub-region, economists use proxy summary statistics that reflect growth of trade.

On the basis of the above idea, this thesis introduces a new methodology of analysis that monitors regional integration process from a new perspective. Called the regional integration evaluation methodology (RIE-Methodology), this methodology will simultaneously study all areas of development (political, social, economic and technological analysis) that each country or domestic development system (DDS) in the same region (same geographical position) shows based on the results of the regional development indexes (X_i)[1]**.** The idea is to demonstrate that regional development (RD)[2] can affect the evolution of the regional integration process considerably. It is based on the application of a group of indexes and graphs. This group of indexes and graphs shows the evolution and stages of the regional integration process of any region from a multi-dimensional analysis.

It is assumed in the RIE-Methodology that the basic pre-condition to start a stronger regional integration process in any type of trade bloc is a stronger domestic development experienced by each country or domestic development system (DDS) in the same region.

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[1] The regional development index (X_i) is as follows: Regional Political Development Index (X_1) will show the level of political environmental that this specific region shows. Regional Social Development Index (X_2) will show trends in social agenda at regional level. Regional Economic Development Index (X_3) will present the economic trends that the region shows. Regional Technological Development Index (X_4**)** will present the level of technology development that this specific region shows. Each component of these regional development indices (Xi) by area will together present the different stages with which any country can chart its own evolution.

[2] Regional development (RD) originates from the different levels of political, social, economic and technological development that each member country in the same region shows. If the gap between all areas of development (political, social, economic and technological) among all members is considerably large, then the regional integration process can experience serious difficulties.

Another pre-condition for a stronger regional integration process is a combination of historical timing and political and social willingness. For the latter, the countries involved must be interested in creating a formal or informal agreement with all its members so as to collectively consolidate themselves into a single region.

The difference between the RIE-Methodology and the traditional models of analysis is that the RIE-Methodology will analyze regional integration from a new analytical perspective, that is, under a multi-dimensional analysis based on the study of all areas that domestic development evolves such as political development, social development, economic development and technological development. It allows for the detection of the pros and cons in the evolution of regional integration blocs in any region from a different perspective. The main idea is to show that successful regional integration blocs depend on the majority of the members being interested in building a trade bloc, and, therefore, there cannot be a large margin of difference in the domestic development (political development, social development, economic development and technological development) among its members. The objective of the RIE-Methodology is to offer policy-makers and researchers a new alternative analytical tool for studying the results achieved with regional integration. This will benefit the parties concerned in their policy-making and program development.

3.2. Background Research and Analysis of Different Fields of Research in the Study of Regional Integration

Regional Integration can be studied and researched based on different focuses and approaches. This chapter applies four traditional fields of research in the study of Regional Integration: economic, political, social and technological fields of research. In the first part of the research pertaining to this study, an effort was made to identify the inclination of the fields of research in the study of regional integration. 500 chapters (100%) on regional integration from 75 journals[3] published between the 1950's and the 1990's were selected for this purpose (see: www.jstor.org and www.sciencedirect.com by Elsevier). Next, the percentage of participation by fields of research (economic, political, social and technological) in the study of regional integration was calculated.

The following trend in terms of fields of research in the study of regional integration was observed: 50% from the economic field of research, 40% from the political field of research, 7% from the social field of research and 3% from the technological field of research. It was also observed that, compared to the 1950's, 1970's and 1980's, the topic of regional integration was more frequently researched and discussed in journals in the 1960's (25%) and 1990's (35%).

[3] American Economic Review, Canadian Journal of Economics, Econometrica, Economic History Review, Economic Journal, International Economic Review, Journal of Economic History, Journal of Economic Literature, Journal of Political Economy, Journal of Policy Modeling, Economic Development Journal, Oxford Economic Chapters, Quarterly Journal of Economics, Review of Economic Studies, Review of Economics and Statistics, Canadian Journal of Economics and Political Science, Journal of Economic Abstracts, Contributions to Canadian Economics, Journal of Labor Economics, Journal of Applied Econometrics, Journal of Economic Perspectives, Publications of the American Economic Association, Brookings Chapters on Economic Activity, microeconomics *and* American Economic Association Quarterly.

3.2.1. The Economic Field of Research in the Study of Regional Integration

In the economic field of research (i.e. the largest field of research) in the study of regional integration, attention was placed on three specific areas: economic theory, political economy and applied economics. Economic theory is divided into two parts, namely microeconomics and macroeconomics, each of which has a different focus. Some of these focuses are: partial or general (type of equilibrium), ex-post or ex-antes (method analysis), static or dynamic (behavior), short term or long term (time frame). Method analysis is either quantitative (econometrics, statistics and mathematics) or qualitative (in the form of comparative studies based on theories or historical data). It is observed that the study of regional integration from the economic perspective mainly centers on macroeconomics applications (80%), quantitative methods (65%), partial equilibrium (60%), ex-antes approach (65%), and static models (65%). Besides, these applications are used in the short term in most research.

The common theories, models and theorems used by researchers in the economic field of research in the study of regional integration are: international trade policy[4] framework, optimal current area theory[5], fiscal federalism theory[6], Heckscher-Ohlin model[7], Kemp and Wan theorem[8]. Among all these theories, the most important theory applied is the customs union

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[4] This includes the basic tariff analysis; cost and benefits of trade; tariff and non-tariff trade barriers analysis and the new protectionism (Krugman and Obstfeld, 2000).

[5] The optimal currency areas were introduced by Mundell (1961) and Mckinnon (1963). "This approach based its study on monetary policy issues (money, markets for goods, and markets for production factors.) First, we will present the concept of a currency area defined as an area in which a common currency exists (Mattli, 1999). Optimal is defined in terms of the ability of an area to achieve both internal balance (maintenance of full employment and stable internal average price level) and external balance (maintenance of balanced international payments equilibrium). The main idea of optimal currency area was developed because of a dilemma between introducing fixed versus flexible exchange rate."

[6] "The fiscal federalism is an offshoot of public finance theory that analyzes the special fiscal problems which arise in federal countries, drawing on the literature on public goods, taxation, income distribution and public debt incidence, and various parts of location theory" (Mattli,1999). We can observe that this approach focuses on fiscal policy issues based on fiscal coordination. The general objective of this theoretical approach is the improvement of market efficiency focused on the interaction of market and public goods. The method applied in fiscal federalism is of a positive dynamic (general equilibrium).

[7] The Heckscher-Ohlin (H-O) model (Breton, Scott, and Sinclair, 1997), "which is the whole theoretical construction concerning trade and production based upon a difference between countries in their factor endowments, and four hypotheses or propositions which arise from this model. The H-O model assume that each country will export products that are intensive in the use of that country's abundant factor of production (labor or capital), and will import products that are intensive factor of production (labor and capital) in the use of the country's scarce factor of production."

[8] The Kemp and Wan theorem presents this proposition related to the formation of custom unions: "It is consider any competitive world trading equilibrium, with any number of countries and commodities, and with no restrictions whatever on the tariffs and other commodity taxes of individual countries, and with costs of transportation fully recognized. Now let any subset of the countries form a customs union. Ten there exists a common tariff vector and a system of lump-sum compensatory payments, involving only members of the union, such that there is an associated tariff-ridden competitive equilibrium in which each individual, whether a member of the union or not, is not worse off than before the formation of the union" (Kemp and Wan, 1976).

theory[9] (including the second best theory[10]). The customs union theory is still used today by many economists to choose between trade creation and trade diversion[11] for evaluating regional integration. However, the static analysis used in the customs union theory poses a problem: it frequently uses a partial competitive equilibrium framework to arrive at a general conclusion about a process that is a general equilibrium phenomenon (Devlin and Ffrench-Davis, 1998).

According to Winters (1997), many economists are of the stand that trade creation versus trade diversion is not the core of the problem. The problem lies with the deficiency of the models of dynamics and empirical foundations used for testing them. In effect, Mordechai and Plummer (2002) point out that economists whose research into regional integration is based on ex-post models include a gravity model, an import-growth simulation and other regression approaches. This is because the computational general equilibrium (CGE)[12] model (multi-country and multi-commodity dimension) has become very popular among economists.

Furthermore, the economic field of research merely applies the positive theories of welfare gains and losses associated with regional integration; it provides no explanations of the political choices that allow for integrated fields of research. As such, the economic field of research negates the global context of the evolution and trend of regional integration process as a whole.

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[9] "The custom union argument is based on the free-trade point of view, whether a particular custom union is a move in the right or in the wrong direction depends, therefore, so far as the argument has as yet been carried, on which of two types of consequences ensue from that custom union. Where the free trade-creating force is predominant, one of the members at least must benefit, both may benefit, the two combined must have a net benefit, and the world at large benefits; but the outside world loses, in the short-run at least, and can gain in the long-run only as the result of the general diffusion of the increased prosperity of the custom union. Where the trade-diverting effect is predominant, one al least of the member countries is bound to be injured, both may be injured, the two combined will suffer a net injury, and there will be injury to the outside world and to the world at large." (Viner, 1950).

[10] "The second best theory was presented by Lipsey and Lancaster (1997). These two authors present a deeper study about the custom union theory of Viner based on the application of a positive dynamic method (general equilibrium) to explain the custom union effect on the world trade. The contribution of Lipsey and Lancaster in the custom union theory follows the Paretian optimum which requires the simultaneous fulfillment of all the optimum conditions based on the general economic problem of maximization. A function is maximized subject to at least one constraint, in this case production function and utility function."

[11] "Trade-creation effect occurs when some domestic production in a nation that is a member of the custom union is replaced by lower-cost imports from another member nation. Assuming that all economic resources are fully employed before and after formation of the custom union, this production is based on comparative advantage. The Trade-diversion effect occurs when lower-cost imports from outside the custom union are replaced by higher cost import from a union member. This is a result of the preferential trade treatment given to member nations. Trade-diversion effect, by itself, reduces welfare because it shifts production from more efficient producers outside the custom union to less efficient inside in the union. Thus, trade diversion worsens the international allocation of resources and shifts production away from comparative advantage." (Salvatore,2001)

[12] "The CGE models are standard tools for analyzing trade policy. The case of general equilibrium models are: first liking trade and productivity growth; second foreign investment and productivity growth; third, endogenous growth and CGE modeling." (Mordechai and Plummer, 2002).

In a nutshell, this book maintains that the economic field of research poses many limitations in the study of the effects of regional integration, and that it is merely one part of the complicated puzzle of regional integration research. On this account, this study further maintains that the study of regional integration requires a multi-dimensional analysis (economic, social, political and technological dimensional simultaneously) to be optimally useful.

3.2.2. Political, Social and Technological Fields of Research

The study of regional integration from the political dimension is also pervasive. It is observed that many studies on regional integration involve extensive elaboration of the following politically-oriented topics: institutional framework (functionalism or neo-functionalism), policy dimensional agreements (negotiation) and international law issues.

As observed, more qualitative rather than quantitative methods of evaluation are used in the political dimension of research. Just as in the economic dimension of research, the political dimension of research in the study of regional integration has many limitations. However, as pointed out by Mattli (1999), the political context in which integration occurs has been specified in the political dimension of research and this has provided insightful accounts of the process of integration.

The third field of research, that is the social field of research, focuses on issues such as history, culture, education, social welfare programs and social policies applied by governments. Usually such research is in the form of comparative studies based on basic statistical comparison, feedback, interview results, history and social theoretical frameworks. Many of these studies are confined to highly important issues that are worthy of consideration in the study of the effects of regional integration.

The fourth field of research, that is the technological field of research, has a relatively smaller presence. It focuses mainly on four specific topics: regional electrical inter-connection, telecommunications, technology transfer, and research and development (R&D). Some of these research documents involve advanced technical terminologies and the application of quantitative methods (statistics and mathematics).

3.3. The Global Dimension of the Regional Integration Model (GDRI-Model)

Economic, political, social and technological dimensions of research into regional integration clearly do not provide a global perspective in the understanding of regional integration. For this reason, the global dimension of the regional integration model (GDRI-Model) is proposed in this thesis to address the issue.

The GDRI-Model is a measuring tool for studying regional integration from a global perspective. The proposed GDRI-Model is a simple and flexible model. It applies dynamic and general equilibrium analysis to show the past and present situations in the regional integration process of any region based on a set of indexes and graphs. Its field application is not constrained by region or the development stage of each member interested in integrating into a single regional bloc.

The GDRI-Model can be applied to any form of regional integration process: between developed countries and developing countries, North-South Integration (e.g. within the Europe Union -EU-), between developed and developing countries (e.g. within the North American free trade area -NAFTA-), and between developing countries or south-south integration (e.g. within MERCOSUR and ASEAN).

The application of the GDRI-Model is based on the characteristics, conditions and historical moments of a region's regional integration development. The GDRI-Model is like a simulator that applies a series of simulations in different scenarios and in different phases of the regional integration process. This model does not attempt in any way to be a forecasting model. It focuses on the past and present situations in the regional integration process as a whole. It helps to provide a general idea about the situations and evolution of the regional integration process in any region.

3.4. The Domestic Development System Concept

This part of the research presents a new concept entitled the "domestic development system (DDS)." The DDS incorporates all economic, political and social characteristics that any country may show in its different phases of development. The GDRI-Model assumes that each country has its own domestic system development. At the same time, it defines regional integration as the joining of a certain number of different countries (or Domestic Development Systems) that are interested in creating a strong regional development system (RDS). The DDS concept is based on five assumptions:

- ✓ Change within the domestic development system (DDS) in any country cannot be forced; it can only be induced by material incentives and motivation.
- ✓ The domestic development system (DDS) of any country is spurred onwards by the limited nature of resources.
- ✓ Each domestic development system (DDS) has its unique set of characteristics. Therefore it might be difficult to try to implement a successful domestic development system (DDS) in another, less successful, domestic development system (DDS).
- ✓ The RDS concept attempts to integrate different DDS into a regional integration agreement (RIA) depending on the different domestic development systems (DDS) that are available for integration into a single regional system.
- ✓ The creation of a regional development system (RDS) depends on the flexibility of each domestic development system (DDS).

The domestic development system (DDS) concept offers a new perspective of analysis and research in the field of regional integration and development economics. The traditional research is based on economic, political, social and technological points of view; but the DDS concept makes it possible to visualize different countries' developments from a global perspective.

3.5. Phases in the Global Dimension of the Regional Integration Model (GDRI-Model)

3.5.1. Phase I: Design of the Multi-input Database Table

The multi-input database table is an alternative style of database analysis framework that permits the storage of large amounts of data to measure a single variable. This single variable can show the evolution of any phenomenon from a general perspective. The multi-input database table is designed to evaluate either by country or region (see Diagram 1).

The multi-input database table is focused on measuring four main independent variables (e.g. X_1, X_2, X_3, and X_4). Each main independent variable is formed by "n" number of sub-variables. The number of sub-variables in each main independent variable is non-limited; for this reason, the multi-input database table concept does not have any specific ranking. Instead, there exists a basic classification of sub-variables. Only two main independent variables have a classification. First, political (X_1) is divided into two large sections: external and internal factors (see Table 3). Second, economic (X_3) is divided into production, consumption, trade, labor, investment, infrastructure, government and international cooperation. However, each sub-variable has a code number respectively. The code number depends on the area of development (X_1 = political; X_2 = social; X_3 = economic and X_4 = technological). The reason that all sub-variables have the same importance (weight) is because we are interested in measuring a single value; in this case, each main independent variable (X_1, X_2, X_3 and X_4). To give the same weight to all sub-variables, it is necessary to use a binary system. The binary system helps to maintain a balance among all variables in each multi-input database table. Another reason is that the binary system helps to create an alternative model of analysis when it comes to countries with limited information, especially in the case of developing countries and less developed countries (LDC's).

The idea of applying a multi-input database is to find the domestic development system -DS- (country) and finally the regional development -RD- (regional bloc). The idea of finding the DDS and the RD is to demonstrate that successful regional integration process depends on the major part of the DDS being strong enough; there can only be a small gap between its members. In this case, the RD is result of the sum of the component DDS. The four main independent variables will show the RD in different areas of development [political (X_1), social (X_2), economic (X_3) and technological (X_4)].

The number of variables used in the GDRI-Model varies, depending on the objectives of the researchers or policy-makers and the orientation of the cases of research. In the case of this thesis, 98 variables with their respective tables and parameters were selected: 19 variables for regional political development index (X_1) [see Table 3]; 15 variables for regional social development index (X_2) [see Table 6]; 54 variables for regional economic development index (X_3) [see Table 9] and 10 variables for regional technological development index (X_4) [see Table 12].

Once the number of sub-variables is determined, the next step is to collect the statistical and historical data that constitute sub-variables ("n" number) in each main independent variable (X_1, X_2, X_3 and X_4). All sub-variables within each main independent variable (X_1, X_2, X_3 and X_4) may not have a direct relationship between them -- they may be independent variables or endogenous variables. However, all the sub-variables in each multi-input database table are meant to measure a single variable or main independent variable, that is, each of the Regional Development Indexes (X_i).

Each of the four X_i indexes (X_1, X_2, X_3 and X_4) to be measured is viewed as a main independent variable (i.e. endogenous variable). However, there is no connection or interdependency among these four X_i indexes when they are joined in the graph. These four Xi indexes are used to draw a graph that represents the evolution and stages of the regional integration process of the region from a general perspective. The objective of this chapter is to apply the GDRI-Model in many trade blocs simultaneously (e.g. European Union -EU-, North America free trade area -NAFTA-, association of south-east Asian nations -ASEAN-, and MERCOSUR).

3.5.1.1. The Rational Selection of Sub-variables in each Multi-input Database Table

Regional Political Development

Regional political development is divided into two large sections: external factors and internal factors.

External factors

Colonization: The model assumes that countries which have been colonized for a long time in the past or continue under the domination of a hegemony can stop the process of regional integration anywhere.

Group negotiation power: This can be analyzed by the number of meetings that all members in the same region organize every year.

Foreign policy orientation of each member: The foreign policy is divided into two large focuses: regional and global level (world).

Negotiation style: This sub-variable shows the style of negotiation, whether individual or group behavior.

Internal factors

International organization support: International organizations can facilitate financial and technical support.

Intra-regional institution number: The number of institutions can play an important role in the development of the regional integration process.

Political regime: This sub-variable encourages the political stability of the region.

Legislative background: This can help to facilitate the regional legal framework for environmental and other issues.

Internal Security: Adequate security measures for local and regional citizens.

Human Rights: The level of protection of human rights offered by each member in the same region.

Border Problems: Border problems can hinder or stop the regional integration process.

Political Stability: This is a basic condition in order to integrate all countries into the same region.

Public Administration: Good public administration can facilitate management of the regional integration process.

Army size: Less expenditure on army services can help to redirect resources towards social and public services.

Bureaucracy level: A complicated bureaucracy system can generate difficulties in the regional integration process.

Regional Social Development

Regional social development is generated by seven sub-variables:

Literacy: This sub-variable shows the human capital stock under regional level.

Social Problems: These can generate instability in one member country or at a regional level

Health and Medical programs: The social welfare orientation of the region is important.
External Culture Influence: Societal behavior in order to become an individual or a collective society.
Food Security: This prevents regional disasters and quick handling of emergencies.
Public Education: Infrastructure for training and higher education at the regional level.
Low Cost Housing Projects: Equitable distribution of income at regional level.

Regional Economic Development

Regional economic development is formed by eight large sections: production, consumption, trade, labor, investment, infrastructure, government and international cooperation.

Production

Eleven sub-variables are considered in this section. Among these eleven sub-variables, we include the study of the GDP to observe production structure and growth. In the same section, we also consider natural resources, oil production and environmental protection to evaluate the supply of resources for the regional production. Market location, industrial concentration and subsidies level can generate distortions in regional prices. Export structure can help to visualize if there exist similarities in the export products that members in the same region offer to the international market. The copyright of patents and trademarks can play an important role in the control of pirated mass production.

Consumption

In the consumption section, seven sub-variables are considered, including income *per-capita*, buyer purchase, poverty level, saving rate, inflation rate and wealth distribution. All these sub-variables need to be found among all members to determine consumption behavior at regional level. Market size can play an important role in the regional integration process, which can help to join small markets into a single larger market.

Trade

The trade section has five sub-variables. All these variables show the behavior of the external sector at regional level and the possible obstacles that each member or the region may face. These variables are intra-regional trade volume, extra-regional trade volume, intra regional tariff application, openness and monopoly controls.

Labor

The labor section has six sub-variables. This section considers the fact that international social division can facilitate the regional integration process together with labor distribution under urban and rural areas. The immigration and emigration levels can demonstrate the mobility of labor into the region and the rest of the world. Population growth is considered a vital variable in the study of labor to observe the population pyramid of the region and predict future human capital stock supply. Labor productivity also plays an important role in encouraging the possibility of FDI attraction to expand regional production and exports.

Investment

This section is divided into seven sub-variables. Three categories of investment - domestic, intra-regional and foreign direct investment - are used in this section. We will study how these three types of investment play an important role in the regional integration process of any region. Additionally, the same section maintains that the privatization process (public goods) needs to be considered in the analysis of regional integration process to facilitate the mobility of capital at regional and international level. The interest rate, exchange rate stability and stock market activity can show the level of banking and stock market development in the region, and the possibility of joining the financial regional system.

Infrastructure

The infrastructure is formed by six sub-variables; this section will show the level of coordinate infrastructure under the regional level, and how it can facilitate the mobility of labor and goods (transport system, intra-regional coordinate projects and tourism), communication services (telecommunications) and energy (electricity production).

Government

The government section has seven sub-variables. The inclusion of this section into the analysis of regional economic development is in order to study the tax income distribution (taxation), domestic debt and foreign debt of each member in the same region. Centred on the same issue, it is possible to observe the level of government income and spending (e.g. government expenditures and planning economy sub-variables) of the different governments in the same region. We assume that the good performance of governments can help the standardization and management of public finances (income and expenditure). Additionally, corruption levels are included in this study to help determine how corruption can affect the regional integration process originated by political groups to protect its personal interests.

<u>Regional Technological Development</u>

Regional technological development is formed by ten sub-variables. This section aims to show the level of technological development of each member in the same region. We assume that if the majority of members in the same region have a small gap of technological development between members, this can facilitate the regional integration process. The variables are technology (R&D) level, internet hosts, software production, internet access, telecommunications, research institutes, biotechnology advances, import of new technologies, R&D public investment and IT development.

3.5.1.2. Types of Multi-input Database Tables

The first type of multi-input database table pertains to “country or domestic system development”. It uses “N” number of variables. The number “N” is decided by researchers or policy-makers. The number of cases in the study is represented by “M”. In the case of the GDRI-Model, “M” represents only one country (i.e. a domestic system development). The time factor “T” depends on the time parameters that the researchers or policy-makers are interested in using. Therefore, “T” can be in terms of years or decades. The second type of multi-input database table pertains to “region or regional system development”. All the conditions and functions of “N”, “M” and “T” factors are the same as that in the first type of multi-input database table, except that “M” here represents a “region or regional system development” rather than a “country or domestic system development”. For this chapter, the second type of multi-input database (by region) is adopted.

3.5.2. Phase II: Measurement of Regional Development Indexes (Xi)

The second phase of the implementation of the GDRI-Model involves the measurement of regional development indexes (X_i) using the variables in four basic multi-input database tables (see Diagram 1). The regional development indexes are regional political development index (X_1)[13], regional social development index (X_2)[14], regional economic development index (X_3)[15] and regional technological development index (X_4)[16]. These variables are analyzed with their codes, descriptions, parameters and sources respectively (see Tables 4, 5, 7, 8, 10, 11, 13 and 14).

[13] The measurement of the regional political development index (X_1) originates from the calculus obtained from the politics multi-input database table (see table 3 and 5). After we obtain the result of X_1, we can proceed to classify the results into three different parameters. These parameters are: under-developed stage or level 1 ($0 \leq X_1 \leq 0.33$), X_1 index is developing stage or level 2 ($0.34 \leq X_1 \leq 0.66$) and X_1 index is developed stage or level 3 ($0.67 \leq X_1 \leq 1$).

[14] The measurement of the regional social development index (X_2) originates from the calculus applied in the social multi-input database table (see table 6 and 8). After we obtain the result of X_2, we can proceed to classify the results into three different parameters. These parameters are under-developed stage or level 1 ($0 \leq X_2 \leq 0.33$), X_2 index is developing stage or level 2 ($0.34 \leq X_2 \leq 0.66$) and X_2 index is developed stage or level 3 ($0.67 \leq X_2 \leq 1$).

[15] The measurement of the regional economic development index (X_3) originates from the calculus applied in the economic multi-input database table (see table 9 and 11). After we obtain the result of X_3, we can proceed to classify the results into three different parameters. These parameters are under-developed stage or level 1 ($0 \leq X_3 \leq 0.33$), X_3 index is developing stage or level 2 ($0.34 \leq X_3 \leq 0.66$) and X_3 index is developed stage or level 3 ($0.67 \leq X_3 \leq 1$).

[16] The measurement of the regional technological development index (X_4) originates from the calculus applied in the technological multi-input database table (see table 12 and 14). After we obtain the result of X_4, we can proceed to classify the results into three different parameters. These parameters are under-developed stage or level 1 ($0 \leq X_4 \leq 0.33$), X_4 index is developing stage or level 2 ($0.34 \leq X_4 \leq 0.66$) and X_4 index is developed stage or level 3 ($0.67 \leq X_4 \leq 1$).

TABLE 3

MULTI-INPUT DATABASE TABLE: REGIONAL GLOBAL POLITICAL DEVELOPMENT OF TRADE BLOC "XYZ"

CODE	TRADE BLOC NAME							
	POLITICAL FACTORS LIST	COUNTRY					Result	
	VARIABLES	C1	C2	C3	C4	......CN	AS	TPR
P.1.	**External factors**							
P.1.1.	Colonization (country)	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ1	5
P.1.2.	Group negotiation power	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ2	5
P.1.3.	Domestic foreign policy influences							
P.1.3.1.	Regional	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ4	5
P.1.3.2.	Global	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ5	5
P.1.4.	Negotiation style	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ6	5
P.2.	**Internal factors**							
P.2.1.	International organizations support	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ7	5
P.2.2.	Regional institutions role	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ9	5
P.2.3.	Political regime	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ10	5
P.2.4.	Legislative background	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ11	5
P.2.5.	Internal security	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ12	5
P.2.6.	Human rights	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ13	5
P.2.7.	Border problems	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ14	5
P.2.8.	Political stability	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ15	5
P.2.9.	Political structure and public admini	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ17	5
P.2.10.	Army size	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ19	5
P.2.11.	Bureaucracy level	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ20	5
TOTAL							**ΣAS**	**ΣTPR**
TOTAL (%)							**AP**	**100%**

AS= ACTUAL SITUATION
TPR = TOTAL OF POSSIBLE RESULTS
Xi= GLOBAL DEVELOPMENT

MEASURES:

Σ1……N = The total sum of all country at the same region
ΣAS = Total of actual situation
ΣTPR= Total of possible results
Xi = ΣAS/ΣTPR

TABLE 4
THE GLOBAL REGIONAL POLITICAL DEVELOPMENT PARAMETERS

CODE	POLITICAL FACTORS LIST VARIABLES	PARAMETERS	
P.1.	**External factors**	**Limit**	**Description**
P.1.1.	Colonization (country)	1= Exist or 0= NE	Short colonization period less than 50 years
P.1.2.	Group negotiation power	1 = O or 0 = S	No. of activities per year under regional level
P.1.3.	Foreign policy orientation in each member		
P.1.3.1.	Regional	1 = H or 0 = L	Foreign affairs policy attention focus
P.1.3.2.	Global	1 = H or 0 = L	Foreign affairs policy attention focus
P.1.4.	Negotiation style	1 = F or 0 = I	Procedures of style negotiations
P.2.	**Internal factors**	**Limit**	**Source**
P.2.1.	International organizations support	1 = H or 0 = L	Number of international organizations
P.2.2.	Intra-Regional institutions number	1 = S or 0 = L	Number of institutions and activities
P.2.3.	Political regime	1 = D or 0 = ND	If exist democracy at the last 15 years
P.2.4.	Legislative background	1 = E or 0 = NE	Law system exist
P.2.5.	Internal security	1 = H or 0 = L	Most safe 100 countries around the world
P.2.6.	Human rights	1 = H or 0 = L	Human rights first 150 countries around the world
P.2.7.	Border problems	1 = Ne or 0 = E	Border problems at the last 30 years
P.2.8.	Political stability	1 = H or 0 = L	Exist democratic elections at the last 20 years
P.2.9.	Public administration	1 = F or 0 = U	Based on taxation system structure
P.2.10.	Army size	1= L or H = 0	Less of the 10% of all population in this country
P.2.11.	Bureaucracy level	1 = L or H = 0	Less than 15% of all population is working at the gov.

OR= Old Regionalism
NR= New Regionalism
FTA= Free Trade Area
CU= Custom Union
D= Democratic
ND= Non Democratic
NE= Non Exist
E= Exist
R= Right
L= Left
U= Unitary
F= Federalism
P= Presidential
Par= Parliamentary

Note: */ We are using in all QT measure, the average variation rate by decade
(e.g. Variation rate between 1960's and 1970's to analyzing decade of 1970's)

TABLE 5

THE GLOBAL REGIONAL POLITICAL DEVELOPMENT SOURCES

CODE	POLITICAL FACTORS LIST VARIABLES	Source
P.1.	**External factors**	
P.1.1.	Colonization (country)	The Library of Congress U.S.:www.loc.gov
P.1.2.	Group negotiation power	Regional Integration Institutions by region in analysis
P.1.3.	Foreign policy orientation in each member	
P.1.3.1.	Regional	Ministry of Foreign Affairs by Country
P.1.3.2.	Global	Ministry of Foreign Affairs by Country
P.1.4.	Negotiation style	Regional Integration Institutions by region in analysis
P.2.	**Internal factors**	
P.2.1.	International organizations support	United Nations: www.un.org
P.2.2.	Intra-Regional institutions number	Ministry of Foreign Affairs by Country
P.2.3.	Political regime	Central Government Homepage by country
P.2.4.	Legislative background	Parlament by country
P.2.5.	Internal security	Ministry of Defence and Police Fources by country
P.2.6.	Human rights	Human Rights Watch: www.hrw.org
P.2.7.	Border problems	Haya Court: www.wpc-in.org
P.2.8.	Political stability	Transparency International: www.transparency.org
P.2.9.	Public administration	Transparency International: www.transparency.org
P.2.10.	Army size	NATO: http://www.nato.int
P.2.11.	Bureaucracy level	Transparency International: www.transparency.org

OR= Old Regionalism
NR= New Regionalism
FTA= Free Trade Area
CU= Custom Union
D= Democratic
ND= Non Democratic
NE= Non Exist
E= Exist
R= Right
L= Left
U= Unitary
F= Federalism
P= Presidential
Par= Parliamentary

Note: */ We are using in all QT measure, the average variation rate by decade
(e.g. Variation rate between 1960's and 1970's to analyzing decade of 1970's)

TABLE 6

MULTI-INPUT DATABASE TABLE: REGIONAL SOCIAL DEVELOPMENT OF TRADE BLOC "XYZ"

CODE	SOCIAL FACTORS LIST VARIABLES	TRADE BLOC NAME COUNTRY C1	C2	C3	C4	......CN	RESULT AS	TPR
S.1.	Literacy	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ1	5
S.2.	Social problems (crime & drugs)	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ8	5
S.3.	Health and medical programs	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ9	5
S.4.	External culture influence	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ10	5
S.5.	Food security	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ13	5
S.6.	Public education	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ14	5
S.7.	Low cost housing projects	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ15	5
TOTAL							ΣAS	ΣTPR
TOTAL (%)							AP	100%

AS= ACTUAL SITUATION
TPR = TOTAL OF POSSIBLE RESULTS
Xi= Regional Development Indexes

Σ1 ......N = The total sum of all country at the same region
ΣAS = Total of actual situation
ΣTPR= Total of possible results
Xi = ΣAS/ΣTPR

TABLE 7

THE REGIONAL SOCIAL DEVELOPMENT PARAMETERS

CODE	SOCIAL FACTORS LIST VARIABLES	PARAMETERS LIMIT	Source
S.1.	Literacy	1= high or 0 = low	> 70% of total population has education
S.2.	Social problems (crime & drugs)	1= low or 0= high	Out of the country list with higher crime and drugs
S.3.	Health and medical programs	1= high or 0 = low	> 45% total of population has health care
S.4.	External culture influence	1= exist or 0 = NE	Cable T.V. Access
S.5.	Food security	1= Exist or 0 = NE	Programs in food security
S.6.	Public education	1=high or 0 = low	Number of public schools and universities
S.7.	Low cost housing projects	1=high or 0 = low	Number of low cost housing projects

H= Homogeneous
M=Multicultural
W= West
E= East
I= Individual
C= Collective
M= Modern
T= Traditional
NE= Non exist

Note: */ We are using in all QT measure, the average variation rate by decade
(e.g. Variation rate between 1960's and 1970's to analyzing decade of 1970's)

TABLE 8: REGIONAL SOCIAL DEVELOPMENT SOURCES

CODE	SOCIAL FACTORS LIST VARIABLES	Source
S.1.	Literacy	United Nations: www.un.org
S.2.	Social problems (crime & drugs)	United Nations Office on Drugs and Crime: www.unodc.org/unodc/en/crime
S.3.	Health and medical programs	World Health Organization: www.who.int
S.4.	External culture influence	Cable TV. customers per capita
S.5.	Food security	United Nations World Food Programme: www.wfp.org
S.6.	Public education	United Nations: www.un.org and World Bank: www.wb.org
S.7.	Low cost housing projects	World Bank: www.worldbank.org/poverty/

TABLE 9: MULTI-INPUT DATABASE TABLE: REGIONAL ECONOMIC DEVELOPMENT OF TRADE BLOC "XYZ"

CODE	TRADE BLOC NAME							
	ECONOMICS FACTORS LIST	COUNTRY					RESULT	
	VARIABLES	C1	C2	C3	C4	......CN	AS	TPR
E.1.	**Production**							
E.1.1.	GDP structure by sector							
E.1.1.1.	Agriculture	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ1	5
E.1.1.2.	Industry	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ2	5
E.1.1.3.	Services	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ3	5
E.1.2.	GDP (%)	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ4	5
E.1.3.	Natural resources	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ5	5
E.1.4.	Market location	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ6	5
E.1.5.	Economic development stage	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ7	5
E.1.6.	Subsidies level	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ8	5
E.1.7.	Environmental protection	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ9	5
E.1.8.	Industrial concentration in large cities	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ10	5
E.1.9.	Export structure	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ11	5
E.1.10.	Oil production and energy resources	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ12	5
E.1.11.	Copy right regulations	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ13	5
E.2.	**Consumption**							
E.2.1.	Income Per-capita	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ14	5
E.2.2.	Buyer purchase	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ15	5
E.2.3.	Market size	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ16	5
E.2.4.	Poverty level	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ17	5
E.2.5.	Inflation rate	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ18	5
E.2.6.	Wealth distribution	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ19	5
E.2.7.	Saving rate level	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ20	5
E.3.	**Trade**							
E.3.1.	Intra-regional trade volume	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ22	5
E.3.2.	Extra-regional trade volume	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ23	5
E.3.3.	Intra-regional tariff application							
E.3.3.1.	Tariff barriers level	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ24	5
E.3.3.2.	Non tariff barriers level	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ25	5
E.3.4.	Opening Economy to the world	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ26	5
E.3.5.	Monopoly controls	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ27	5
E.4.	**Labor**							
E.4.1.	International social division	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ28	5
E.4.2.	Labor concentration							
E.4.2.1.	Urban	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ29	5
E.4.2.2.	Rural	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ30	5
E.4.3.	Immigration level	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ31	5
E.4.4.	Emigration level	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ32	5
E.4.5.	Population growth	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ33	5
E.4.6.	Labor productivity	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ35	5
E.5.	**Investment**							
E.5.1.	Domestic Direct investment -DDI-	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ36	5
E.5.2.	Intra-regional Direct Invesment -IDI-	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ37	5
E.5.3.	Foreign Direct Investment -FDI-	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ38	5
E.5.4.	Privatization process	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ40	5
E.5.5.	Interest rate	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ41	5
E.5.6.	Exchange rate stability	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ42	5
E.5.7.	Stock market activity	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ43	5

MULTI-INPUT DATABASE TABLE: REGIONAL ECONOMIC DEVELOPMENT OF TRADE BLOC "XYZ"

CODE	TRADE BLOC NAME							
	ECONOMICS FACTORS LIST	COUNTRY					RESULT	
	VARIABLES	C1	C2	C3	C4	……CN	AS	TPR
E.6.	**Infrastructure**							
E.6.1.	Domestic physical infrastructure	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ44	5
E.6.2.	Transportation system	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ45	5
E.6.3.	Intra-regional physical projects	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ46	5
E.6.4.	Tourism facilities	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ47	5
E.6.5.	Telecommunications	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ48	5
E.6.6.	Electricity production	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ49	5
E.7.	**Government**							
E.7.1.	Taxation							
E.7.1.1.	Indirect	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ50	5
E.7.1.2.	Direct	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ51	5
E.7.2.	Domestic debt	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ52	5
E.7.3.	Foreign debt	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ53	5
E.7.4.	Government expenditures							
E.7.4.1.	Operational and administratives	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ54	5
E.7.4.2.	Investment	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ55	5
E.7.5.	Trade promotion expenditures	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ56	5
E.7.6.	Corruption level	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ57	5
E.7.7.	Planning economy (medium run)	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ58	5
E.8.	**International cooperation**							
E.8.1.	Financial	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ59	5
E.8.2.	Technical	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ60	5
TOTAL							ΣAS	ΣTPR
TOTAL (%)							AP	100%

AS= ACTUAL SITUATION

TPR = TOTAL OF POSSIBLE RESULTS

Xi= REGIONAL DEVELOPMENT INDIXES

MEASURES:

Σ1……N = The total sum of all country at the same region

ΣAS = Total of actual situation

ΣTPR= Total of possible results

Xi = ΣAS/ΣTPR

TABLE 10: REGIONAL ECONOMIC DEVELOPMENT PARAMETERS

CODE	ECONOMICS FACTORS LIST VARIABLES	PARAMETERS	
E.1.	**Production**	**Limit**	**Source**
E.1.1.	GDP structure by sector		
E.1.1.1.	Agriculture	1= high or 0= low	Rate variation between two periods
E.1.1.2.	Industry	1= high or 0= low	Rate variation between two periods
E.1.1.3.	Services	1= high or 0= low	Rate variation between two periods
E.1.2.	GDP (%)	1= high or 0= low	GDP real > 2%
E.1.3.	Natural resources	1=high or 0=low	Agriculture line < 50%
E.1.4.	Market location	1=C or 0=Fsr	Gravity model results
E.1.5.	Economic development stage	1=Develped or 0= dev	World Bank Classification based on income
E.1.6.	Subsidies level	1= low or 0=high	Free of subsidies or < 10% of production has subs.
E.1.7.	Environmental protection	1= high or 0= low	Exist a legal framework can protect environmetal
E.1.8.	Industrial concentration in large cities	1=low or 0=high	< 45% of the industry is concetrated at capital city
E.1.9.	Export Gross	1= HAV or 0= LAV	Rate variation between two periods
E.1.10.	Oil production and energy resources	1=high or 0=low	Country can generate 40% of the local energy
E.1.11.	Copyright regulations	1= E or 0= NE	Exist a legal framework can protect copyright issues
E.2.	**Consumption**		
E.2.1.	Income Per-capita	1= high or 0= low	Amount of income > US$ 1,500 per year
E.2.2.	Buyer purchase	1= high or 0= low	Table of buyer purchase by country based on a list
E.2.3.	Market size	1= large or 0= small	> 5 millions Population level
E.2.4.	Poverty level	1= low or 0= high	< 25% in the poverty line
E.2.5.	Inflation rate	1= low or 0= high	rate of inflation < 5% annual
E.2.6.	Wealth distribution	1= low or 0= high	Gini coefficient by country and region
E.2.7.	Saving rate level	1= high or 0= low	Amount of private deposits, variation rate
E.3.	**Trade**		
E.3.1.	Intra-regional trade volume	1= high or 0= low	Variation rate of trade volume (export and import)
E.3.2.	Extra-regional trade volume	1= high or 0= low	Variation rate of trade volume (export and import)
E.3.3.	Intra-regional tariff application		
E.3.3.1.	Tariff barriers level	1= high or 0= low	Percentage of tariiff barriers average variateion rate
E.3.3.2.	Non tariff barriers level	1= high or 0= low	Number of cases apply Non-trade barriers
E.3.4.	Opening Economy to the world	1= high or 0= low	Index of freedom market between the first 50 countries
E.3.5.	Monopoly controls	1= high or 0= low	Index of Anti-trust law report (the first 50 countries)
E.4.	**Labor**		
E.4.1.	International social division	1= high or 0= low	Industrial and Services sector < 60%
E.4.2.	Labor concentration		
E.4.2.1.	Urban	1= high or 0= low	Variation rate of the urban labor concentration
E.4.2.2.	Rural	1= low or 0= high	Variation rate of the rural labor concentration
E.4.3.	Immigration level	1= low or 0= high	Variation rate of the number of Immigrants per year
E.4.4.	Emigration level	1= high or 0= low	Variation rate of number of emigrants per year
E.4.5.	Population growth	1= low or 0= high	Percentage of population growth < 2%
E.4.6.	Labor productivity	1= high or 0= low	Index of productivity first 50 countries arounf the world
E.5.	**Investment**		
E.5.1.	Domestic Direct investment -DDI-	1= high or 0= low	Rate variation between two periods
E.5.2.	Intra-regional Direct Invesment -IDI-	1= high or 0= low	Rate variation between two periods
E.5.3.	Foreign Direct Investment -FDI-	1= high or 0= low	Rate variation between two periods
E.5.4.	Privatization process	1= high or 0= low	Number of privatizations projects
E.5.5.	Interest rate	1= low or 0= high	Rate variation between two periods
E.5.6.	Exchange rate stability	1= high or 0= low	Rate variation between two periods
E.5.7.	Stock market activity	1= high or 0= low	Rate variation between two periods

	REGIONAL GLOBAL ECONOMIC DEVELOPMENT PARAMETERS		
CODE	ECONOMICS FACTORS LIST VARIABLES	PARAMETERS	
E.6.	**Infrastructure**		
E.6.1.	Domestic physical infrastructure	1= high or 0= low	Number of airports, ports, Km.highways and rail
E.6.2.	Transportation system	1=cheap or 0=exp.	Prices level of basic transportation is using into the region
E.6.3.	Intra-regional physical projects	1= high or 0= low	Number of projects under regional level
E.6.4.	Tourism facilities	1= high or 0= low	Number of hotels and travel agencies
E.6.5.	Telecommunications	1= high or 0= low	Number of telecommunications companies
E.6.6.	Electricity production	1= high or 0= low	Variation rate of electricity production per year
E.7.	**Government**		
E.7.1.	Taxation		
E.7.1.1.	Indirect	1= high or 0= low	Rate variation of the total of indirect tax
E.7.1.2.	Direct	1= high or 0= low	Rate variation of the total of direct tax
E.7.2.	Domestic debt	1= high or 0= low	Rate variation between two periods
E.7.3.	Foreign debt	1= high or 0= low	Rate variation between two periods
E.7.4.	Government expenditures		
E.7.4.1.	Operational and administratives	1= high or 0= low	Rate variation between two periods
E.7.4.2.	Investment	1= high or 0= low	Rate variation between two periods
E.7.5.	Trade&Tourism promotion expenditures	1= high or 0= low	Gov. expenditures variation rate
E.7.6.	Corruption level	1= high or 0= low	Outside from the first 50 countries with higher corruption
E.7.7.	Planning ecomomy (medium run)	1= high or 0= low	Number of macro-prejects in the medium run
E.8.	**International cooperation**		
E.8.1.	Financial	1= high or 0= low	Rate variation between two periods
E.8.2.	Technical	1= high or 0= low	Number of trainig programs

QL = Qualitative Variable
QT = Quantitative Variable
%= Percentage
S= Strategic
NS= Non Strategic
Dd= Developed Country
Ding= Developing Country
LDC= Less Developed Country
E= Exist
NE= Non exist

Note: */ We are using in all QT measure, the average variation rate by decade
(e.g. Variation rate between 1960's and 1970's to analizing decade of 1970's)

TABLE 11: REGIONALECONOMIC DEVELOPMENT SOURCES

CODE	ECONOMICS FACTORS LIST VARIABLES	Source
E.1.	**Production**	
E.1.1.	GDP structure by sector	
E.1.1.1.	Agriculture	World Bank: www.worldbank.org/data/
E.1.1.2.	Industry	World Bank: www.worldbank.org/data/
E.1.1.3.	Services	World Bank: www.worldbank.org/data/
E.1.2.	GDP (%)	World Bank: www.worldbank.org/data/
E.1.3.	Natural resources	Ministry of Trade and Industry by Country
E.1.4.	Market location	Department of Statistics in each Country
E.1.5.	Economic development stage	World Bank: www.worldbank.org/data/
E.1.6.	Subsidies level	World Trade Organization: www.wto.org
E.1.7.	Environmental protection	Green Peace Organization: www.greenpeace.org
E.1.8.	Industrial concentration in large cities	Ministry of Trade and Industry by Country
E.1.9.	Export Gross	World Bank: www.worldbank.org/data/
E.1.10.	Oil production and energy resources	Oil Producers Organization (OPEC): www.opec.org
E.1.11.	Copyright regulations	International Federation of Reproduction Rights Organizations: www.ifrro.org
E.2.	**Consumption**	
E.2.1.	Income Per-capita	World Bank: www.worldbank.org/data/
E.2.2.	Buyer purchase	World Bank: www.worldbank.org/data/
E.2.3.	Market size	Department of Statistics by Country
E.2.4.	Poverty level	World Bank: www.worldbank.org/data/
E.2.5.	Inflation rate	World Bank: www.worldbank.org/data/
E.2.6.	Wealth distribution	World Bank: www.worldbank.org/data/
E.2.7.	Saving rate level	World Bank: www.worldbank.org/data/
E.3.	**Trade**	
E.3.1.	Intra-regional trade volume	World Bank: www.worldbank.org/data/
E.3.2.	Extra-regional trade volume	World Bank: www.worldbank.org/data/
E.3.3.	Intra-regional tariff application	
E.3.3.1.	Tariff barriers level	World Trade Organization: www.wto.org
E.3.3.2.	Non tariff barriers level	World Trade Organization: www.wto.org
E.3.4.	Opening Economy to the world	World Trade Organization: www.wto.org
E.3.5.	Monopoly controls	Ministry of Trade and Industry by Country
E.4.	**Labor**	
E.4.1.	International social division	Department of Statistics in each Country
E.4.2.	Labor concentration	
E.4.2.1.	Urban	Department of Statistics in each Country
E.4.2.2.	Rural	Department of Statistics in each Country
E.4.3.	Immigration level	Ministry of Foreign Affairs by Country
E.4.4.	Emigration level	Ministry of Foreign Affairs by Country
E.4.5.	Population growth	Department of Statistics in each Country
E.4.6.	Labor productivity	Ministry of Industry and Trade by Country
E.5.	**Investment**	
E.5.1.	Domestic Direct investment -DDI-	Central Bank by Country
E.5.2.	Intra-regional Direct Invesment -IDI-	Central Bank by Country
E.5.3.	Foreign Direct Investment -FDI-	Central Bank by Country
E.5.4.	Privatization process	Central Bank by Country
E.5.5.	Interest rate	Central Bank by Country
E.5.6.	Exchange rate stability	Central Bank by Country
E.5.7.	Stock market activity	Central Bank by Country

REGIONAL ECONOMIC DEVELOPMENT SOURCES

CODE	ECONOMICS FACTORS LIST VARIABLES	Source
E.6.	**Infrastructure**	
E.6.1.	Domestic physical infrastructure	Ministry of Communication by country
E.6.2.	Transportation system	Ministry of Communication by country
E.6.3.	Intra-regional physical projects	World Trade Organization: www.wto.org
E.6.4.	Tourism facilities	Tourism Agency by country
E.6.5.	Telecommunications	Tecommunications companies by country
E.6.6.	Electricity production	Electricity Power Companies by country
E.7.	**Government**	
E.7.1.	Taxation	
E.7.1.1.	Indirect	International Monetary Found (IMF): www.imf.org
E.7.1.2.	Direct	International Monetary Found (IMF): www.imf.org
E.7.2.	Domestic debt	International Monetary Found (IMF): www.imf.org
E.7.3.	Foreign debt	International Monetary Found (IMF): www.imf.org
E.7.4.	Government expenditures	Ministry of Finance by country
E.7.4.1.	Operational and administratives	Ministry of Finance by country
E.7.4.2.	Investment	Ministry of Finance by country
E.7.5.	Trade&Tourism promotion expenditures	International Trade Promotion Agencies by Country
E.7.6.	Corruption level	Transperency International: www.transparency.org
E.7.7.	Planning economy (medium run)	Ministry of Planining and Development by Country
E.8.	**International cooperation**	
E.8.1.	Financial	Ministry of Foreign Affairs by Country
E.8.2.	Technical	Ministry of Foreign Affairs by Country

TABLE 12

MULTI-INPUT DATABASE TABLE:REGIONAL TECHNOLOGICAL DEVELOPMENT OF TRADE BLOC "XYZ"

CODE	TRADE BLOC NAME						RESULT	
	TECHNOLOGY FACTORS LIST	COUNTRY						
	VARIABLES	C1	C2	C3	C4	......CN	AS	TPR
T.1.	Technology (R&D) level	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ1	5
T.2.	Internnet hosts	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ2	5
T.3.	Software production	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ3	5
T.4.	Internnet access	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ4	5
T.5.	Telecommunications (mobil phones)	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ5	5
T.6.	Research institutes	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ6	5
T.7.	Biotechnology advances	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ7	5
T.8.	Import of new technologies	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ8	5
T.9.	R&D public investment	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ9	5
T.10.	Technology information development	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ10	5
TOTAL							ΣAS	ΣTPR
TOTAL (%)							AP	100%

AS= ACTUAL SITUATION

TPR = TOTAL OF POSSIBLE RESULTS

Xi= REGIONAL DEVELOPMENT INDEXES

MEASURES:

Σ1……N = The total sum of all country at the same region

ΣAS = Total of actual situation

ΣTPR= Total of possible results

Xi = ΣAS/ΣTPR

TABLE 13

THE TECHNOLOGICAL DEVELOPMENT PARAMETERS

CODE	TECHNOLOGY FACTORS LIST VARIABLES	PARAMETERS	
			DESCRIPTION
T.1.	Technology (R&D) level	1 = High or 0 = low	Number of technological parks and institutes
T.2.	Internnet hosts	1 = High or 0 = low	Number of WEB's
T.3.	Software production	1 = High or 0 = low	Number of software companies
T.4.	Internnet access	1 = High or 0 = low	Internet acces per habitant
T.5.	Telecommunications (mobil phones)	1 = High or 0 = low	Percentage of population using hand phone
T.6.	Research institutes	1 = High or 0 = low	Number of Universities and research inst.
T.7.	Biotechnology advances	1 = High or 0 = low	Number of Universities and research inst.
T.8.	Import of new technologies	1 = High or 0 = low	Percentage of capital goods import
T.9.	R&D public investment	1 = High or 0 = low	Number of Public Universities and Research Inst.
T.10.	Information Technology Development	1 = High or 0 = low	Number of the Home-page Designers Companies

Note: */ We are using in all QT measure, the average variation rate by decade
(e.g. Variation rate between 1960's and 1970's to analizing decade of 1970's)

TABLE 14

THE REGIONAL TECHNOLOGICAL DEVELOPMENT SOURCES

CODE	TECHNOLOGY FACTORS LIST VARIABLES	Source
T.1.	Technology (R&D) level	Technological and Universities by Country
T.2.	Internnet hosts	Internet Suppliers
T.3.	Software production	Companies Homepage
T.4.	Internnet access	Telecoommunications companies by Country
T.5.	Telecommunications (mobil phones)	Telecoommunications companies by Country
T.6.	Research institutes	Universities by Country
T.7.	Biotechnology advances	Biotechnology research centers by Country
T.8.	Import of new technologies	Customs Services Agencies by country
T.9.	R&D public investment	National Budget by Country
T.10.	Technology information development	Home-page Designers Companies

The parameters are divided into two categories. The categories are:

(i) Quantitative variables

(i.a.) The measurement of the regional variation rate (RVR) consists of two phases. The first phase is to measure the variation rate by country (VRC). The VRC is calculated based on two periods: present period data minus last period data. The data of each period can be in percentage or absolute values. In the second phase, the sum of all VRC is divided by the total number of countries in the trade bloc. The end result is the number RVR.

RGR = Σ VRC / total number of countries

RGR = Σ (present period data – last period data) / total number of countries

The RVR can then be compared against each VRC. The final result obtained presents two possible scenarios: first, if RVR ≤ VRC then this specific country in the trade bloc obtains a value of 1; second, if RVR ≥ VRC then this specific country in the regional bloc obtains a value of 0.

(i.b.) the regional average rate (RAR) is obtained by dividing the sum of the local input data of each country in the trade bloc by the total number of countries in the trade bloc.

RAR = Σ local input data / total number of countries

The RAR is a fixed parameter that can be compared against each local input data by country. The final result of the RAR presents two possible scenarios: first, if the RAR ≥ country value, then the final data has the average rate = 0; second, if the RAR ≤ country value, then the final data has the average rate = 1.

(ii) Qualitative variables

(ii.a.) the historical data focalization (HDF) can be classified by existence (i.e. an attempt is made to prove if 1 = existing data or 0 = non-existing data). This type of qualitative variable provides an alternative way to measure non-quantitative variables that affect ranking regional integration process.

(ii.b.) the ranking list (RL) originates from the best results of certain areas (social, economic, political and technological) in some countries. The RL can be found in international organizations such as United Nations, World Bank, International Monetary Fund and etc. The size of the RL is determined by the researcher or policy maker interested in applying the RL.

Once the RL is established, countries in the trade bloc can be compared. The RL can present two possible results: first, if the country in the trade bloc is found in the RL, then this country receives a value of 1; second, if the country in the trade bloc cannot be found in the RL, then this country receives a value of 0.

3.5.2.1. Steps to Obtain Regional Development Indexes (X_i)

There are four regional development indexes (Xi) to be obtained. These four Xi indexes are: regional political development index (X_1), regional social development index (X_2), regional economic development index (X_3) and regional technological development index (X_4). The first step is to define all variables and parameters. Once all the variables and parameters are defined, all the data based on the variables and parameters is listed in each multi-input database table. The next step is to add the values of all variables in the column of the actual situation (AS) in each multi-input database table. The total possible results (TPR) obtained are then located in the TPR column next to AS column. With the TPR in place, the next step is to compute each regional development index (X_i). The computation is done by applying the expression (1) to the values in the multi-input database tables.

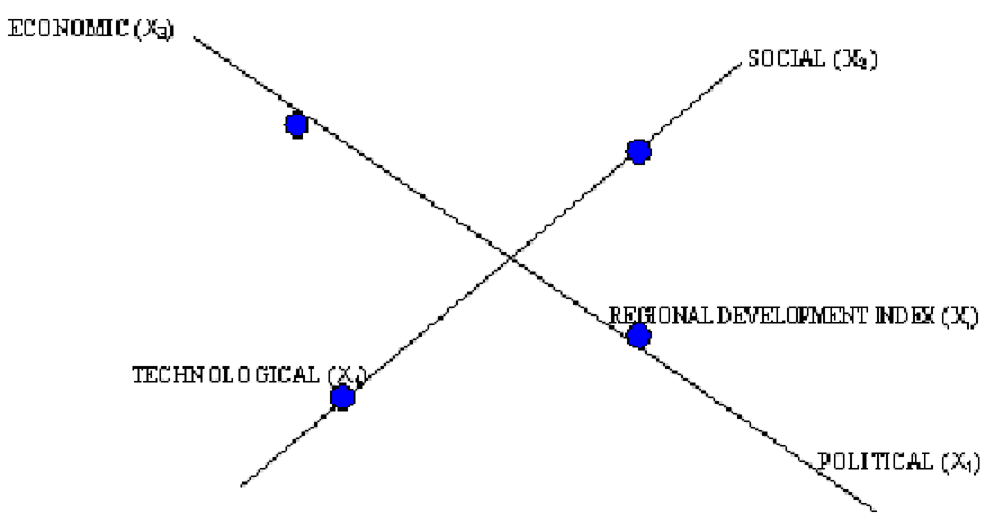
$$(1) \qquad X_i = \sum_{i=1}^{4} X_i = \Sigma AS_i \times 100 / \Sigma TPR_i$$

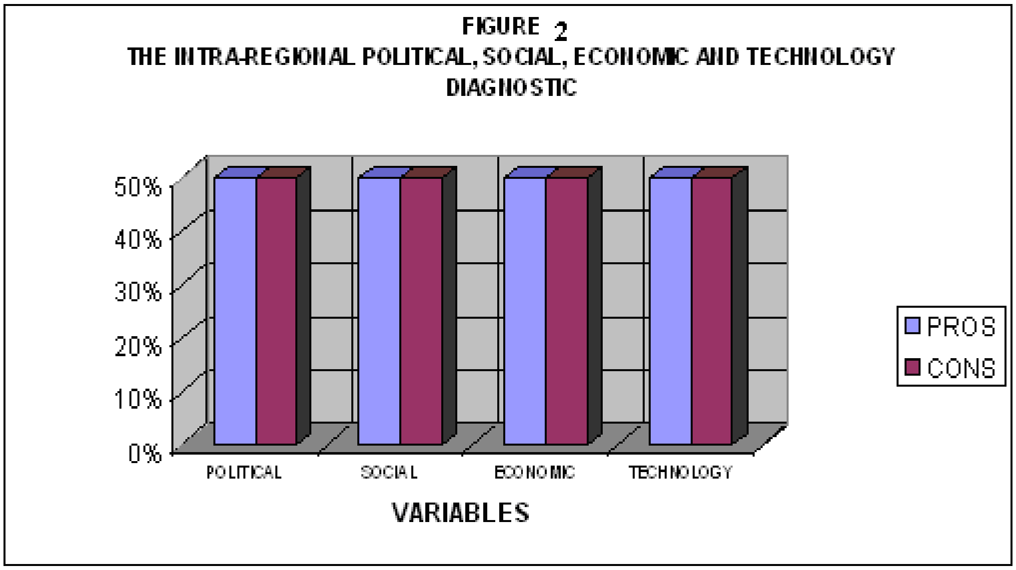
Following the above four steps, the fifth step is the plotting of two graphs: (a) the regional development indexes (X_i) (see Figure 1), and (b) the regional political, social, economic and technological diagnostic (see Figure 2). The latter graph serves as a means to study the balance between achievements and difficulties that any region may experience in its regional integration process (see Figure 2).

3.5.2.2. Introduction to Analysis of the RD Index and the RIS Index

Each of the regional global indexes ($X_{i's}$) plays an important role in the measurement of the regional development (RD) index and the regional integration stage (RIS) index. These two indexes can be affected by any change in the Xi indexes in the short and long term. The Xi indexes may reflect one of two different scenarios. First, if some or all regional development indexes which are political (X_1), social (X_2), economic (X_3) and technological (X_4) increase, then the RD index and the RIS index may increase. The second scenario is that if some or all regional development indexes (X_i) by area of development (political, social, economic and technological) decrease, then the RD index and the RIS index may decrease.

FIGURE 1
THE REGIONAL DEVELOPMENT (Xi) INDEXES DIAGRAM





3.5.3. Phase III: Measurement of the Regional Development (RD) Index

The third phase of the implementation of the GDRI-Model presents a general definition of the regional development indexes (X_i) (see Diagram 1). The RD index is an indicator to compare different historical periods of the regional integration process in any region. It is based on the regional development indexes (X_i) of a region. Therefore, the RD index is a means of analyzing the evolution of any regional integration process from a global perspective.

3.5.3.1. Steps to Obtain the RD Index

The first step is to plot each (X_i) index: regional political development index (X_1), regional social development index (X_2), regional economic development index (X_3) and regional technological development index (X_4) on the Cartesian plane (see Figure 3 and Figure 5). It should be noted that the RD index value (single percentage) is an approximation of the past and present situations that any trade bloc may encounter in its evolution. The RD index is the summation of all the four regional development indexes (X_i). The second step is to plot the RD graph based on the total value of the four regional development indexes (X_i). This is followed by the calculation of the regional technological index (X_4) based on expression (2). It should be noted that the values of the X_i indexes are independent of one another. The RD graph consists of four different areas, where each area has a limit equivalent to 0.25. The total value of these four areas is equal to 1 as observed in the expression (2.6.)

Each axis of Figure 8 and Figure 9 is either the base or the height of the graph (represented by B and H respectively in the graph). The RD_1 uses the result of the global development index in the axis X_1 which is equal to B_1, and the global development index in the axis X_2 which is equal to H_1, followed by the application of (2.1.) The same steps and expression are used for RD_1, RD_2, RD_3 and RD_4 (see Figure 4). The total RD index for this period is the sum of all the RDs. This is depicted in expression (2.5.) The total area is divided into four dissimilar triangles each with an area equal to {Base (=B_i) x Height (=H_i)}/2. Therefore, the triangle areas have to be summed up to derive the total surface area (see expression 2.5.)

$$(2) \qquad \sum_{i=1}^{4} RD_i = \sum_{i=1}^{4} \{Base\ (=X_i) \times Height\ (=H_i)\} / 2$$

2.1.) $[B_1 = H_4]$: $RD_1 = \{X_1(=B_1) \times X2(=H_1)\}/2$
2.2.) $[B_2 = H_1]$: $RD_2 = \{X_2(=B_2) \times X3(=H_2)\}/2$
2.3.) $[B_3 = H_2]$: $RD_3 = \{X_3(=B_3) \times X_4(=H_3)\}/2$
2.4.) $[B_4 = H_3]$: $RD_4 = \{X_4(=B_4) \times X_1(=H_4)\}/2$
2.5.) $RD = RD_1 + RD_2 + RD_3 + RD_4$

B= Base H= Height

The main reason to apply this formula is based on the measurement of the area of the four sided figure on the horizontal plane. Therefore, the value of each area will be used to measure the final result on the origin (Y) or fifth axis. Y is based on the result of the four triangle areas under the horizontal plane.

3.5.3.2. Analysis of the RD Index

The analysis of the RD index is based on the comparison of two periods or regions. In the case of this thesis, two periods (i.e. first period and second period) are compared. The total RD index may present three possible scenarios, namely (a) expansion (RD' first period < RD'' second period), (b) stagnation (RD' first period = RD'' second period) and (c) contraction (RD' first period > RD'' second period).

In terms of time-span, the RD index can be measured and compared on a yearly basis, five-yearly basis, and by decades. For this research, the time-span is divided into four specific decades (the 1960's to the 1990's), which can later be compared. In terms of space, the RD index can be measured and compared in relation to countries or regional blocs. At any historical moment, the regional integration process in any region is based on the comparison of the size of the regional development index (X_i).

FIGURE 3
THE REGIONAL DEVELOPMENT (RD) INDEX

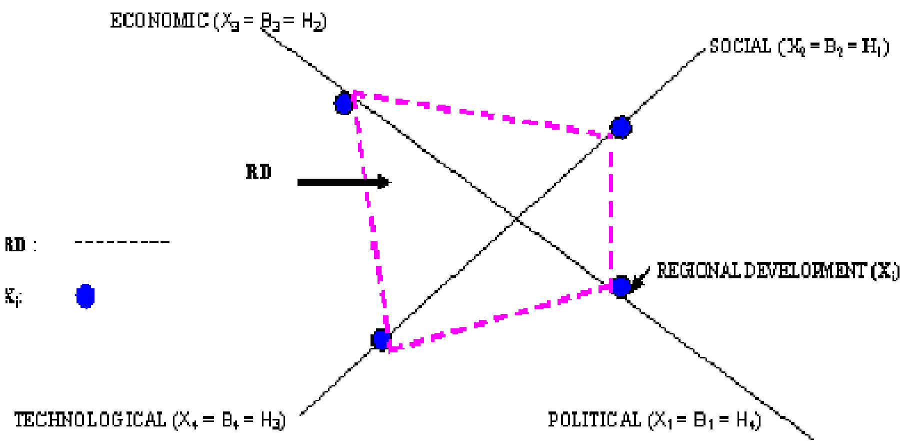
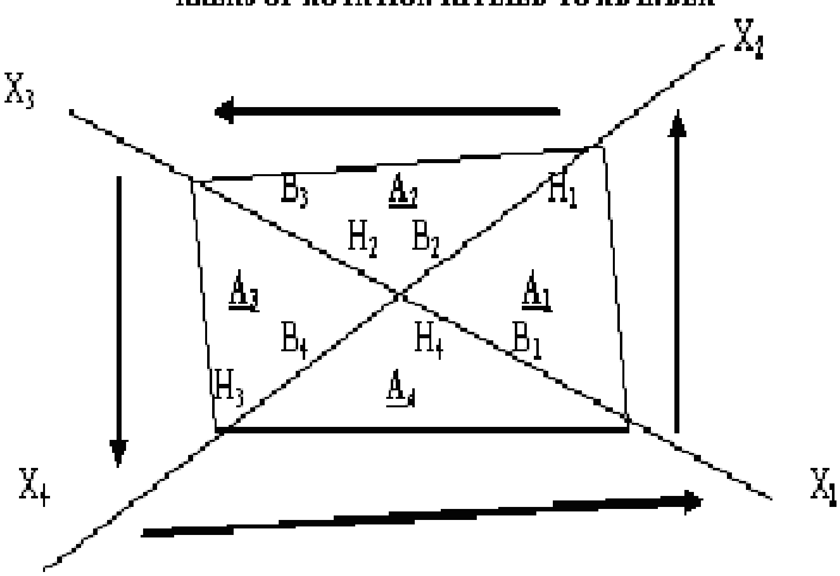
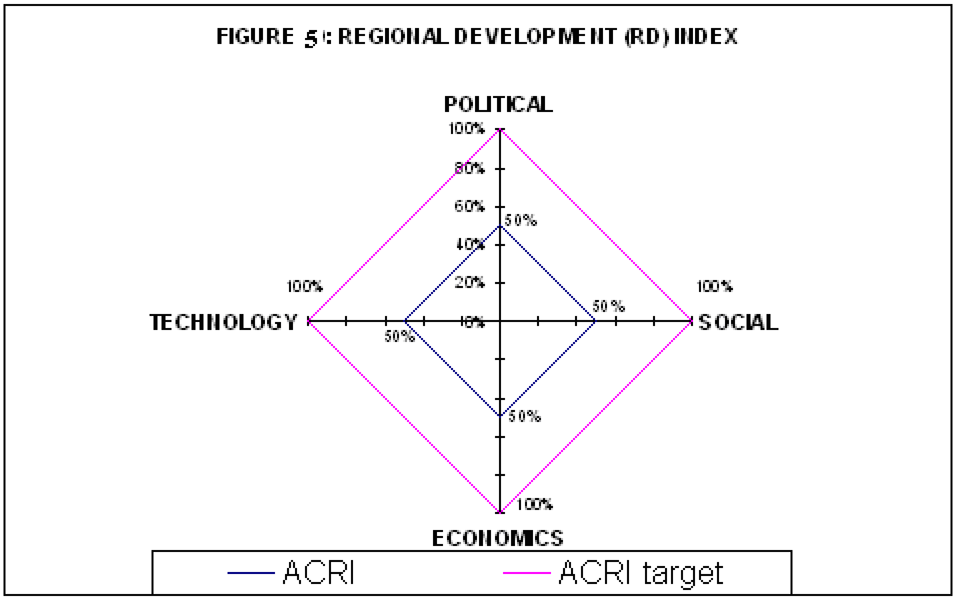


FIGURE 4
AREAS OF ROTATION APPLIED TO RD INDEX





3.5.4. Phase IV: Measurement of the Regional Integration Stage (RIS) Index

The last phase in the implementation of the GDRI-Model is the measurement of the regional integration stage (RIS) index (see Diagram 1). The RIS index measures the degree or stage of the regional integration development that any region achieves in its different stages of evolution. The RIS index is considered a dependent variable in the GDRI-Model.

In the measurement of the RIS index, four regional development indexes (X_i) are used: regional political development index (X_1), regional social development index (X_2), regional economic development index (X_3) and regional technological development index (X_4). A constant coefficient - regional integration approach inclines (RIAI) - is also used concurrently. The RIAI is represented by a, b, c, and d in expression (3) and is applied to each global development index (Xi). Each RIAI (a, b, c, or d) has a limit that is equal to 1 [Refer to expression (3)]. The weighted sum of the RIAI's cannot be more than 1.

The application of the RIAI is twofold. The first application is the RIAI Homogeneous Interest. In this application, each RIAI has the same level of importance in the analysis [Refer to expression (3.1.)]. The second application is the RIAI Incline. There are four possibilities in this application: political approach incline (3.2.), social approach incline (3.3.), economic approach incline (3.4.) and technological approach incline (3.5.)

Analysis of the RIS Index

After the type of RIAI to be applied is determined, the regional integration stage (RIS) index is measured according to expression (3). The RIS index analysis may reveal one of three different scenarios, namely (a) under-developed stage ($0 \leq RIS \leq 0.33$), (b) developing stage ($0.34 \leq RIS \leq 0.66$) and (c) developed stage ($0.67 \leq RIS \leq 1$). The analysis of the RIS index can provide a general idea or approximation of the stage of regional integration achieved in any region through time and space. The following is a suggested combination of the application of the RIAI in the measurement of the RIS index:

$$(3.) \quad Y = RIS = aX_1 + bX_2 + cX_3 + dX_4 \leq 1$$

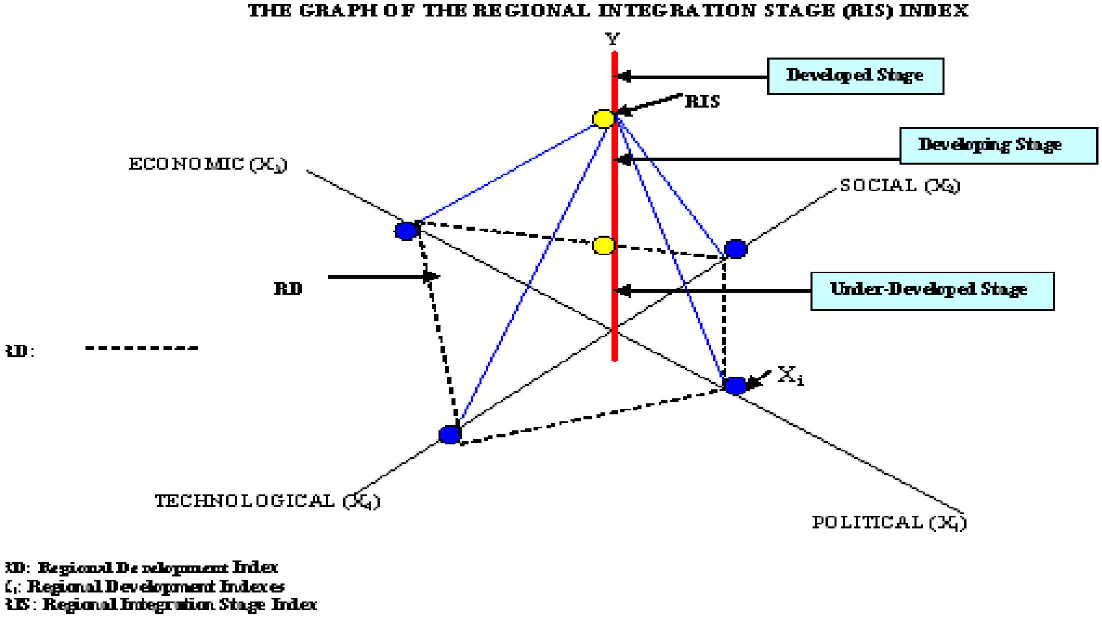
(3.1.) a = 0.25, b = 0.25, c = 0.25, d = 0.25 = 1 => RIAI homogeneous interest
(3.2.) a = 0.40, b = 0.20, c= 0.20, d = 0.20 = 1 => RIAI political approach incline
(3.3.) a = 0.20, b = 0.40, c = 0.20, d = 0.20 = 1 => RIAI social approach incline
(3.4.) a = 0.20, b = 0.20, c = 0.40, d = 0.20 = 1 => RIAI economic approach incline
(3.5.) a = 0.20, b = 0.20, c = 0.20, d = 0.40 = 1 => RIAI technological approach incline

It must be highlighted that the above combination represents only several of many possibilities or permutations. This should draw attention to the flexibility of the RIS index in adapting to any situation or chosen policy mode. The RIS index presents an approximation of the global development from the political, social, economic and technological perspectives concurrently based on a new concept of graphic representation. This new concept of graphic representation consists of five axes, each of which has a positive value (in the case of this research, the value in each axis is represented by a percentage). Once the axes of the graph are in place, the next step is to plot the four X_i indexes (political, social, economic, and technological X_i indexes) in four of the axes respectively. These X_i indexes are independent variables. The total value of the four axes is equal to 1 (see Figure 6). The fifth axis, which is represented by Y and positioned in the center of the graph (among the other four axes), represents the dependent variable RIS index. This fifth axis is the convergent point of all the other four axes or more precisely, the four areas - political, social, economic, and technological - of the regional development indexes (X_i). The RIS index (Y) is depicted as follows in expression (4):

$$Y = F(X_1, X_2, X_3, X_4) \leq 1$$

FIGURE 6

THE GRAPH OF THE REGIONAL INTEGRATION STAGE (RIS) INDEX



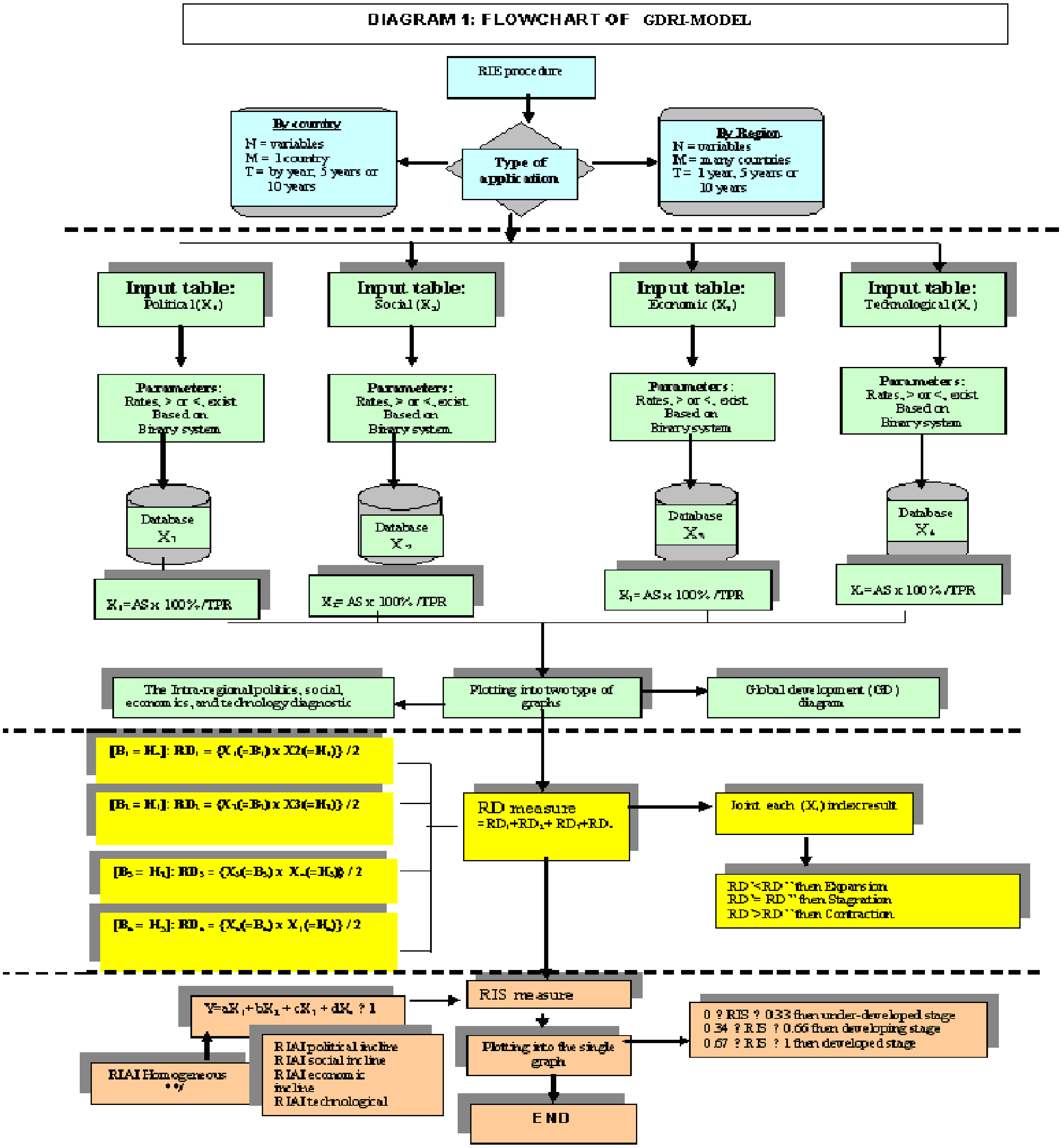


DIAGRAM 1: FLOWCHART OF GDRI-MODEL
RIS procedure
By country
N = variables
M = 1 country
T = by year, 5 years or 10 years
Type of application
By Region
N = variables
M = many countries
T = 1 year, 5 years or 10 years
Input table: Political (X1)
Input table: Social (X2)
Input table: Economic (X3)
Input table: Technological (X4)
Parameters: Rates, > or <, exist Based on Binary system
Database X1
Database X2
Database X3
Database X4
X1=AS x 100%/TPR
X2=AS x 100%/TPR
X3=AS x 100%/TPR
X4=AS x 100%/TPR
The Intra-regional politics, social, economics, and technology diagnostic
Plotting into two type of graphs
Global development (GD) diagram
RD measure
Joint each (Xi) index result
RIS measure
Plotting into the single graph
END

3.6. Application of the GDRI-Model into a Single Trade Bloc:

The GDRI-Model can be also applied to different trade blocs in different regions around the world. The trade blocs under study in this thesis are the European Union (EU), the North American free trade area (NAFTA), the association of Southeast Asian nations (ASEAN-5) and the Market of the South cone (MERCOSUR). The two periods identified in the application of GDRI-Model are the 1980's, 1990's and the period from 2000-2006.

3.6.1. The European Union (EU): Advanced Regional Integration Development

The regional integration of the EU is based on the old regionalism. The custom union scheme in the EU generated the highest level of regional development indexes (Xi) by area (political, social, economic and technological). The result of the regional political development index (X_1) was 0.80 and the regional social development index (X_2) was 0.71 (see Table 15). These two results locate EU in the top position of the regional integration development stage in the world. Meanwhile, the regional economic development index (X_3) and regional technological development index (X_4) were 0.83 and 0.88 respectively (see Table 15). The X_3 and X_4 were located at the developed stage, but not at the same level as the regional political development (X_1) and regional social development (X_2). While the RIS index of the EU in the 1980's was 0.81, the RIS of the same trade bloc in the 1990's was 0.83. The RIS index in the 1990s was located in the developed stage, as shown in Figure 8.

In the 1990's, all regional development indexes (X_i) of EU (politics, social, economic, and technology) present a stronger growth. The regional political development index (X_1) and regional social development index (X_2) present the highest value ever of 0.81 and 0.78 respectively. The RIS index in the 1990's is located in the developed stage of 0.83 (see Figure 8). It is clear that the strong regional development indexes (X_i) in EU are the regional political development index (X_1) and the regional social development index (X_2). The regional economic development index (X_3) and regional technological development index (X_4) present positive advances of 0.85 and 0.89 respectively (see Table 15). The EU scheme proves that if each member in the same region presents strong regional development indexes (X_i) in each area (political, social, economic, and technological), then regionalism can be successful. At the same time, successful regionalism can generate expansion of the regional development indexes (X_i) in each member.

In the period from 2000-2006, the idea came up to incorporate new members into the EU with less regional development (social, political, economic and technological) such as the Republic of Cyprus (2004), the Republic of Estonia (2004), the Republic of Hungary (2004), the Republic of Latvia (2004), the Republic of Lithuania (2004), the Republic of Malta (2004), the Republic of Poland (2004), the Slovak Republic (2004), the Republic of Slovenia, and the Czech republic (2004). This generated a negative impact on the EU Regional Development Stage (RIS) during this specific period. The regional political development index (X_1) was 0.75, the regional economic development index (X_3) was 0.80, regional social development index (X_3) was 0.73 and regional technological development index (X_4) was 0.85. In this period, the new European Union members saw some amount of negative impact in all regional development indexes (Xi) of EU members. Meanwhile, the regional development stage (RIS) index decreased to 0.78 (see Figure 9). However, the RIS index in the 2000-2006 periods was lower than those of the 1990's due to the introduction of new members into the EU.

3.6.2. NAFTA: Constant Regional Integration Development

Unlike the EU, the North America Free Trade Area (NAFTA) applies the Free Trade Areas scheme. The regional development in NAFTA in the 1980's saw a high regional economic development index (X_3). X_3 is located in the developed stage with the value of 0.65 (see Table 15). X_3 of NAFTA is a higher value compared to the rest of the regional development indexes (X_i) of other areas: political, social and technological development indexes (see Figure 7).

The regional technological development index (X_4) was in the development stage of 0.90. The regional political development index (X_1) and regional social development index (X_2) have lower results of 0.65 and 0.48 respectively. While the regional integration stage (RIS) index in NAFTA in the 1980's is 0.69, in the 1990's the RIS index experienced an expansion to the level of 0.80. Meanwhile the regional integration stage (RIS) index in the 1980s and the 1990s are both located in the developed stage with the value of 0.69 and 0.80 respectively (see Figure 8).

In the 1990's, favorable conditions resulting from the improvement of the global development of Mexico made it possible for it to join NAFTA. The regional political development index (X_1) of NAFTA was 0.67 and the regional economic development index (X_3) of NAFTA was 0.82. While X_1 continued in the same stage level (developed stage), the regional social development index (X_2) in the 1990's saw a rise compared to 0.76, but continued to be in the developed stage. The regional technological development index (X_4) also observed an expansion to 0.93 (see Table 15). The improvement of X_i originated mainly from a strong regional economic development (X_3).

The expansion of NAFTA in the period from 2000-2006 is constant. The regional economic development index (X_3) then was 0.70 (see Figure 9). It is now being suggested that much of the growth during this period was actually due to export and, more specifically, to exports that were destined abroad rather than among member countries. There are also favorable terms of trade, especially with respect to Mexico. The regional technological development index (X_4) was recorded as 0.93. It is important to note that, in the period from 2000-2006, Mexico presented a better political situation compared to the 1980's and the 1990's. This improvement was reflected in the regional political development index (X_1) of 0.70. The regional social development index (X_2) was 0.76, which moved within the developed stage or level 3. The regional integration stage (RIS) index being 0.81, the NAFTA was in the developing stage of regional integration (see Figure 9). It can be concluded that in the period 2000-2006 NAFTA witnessed strong trade unification in this stage.

3.6.3. ASEAN: Stagnant Regional Integration Development

The following are the results of the regional development indexes (X_i) by area in the Association of Southeast Asian Nations (ASEAN) in the 1980's (see Figure 7): the regional political development index (X_1) was in the under-developed stage of 0.23; the regional social development index (X_2) was in the developing stage of 0.37; the regional economic development (X_3) was in the developing stage of 0.36 and the regional technological development (X_4) was located in the under-developed stage of 0.22 (see Table 15). The low regional development indexes (X_i) by area in ASEAN originated from the different levels of development in all member countries. There was a large gap in the regional development among most ASEAN members.

However, in the 1990's, the regional political development index (X_1) of ASEAN expanded to 0.33 (see Table 15). X_1 was located in the developing stage. The regional social development index (X_2) maintained a high rate of 0.46. X_2 is in the developing stage. It is important to note that in the 1990s, the financial crisis of 1997 affected several ASEAN members, especially Indonesia, Thailand and Malaysia. In fact, the financial crisis in these three countries affected the regional economic development index (X_3) of ASEAN in the 1990's, as it was located in the developing stage of 0.41 (see Table 15).

The regional technological development index (X_4) also received a negative impact, with the value of 0.51. It was in the developing stage. The RIS index in the 1980's was located in the under-developed stage with 0.30, but with the value of 0.43 in the 1990's. It continues to be in the developing stage (see Figure 7). From the above, it can be observed that the major factor that contributed to the small improvement of the regional development index (X_i) of ASEAN is the small improvement of the regional political development (X_1).

The ASEAN regional integration process continued to decline in the period from 2000-2006. The average growth rates relative to those achieved in the previous decade declined. The regional economic development index (X_3) of the ASEAN then fell to 0.32. The root of the problem was that ASEAN depended mainly on weak integration models. The regional technological development index (X_4) was then 0.52. Consequently, ASEAN saw a drastic shift in the terms of trade among its members. It generated high levels of inflation and negative payoff trade with the rest of the world, especially from the Philippines, Indonesia and Thailand. Consequently, the interregional system of payments of the region is weak and a foreign exchange vulnerable in these three countries.

There was growing disillusionment among ASEAN members. The constant competition to attract foreign direct investment (FDI) among ASEAN members produced a large obstacle in the regional integration process of ASEAN. Several social problems also started to surface in some ASEAN members in the case of the South Part of Thailand (army forces and Islamic radical groups) during this period. This situation was reflected in the regional political development index (X_2) of 0.32. It was also from 2000-2006 that several political problems in Thailand arose against the former prime minister of Thailand Mr. Thaksin Shinawatra. As a result, the regional political development index (X_1) decreased to 0.32 (see Table 15). Natural disasters were another negative contributory factor to the regional integration process of ASEAN members. Indonesia, Thailand and Malaysia were hit by a massive tsunami in 2004. This tsunami generated a higher social and economic cost for these three countries from 2004-2005. During this period, all regional development indexes (X_i) for ASEAN members were located in the developing stage or level 1 and 2. The regional integration stage (RIS) index was 0.41 compared to 0.44 in the 1990's. Obviously, there was a small contraction in the regional integration process of ASEAN members from 2000-2006 (see Figure 9).

3.6.4. MERCOSUR: Fast Regional Integration Development

The market of the South Cone (MERCOSUR) followed the NAFTA regional integration scheme (new regionalism). The RIS of MERCOSUR in the 1980's was 0.26, but in the 1990's the RIS expanded to 0.46. The regional global development indexes (X_i) by area of MERCOSUR in the 1980's exhibited these results: the regional political development index (X_1) was in the under-developed stage of 0.11; the regional social development index (X_2) was in the developing stage with a value of 0.36; the regional economic development index (X_3) was located in the under-developed stage of 0.32 and the regional technological development index (X_4) was in the under-developed stage with the value of 0.23 (see Table 15). It can be observed that X_1 in the 1980's was weak and non-stable. The lower value of X_1 in the 1980's originated from military governments led by dictators and copula military groups.

In the 1990's, the RIS reached 0.46. This is an expansion compared to the RIS of the 1980's. The regional integration stage (RIS) attained the value of 0.46 (see Figure 7 and 8). Thereafter, the RIS in the 1990's was located in the developing stage. The better result of the RIS in the 1990's originated from the improved regional political development index (X_1) of 0.44, which is located in the developing stage. However, the regional social development index (X_2) was in the developing stage with a value of 0.46. The regional economic development index (X_3) moved to the developing stage of 0.41. Meanwhile, the regional technological development index (X_4) was in the developing stage with a value of 0.51 (see Table 15).

Two basic factors that led to the formation of MERCOSUR are: (i) better conditions in external debt and a stable exchange rate in Argentina in the 1990's, and (ii) the strengthening of democracy in the 1990's (democracy is a decisive factor that consolidated the formation of MERCOSUR). Two main reasons for the improvement of the regional economic development index (X_3) among MERCOSUR members in the 1990's were the privatization of public enterprises coupled with the attraction and greater dynamism of foreign direct investment (FDI). Member countries of MERCOSUR encouraged the transfer of technology which then produced a greater dynamism in their market. Transfer of technology also permitted a higher competitiveness and greater productivity among MERCOSUR members. MERCOSUR can be considered the leader of the regional integration process of Latin America. It can be concluded that MERCOSUR has higher regional development indexes (X_i) value compared to the rest of the trade blocs in Latin America (e.g. CACM and AC), especially in the regional political development index (X_1) and regional economic development index (X_3).

The regional integration process of MERCOSUR from 2000-2006 has an RIS index result of 0.51 (see Figure 9). The Xi indexes by area in the period 2000-2006 are as follows: the regional political development index (X_1) in the developing stage with the value of 0.52; the regional social development index (X_2) in the developing stage of 0.50; the regional economic development index (X_3) in the developing stage of 0.48 and the regional technological development index (X_4) in the developing stage of 0.55 (see Table 15). The origin of these better results, especially in the regional economic development (X_3) was high inter-trade exchange, stable exchange rates and improvement of external debts in the major part of MERCOSUR members. The strong trade and investment relationship between Argentina and Brazil was based on a free trade regional agreement that was oriented to the intra-regional trade development adopted by MERCOSUR in the 1990's. The MERCOSUR regional integration scheme is generating positive results among MERCOSUR member countries.

TABLE 15:
Regional Political, Social, Economic and Technological Development
&
Regional Integration Stage (RIS)

	RPD		RSD		RED		RTD		RIS
NAFTA									
1980	0.65	16.25	0.48	12	0.74	18.5	0.90	22.5	69
1990	0.67	16.75	0.76	19	0.82	20.5	0.93	23.25	80
2000-2006	0.70	17.5	0.76	19	0.85	21.25	0.93	23.25	81
MERCOSUR									
1980	0.11	2.75	0.36	9	0.32	8	0.23	5.75	26
1990	0.44	11	0.46	11.5	0.41	10.25	0.51	12.75	46
2000-2006	0.52	13	0.50	12.5	0.48	12	0.55	13.75	51
EUROPEAN UNION									
1980	0.80	20	0.71	17.75	0.83	20.75	0.88	22	81
1990	0.81	20.25	0.78	19.5	0.85	21.25	0.89	22.25	83
2000-2006	0.75	18.75	0.73	18.25	0.80	20	0.85	21.25	78
ASEAN									
1980	0.23	5.75	0.37	9.25	0.36	9	0.22	5.5	30
1990	0.33	8.25	0.46	11.5	0.41	10.25	0.51	12.75	43
2000-2006	0.32	8	0.40	10	0.41	10.25	0.52	13	41

Figure 7: Regional Integration Stage (RIS) in Different Trade Blocs in the 1980s

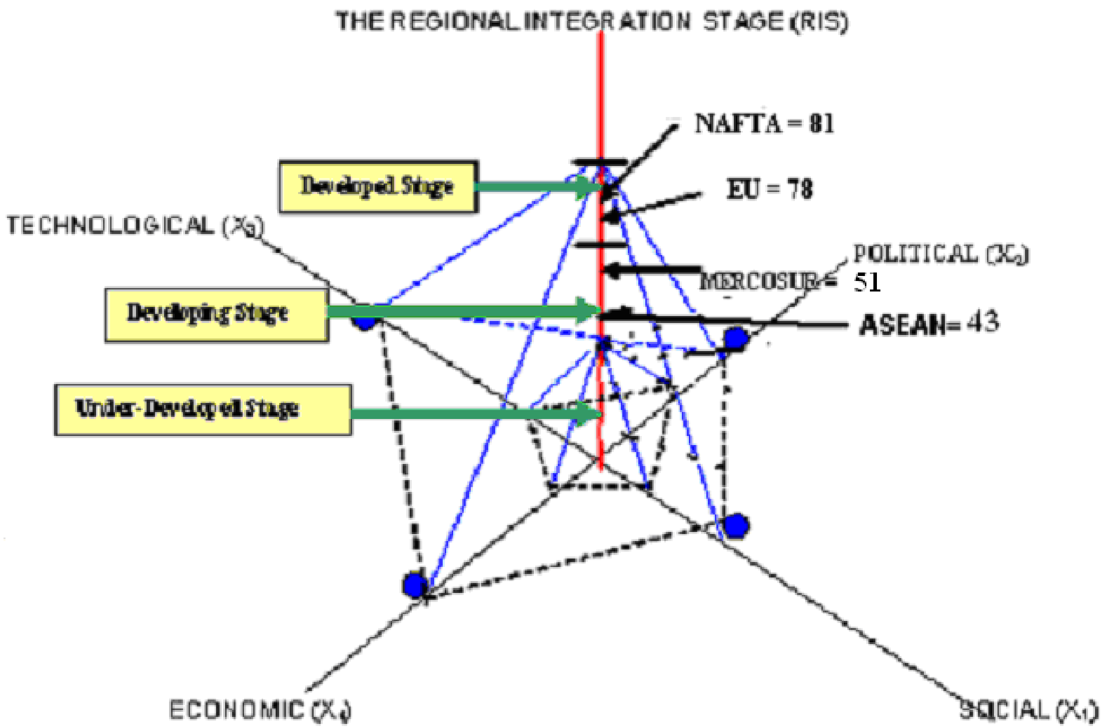


Figure 8: Regional Integration Stage (RIS) in Different Trade Blocs in the 1990s

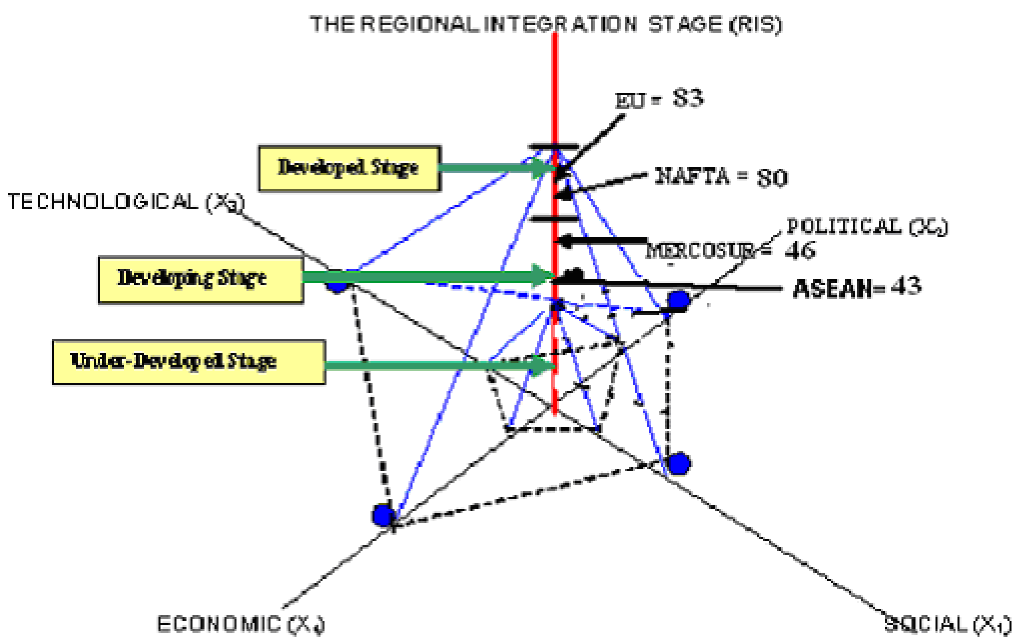
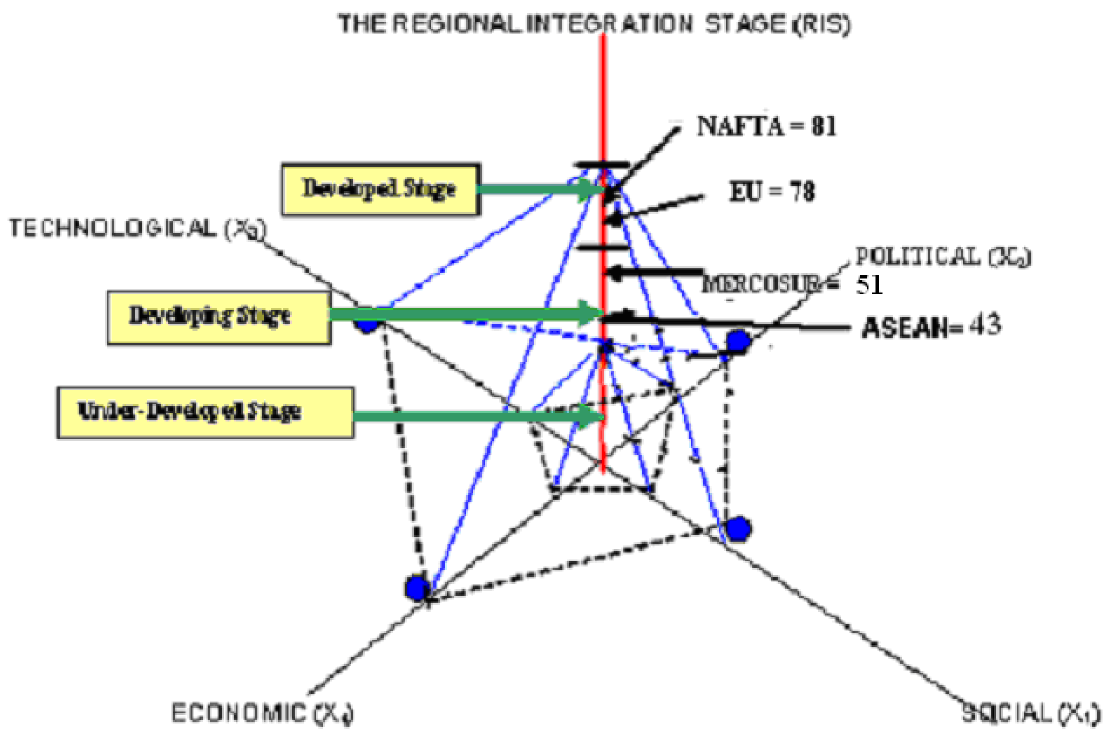


Figure 9: Regional Integration Stage (RIS) in Different Trade Blocs from 2000-2006



3.7. Concluding Remarks

Regional Integration can be given a new definition. It can be defined as a process that combines different domestic development systems (DDS) (countries) into a single regional development system (trade bloc). Strong regionalism, whether old regionalism or new regionalism, depends on the favorable conditions derived from regional development (RD), where RD is the combined result of all or most individual domestic development systems in the same trade bloc. Meanwhile, growth of RD in a trade bloc can be generated through strong domestic development systems (DDS) in the same region. If the domestic development systems (DDS) in some or most member countries in the trade bloc are weak, then the trade bloc cannot be successful.

This chapter maintains that there is a strong inter-dependency between regional global development (RGD) and domestic development systems (DDS). This can be observed from the application of the RIE-Model (Chapter 3) to different trade blocs (i.e. European Union [EU], North America free trade area [NAFTA], association of Southeast Asian nations [ASEAN] and MERCOSUR).

CHAPTER 4

THE TRADE LIBERALIZATION MONITORING MODEL (TLM-MODEL): THEORETICAL FRAMEWORK

The trade liberalization monitoring model (TLM-Model) is a measuring tool for studying regional integration from a global perspective. The proposed trade liberalization monitoring model (TLM-Model) is a simple and flexible model. It applies dynamic and general equilibrium analysis to show the past and present situations in the trade liberalization process of any country based on a set of indexes and figures. Its field application is not constrained by regions or the development stage of each country interested in negotiating a free trade area (FTA). The TLM-Model (Ruiz Estrada, 2004) can be applied to any form of country in its trade liberalization issues, whether it is a developed country (e.g. Japan), a developing country (e.g. Malaysia) or a less developed country (e.g. Cambodia).

The application of the TLM-Model is also based upon the characteristics, conditions and historical moments that any country incorporates in its trade liberalization development. In its application, TLM-Model is like a simulator that allows the application of a series of simulations in different scenarios and in the different phases of the trade liberalization process of any country. This model does not try at any time to be a forecasting model. It is focused upon showing the past and present situations in a free trade area process as a whole. It can help to provide a general idea about the situations and evolution of the trade liberalization process of any country.

4.1. Introduction

We can observe the fast expansion of preferential trade agreements (PTAs) that has taken place throughout the world till today. In the shape of free trade area (FTA), the participant countries agree to eliminate internal tariff barriers but set their external tariff barriers independently (Bhagwati, 1993b). It is important to remember that the customs union (CU) (Viners, 1950) constitutes the other main shape of PTAs. CU differs from FTA essentially because its members have a common external trade policy (Breton, Scott, & Sinclair, 1997).

We consider it necessary to analyze the different evaluation methods and theories applied to the study of free trade areas (FTA's) or customs union (CU) before addressing trade liberalization policies from two different approaches, namely the multilateralism[17] approach and

[17] "Multilateralism is considered a basic principle of globalization (Bhagwati, 1993a). This principle tries to promote the free market through trade and non-trade barriers measures among nations without discrimination or some preferences under the control of the general agreement trade and tariffs (GATT). From 1947 until today, GATT is considered by many experts in the international trade field as an organization that plays the role of mediator and moderator in the international trade legal framework among all members of GATT that have trade differences. The GATT base is supported by the application of the unconditional and voluntary principles of non-discrimination and reciprocity based on the most-favored-nation (MFN) clause. The MFN complies with the *modus operandi* of the GATT, and it is given the basic elements to bilateralism in all GATT negotiations among its members. Usually, when we refer to GATT, some confusion may arise especially when the GATT focus its attention on multilateralism, and we forget that the importance of bilateralism which is a vital complementary part of

the regionalism[18] approach (Baldwin, Cohen, Sapir and Venables, 1999). In this chapter, the regionalism approach is adopted. Moreover, two categories of the regionalism approach are applied. These two categories of regionalism, as suggested by Bhagwati, Krishna and Panagarija (1999) are the old regionalism (i.e. close regionalism) and the new regionalism (i.e. open regionalism).

The old regionalism was used in the 1950's, 1960's and 1970's. It was used constantly and in successive stages. It covered preferential trade arrangements, free trade areas, customs union, common market and economic union. The old regionalism is applied in the development strategy known as Import Substitution Industrialization Strategy (ISI)[19].

The new regionalism, on the other hand, was developed and promoted in the end of the 1980's and 1990's. It is based on trade liberalization or open market. It uses the export-led oriented or outward oriented model strategy. In contrast with the old regionalism, the new regionalism endeavors to eliminate all trade barriers and non-trade barriers in the same region.

Both cases of regionalism revolve around static trade creation and trade diversion effects. This is partly due to the fact that many economists consider these effects to be the fundamental dimension for evaluating regional integration (Devlin and Efrench-Davis, 1998). This chapter, however, is of the view that these models of analysis require considerable transformation for application in the study of trade liberalization issues. The core idea presented here is that the study of trade liberalization should encompass more than one isolated economic or political analysis revolving around one specific problem. The common theories and models used by researchers and specialists in the economic area of research in the study of free trade areas (FTAs) are: effective rate of protection for industry (j); free trade production coefficient (Aij) and the frequency indexes (Fj) covered by NTB's; general equilibrium. Of all these methods of analysis in trade liberalization, the most important is the effective rate of protection. The customs union theory is still used today and continues to be used by many economists to consider static trade creation and trade diversion for evaluating free trade agreements. However, the static analysis used in the customs union theory poses a problem: it frequently uses a partial competitive equilibrium framework to arrive at a general conclusion about a process that is a general equilibrium phenomenon.

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multilateralism. After this clause was implemented, it gave rise to article XXIV. Article XXIV refers to regional agreements based on custom union and free trade areas." (Deardorff and Stern,1994).

[18] Regionalism is defined by many experts as the formation of trade blocs or regional integration agreements (RIA's) based on reduction of tariff measures (import tariff) and non-tariff measures (quotas and quality controls) among its members under the implementation of custom unions and free trade areas among a group of countries in the same geographical area.

[19] ISI applies higher tariffs to protect some specific areas of production based on the infant industry principle.

4.2. Phases of the Trade Liberalization Evaluation Monitoring Model (TLM-Model)

4.2.1. Phase I: Design of the Multi-input Tariff Database Table

The multi-input tariff database table is a new style of analysis framework that permits storage of a large amount of data to measure a single variable. This single variable can show the evolution of any phenomenon from a global perspective. The multi-input tariff database table is designed to evaluate two countries or many countries simultaneously (see Diagram 1 and Table 1). The country multi-input database table pertains to "country". It uses "n" number of variables. The number "n" is decided by the researchers or policy-makers. The number of cases in the study is represented by "m". In the case of the TLM-Model, "m" represents one country. The time factor "t" depends upon the time parameters that the researchers or policy-makers are interested in using. Therefore, "t" can be in terms of years or decades.

4.2.2. Phase II: Measurement of the Trade Liberalization Index by Production Sector (Xi)

The second phase of the implementation of the trade liberalization monitoring model (TLM-Model) involves the measurement of the trade liberalization index by production sector (X_i) using the variables in four basic multi-input tariff database tables (see Diagram 1). The trade liberalization evaluation methodology (TLE-Methodology) indexes are the agriculture trade liberalization index (X_1)[20], the heavy industry trade liberalization index (X_2)[21], the light industry trade liberalization index (X_3)[22] and the services trade liberalization index (X_4)[23]. These variables (tariff and non-tariff barriers) are analyzed with their codes, descriptions and parameters respectively. The parameters are divided into two categories. The categories are: tariff barriers

[20] The measurement of the agriculture trade liberalization index (X_1) originates from the calculus obtained from the agriculture multi-input tariff database table (see Table 1). After we have obtained the result of X_1, we can proceed to classify the results into three different parameters. These parameters are lower trade liberalization or level 1 ($0 \leq X_1 \leq 0.33$), stagnant trade liberalization or level 2 ($0.34 \leq X_1 \leq 0.66$) and higher trade liberalization or level 3 ($0.67 \leq X_1 \leq 1$).

[21] The measurement of the heavy industry trade liberalization index (X_2) originates from the calculus applied in the heavy industry multi-input tariff database Table (see Table 1). After we have obtained the result of X_2, we can proceed to classify the results into three different parameters. These parameters are lower trade liberalization or level 1 ($0 \leq X_2 \leq 0.33$), stagnant trade liberalization or level 2 ($0.34 \leq X_2 \leq 0.66$) and higher trade liberalization or level 3 ($0.67 \leq X_2 \leq 1$).

[22] The measurement of the light industry trade liberalization index (X_3) originates from the calculus applied in the light industry multi-input tariff database Table (see Table 1). After we have obtained the result of X_3, we can proceed to classify the results into three different parameters. These parameters are lower trade liberalization or level 1 ($0 \leq X_3 \leq 0.33$), stagnant trade liberalization or level 2 ($0.34 \leq X_3 \leq 0.66$) and higher trade liberalization or level 3 ($0.67 \leq X_3 \leq 1$).

[23] The measurement of the services trade liberalization index (X_4) originates from the calculus applied in the services multi-input tariff database Table (see Table 1). After we have obtained the result of X_4, we can proceed to classify the results into three different parameters. These parameters are lower trade liberalization or level 1 ($0 \leq X_4 \leq 0.33$), stagnant trade liberalization or level 2 ($0.34 \leq X_4 \leq 0.66$) and higher trade liberalization or level 3 ($0.67 \leq X_4 \leq 1$).

rate based on limits (e.g. we have tariff rate acceptable (TRA)[24] and actual tariff rate (ATR); if ATR is large than TRA, then it is equal to 0, but if ATR is equal or less than TRA, then it is equal to 1) and non-tariff barriers analysis based on the existence or non-existence of non-tariff barriers) (e.g. an attempt is made to prove the following: if the non-tariff barriers exist, then it is equal to 0; if non-tariff barriers do not exist, it is equal to 1.)

[24] Tariff rate acceptable (TRA) is fixed by the researcher, policy maker, or based on parameters of international trade organizations (e.g. World Trade Organization (WTO) or UNCTAD) interested in evaluating the tariff structure of any country or region.

Diagram 1 Flowchart of Trade Liberalization Evaluation (TLE) Methodology

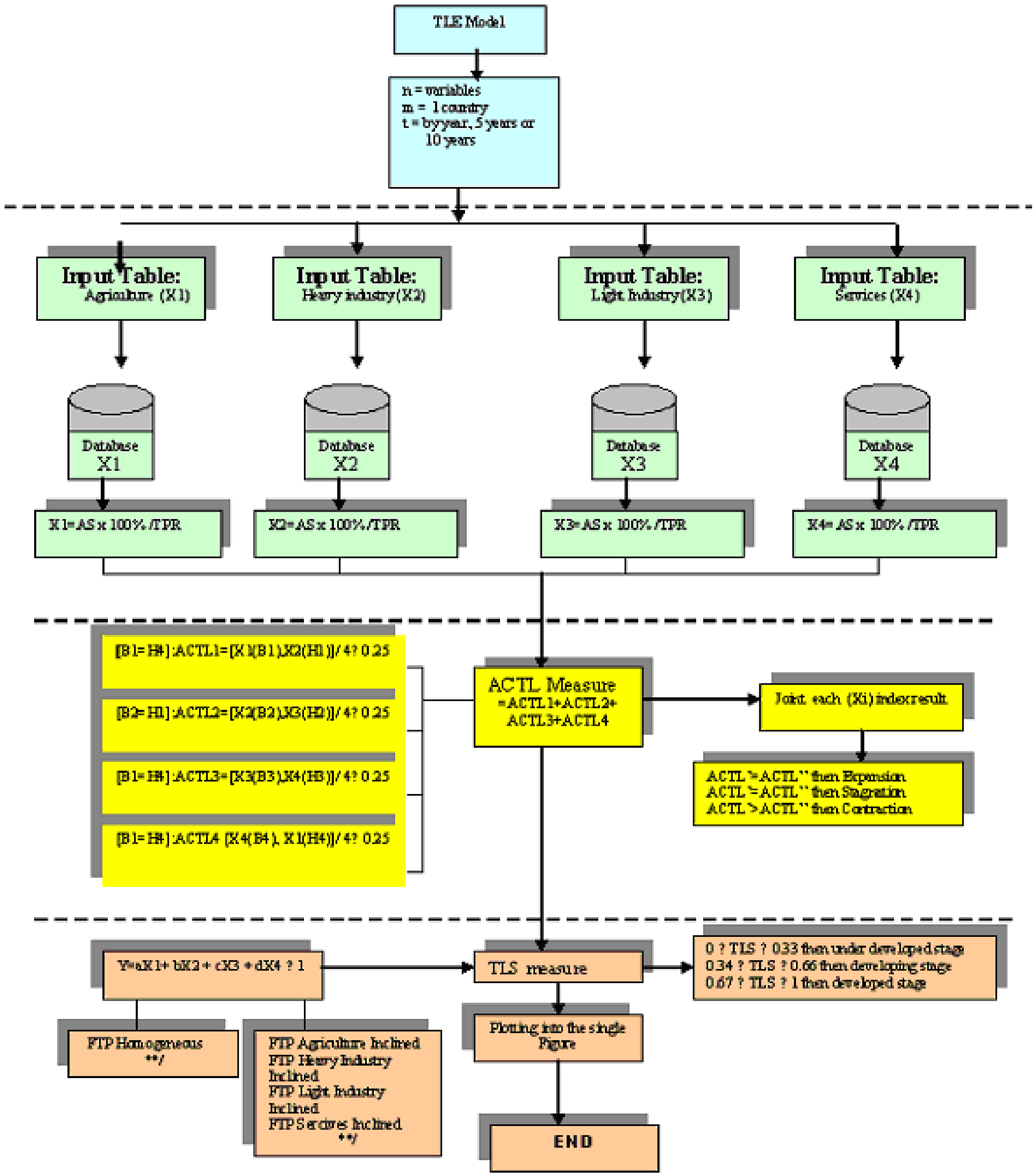


TABLE 1
MULTI-INPUT TARIFF DATABASE TABLE

CODE	TRADE BLOC NAME						ATS	TPR
	TITLED	COUNTRY						
		Y1	Y2	Y3	Y4	......YN		
Tariff Barriers (%)								
Item-1	Titled-1	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ1	T1
Item-2	Titled-2	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ2	T2
Item-3	Titled-3	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ3	T3
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ4	T4
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ5	T5
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ6	T6
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ7	T7
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ8	T8
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ9	T9
Non-tariff Barriers (No. cases)								
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ10	T10
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ11	T11
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ12	T12
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ13	T13
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ14	T14
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ15	T15
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ16	T16
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ17	T17
.	.	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σ18	T18
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
Item-n	Titled-n	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	Σn	Σn
TOTAL							ΣATS	ΣTPR

The number of variables used in the TLM-Model varies, depending on the objectives of the researchers or policy-makers and the research orientation. In the case of the present study, 40 items from the tariff manual of each country under analysis with their respective parameters were selected: 10 items for the agriculture trade liberalization index (X_1); 10 items for the heavy industry trade liberalization index (X_2); 10 items for the light industry trade liberalization index (X_3) and 10 items for the services trade liberalization index (X_4).

Once the number of variables has been determined, the next step is to collect the statistical and historical data that constitutes the variables. Variables in each multi-input tariff database table may not have a direct relationship among themselves; they may be dependent variables or exogenous variables. However, all the variables in each multi-input tariff database table are meant to measure a single general variable, that is, each of the trade liberalization indexes by production sector (X_i).

Each of the four trade liberalization indexes by production sector (X_i) is viewed as a dependent variable (i.e. exogenous variable) for measurement. However, there is no connection or interdependency among these four trade liberalization indexes by production sector (X_i) when they are joined in the figure. These four trade liberalization indexes by production sector (X_i) are used to draw a figure that represents the evolution and stages of the regional integration process of the region from a global perspective. The objective of this study is to apply the TLE-Methodology to the case of trade liberalization trends and stages between developing and developed country.

4.2.2.1. Steps to Obtain Each Trade Liberalization Index by Production Sector (X_i)

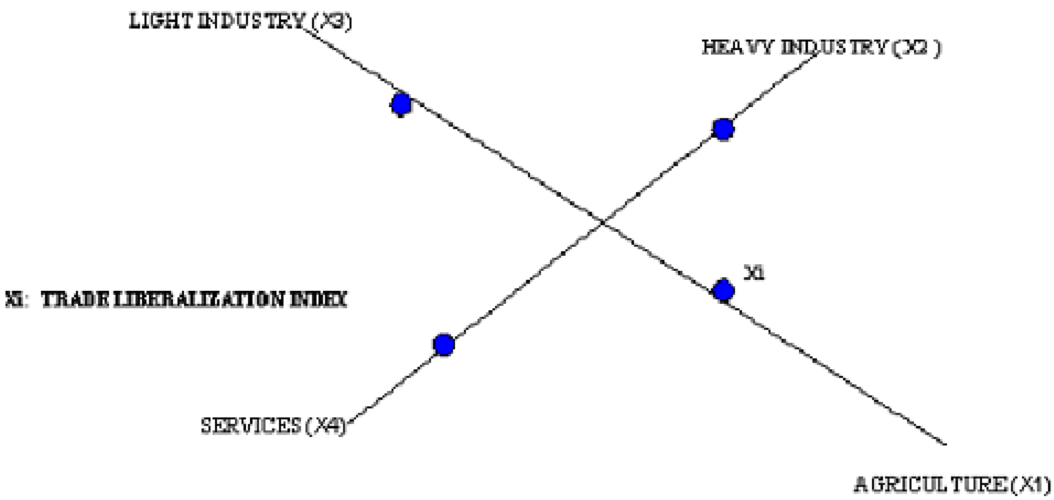
There are four trade liberalization indexes by production sector (X_i) to be obtained. These four trade liberalization indexes by production sector (X_i) are: the agriculture trade liberalization index (X_1), the heavy industry trade liberalization index (X_2), the light industry trade liberalization index (X_3) and the services trade liberalization index (X_4). The first step is to define all variables and parameters. Once all the variables and parameters are defined, all the data based on the variables and parameters are listed in each multi-input tariff database table.

The next step is to add up the values of all variables in the column of the actual situation (AS) in each multi-input tariff database table. The total possible results (TPR) obtained is then located in the TPR column next to the AS column. With the TPR in place, the next step is to compute each trade liberalization index by production sector (X_i). The computation is done by applying expression (1) to the values in the multi-input tariff database tables:

$$\sum_{i=1}^{4} X_i = \Sigma AS_i \times 100 / \Sigma TPR_i \qquad (1)$$

Following the above four steps, the fifth step is the plotting of a figure: (a) the trade liberalization index by production sector (X_i) diagram (see Figure 2).

FIGURE 2:
THE TRADE LIBERALIZATION INDEX BY PRODUCTION SECTOR (Xi) DIAGRAM



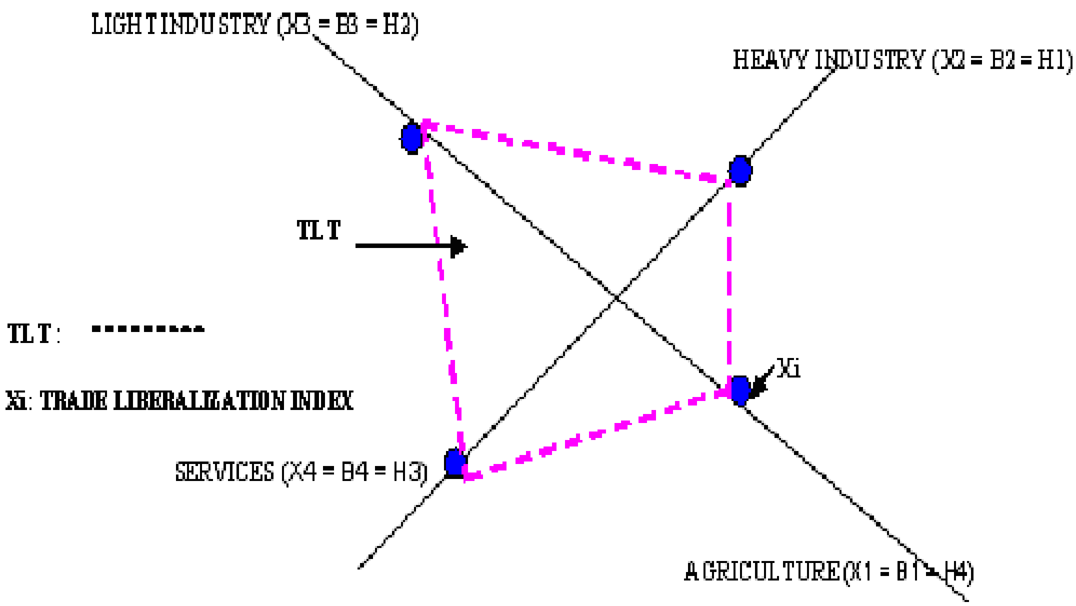
4.2.3. Introduction to Analysis of the TLT Index and the TLS Index Based on the Trade Liberalization Index by Production Sector (Xi)

Each trade liberalization index by production sector (X_i) plays an important role in the measurement of the trade liberalization trend (TLT) index and the trade liberalization stage (TLS) index. These two indexes can be affected by any change in the X_i indexes in the short and long term. The liberalization index by production sector (X_i) may reflect one of two different scenarios. First, if some or all trade liberalization indexes (agriculture, heavy industry, light industry and services) increase, then the TLT index and the TLS index may increase. The second scenario is, if some or all trade liberalization indexes by production sector (agriculture, heavy industry, light industry and services) decrease, then the TLT index and the TLS index may decrease.

4.2.4. Phase III: Measurement of the Trade Liberalization Trend (TLT) Index

The third phase of the implementation of the trade liberalization monitoring model (TLM-Model) presents a general definition of the trade liberalization trend (TLT) index (see Diagram 1). The TLT index is an indicator to compare different trends of the trade liberalization process in any country. It is based on the trade liberalization index by production sector (X_i) of a country. Therefore, the TLT index is a means of analyzing the evolution of any trade liberalization process from a global perspective.

FIGURE 3:
THE TRADE LIBERALIZATION TREND (TLT) FIGURE

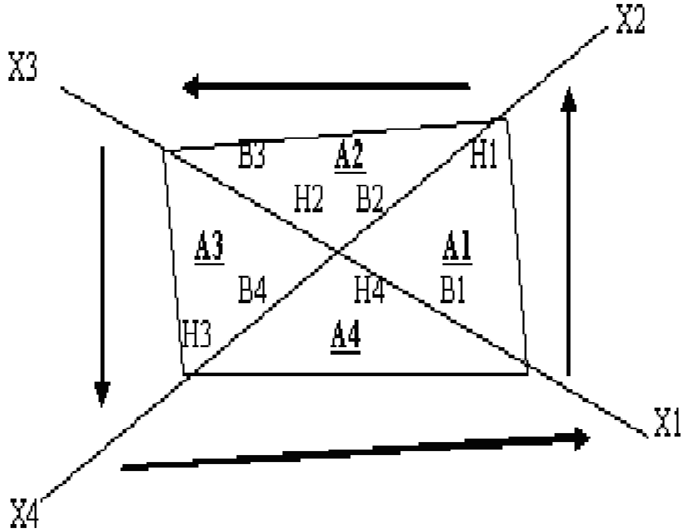


4.2.4.1. Steps to Obtain the TLT Index

The first step is to plot each (Xi) index: the agriculture trade liberalization index (X_1), the heavy industry trade liberalization index (X_2), the light industry trade liberalization index (X_3) and the services trade liberalization index (X_4) on the Cartesian plane (see Figure 3 and 4). It should be noted that the TLT index value (single percentage) is an approximation of the past and present situations that any trade bloc may encounter in the evolution of its trade liberalization. The TLT index is the summation of all the four trade liberalization indexes by production sector (X_i).

The second step is to plot the TLT figure based on the total value of the four trade liberalization indexes by production sector (X_i). This is followed by calculation of the trade liberalization trend (TLT) index based on expression (2). It should be noted that the values of the X_i indexes are independent of one another. The TLT Figure consists of four different areas, where each area has a limit equivalent to 0.25. The total value of these four areas is equal to 1 as observed in the expression (2.6.)

FIGURE 4:
TLT INDEX MEASUREMENT AND AREAS OF ROTATION



Each axis of Figure 2 and Figure 3 is either the base or the height of the figure (represented by B and H respectively in the figure). TLT_1 uses the result of the production sector X_1 which is equal to B_1, and the production sector X_2 which is equal to H1, followed by the application of (2.1.) The same steps and expression are used for TLT_1, TLT_2, TLT_3 and TLT_4 (See Figure 4). The total TLT index for this period is the sum of all the TLT values. This is shown in expression (2.5.)

The total area is divided into four dissimilar triangles each of area equal to {base (=B_i) x height (=H_i)}/2. Therefore, the triangle areas have to be summed up in order to derive the total surface area (see expression 2.5.)

$$(2.1)\qquad \sum_{i=1}^{4} RD_i = \sum_{i=1}^{4} \{Base\ (=X_i) \times Height\ (=H_i)\}/2$$

2.2.) $[B_1 = H_4]$: $RD_1 = \{X_1(=B_1) \times X_2(=H_1)\}/2$
2.3.) $[B_2 = H_1]$: $RD_2 = \{X_2(=B_2) \times X_3(=H_2)\}/2$
2.5.) $[B_3 = H_2]$: $RD_3 = \{X_3(=B_3) \times X_4(=H_3)\}/2$
2.6.) $[B_4 = H_3]$: $RD_4 = \{X_4(=B_4) \times X_1(=H_4)\}/2$
2.7.) $RD = RD_1 + RD_2 + RD_3 + RD_4$

B= Base H= Height

We have applied the same concept as we used in the regional integration evaluation (GDRI-Model) in Chapter 3 to measure the area of the four sides of the figure on the horizontal plane.

4.2.4.2. Analysis of the TLT Index

The analysis of the TLT index is based on the comparison of two periods or countries. In the case of this study, two periods (i.e. first period and second period) are compared. The total TLT index may present three possible scenarios, namely:

(a) The trade liberalization expansion (TLT' first period < TLT'' second period)
(b) The trade liberalization stagnation (TLT' first period = TLT'' second period)
(c) The trade liberalization contraction (TLT' first period > TLT'' second period)

In terms of time-span, the TLT index can be measured and compared on a yearly basis, five-yearly basis, and by decades. For this research, the time-span is one decade (the 1990s), which can later be compared to other decades. In terms of space, the TLT index can be measured and compared in relation to countries or regions. At any historical moment, the regional integration process in any region is based on the comparison of the size of the trade liberalization trend (TLT) index.

4.2.5. Phase IV: Measurement of the Trade Liberalization Stage (TLS) Index

The last phase in the implementation of the trade liberalization evaluation monitoring model (TLM-Model) is the measurement of the trade liberalization stage (TLS) (see Diagram 1). The TLS index measures the degree of the trade liberalization that any country achieves in the different stages of its evolution. The TLS index is considered a dependent variable in the TLE-Methodology. In the measurement of the TLS index, four trade liberalization indexes by production sector (X_i) are used: the agriculture trade liberalization index (X_1), the heavy industry trade liberalization index (X_2), the light industry trade liberalization index (X_3) and the services trade liberalization index (X_4). A constant coefficient, the focal trade policy approach incline (FTP-Approach incline) is also used concurrently. The FTP-Approach incline is represented by a, b, c, and d in expression (3) and is applied to each trade liberalization index by production sector (X_i). Each FTP-Approach incline (a, b, c, or d) has a limit that is equal to 1 [Refer to expression (3)]. The sum of the FTP-Approach incline cannot be more than 1.

The application of the FTP-Approach incline is twofold. The first application is the FTP-Approach incline homogeneous interest. In this application, each FTP-Approach incline has the same level of importance in the analysis [refer to expression (3.1)]. The second application is the FTP-Approach incline. There are four possibilities in this application: the agriculture trade liberalization approach incline (3.2.), the heavy industry liberalization approach incline (3.3.), the light industry trade liberalization approach incline (3.4.) and the services trade liberalization approach incline (3.5.)

4.2.5.1. Analysis of the TLS Index

After the type of FTP-approach incline to be applied is determined, the trade liberalization stage (TLS) index is measured according to expression (3). The TLS index analysis may reveal one of three different scenarios, namely:

(a) The trade liberalization at an under-developed stage or level 1 ($0 \leq TLS \leq 0.33$)
(b) The trade liberalization at a developing stage or level 2 ($0.34 \leq TLS \leq 0.66$)
(c) The trade liberalization at a developed stage or level 3 ($0.67 \leq TLS \leq 1$).

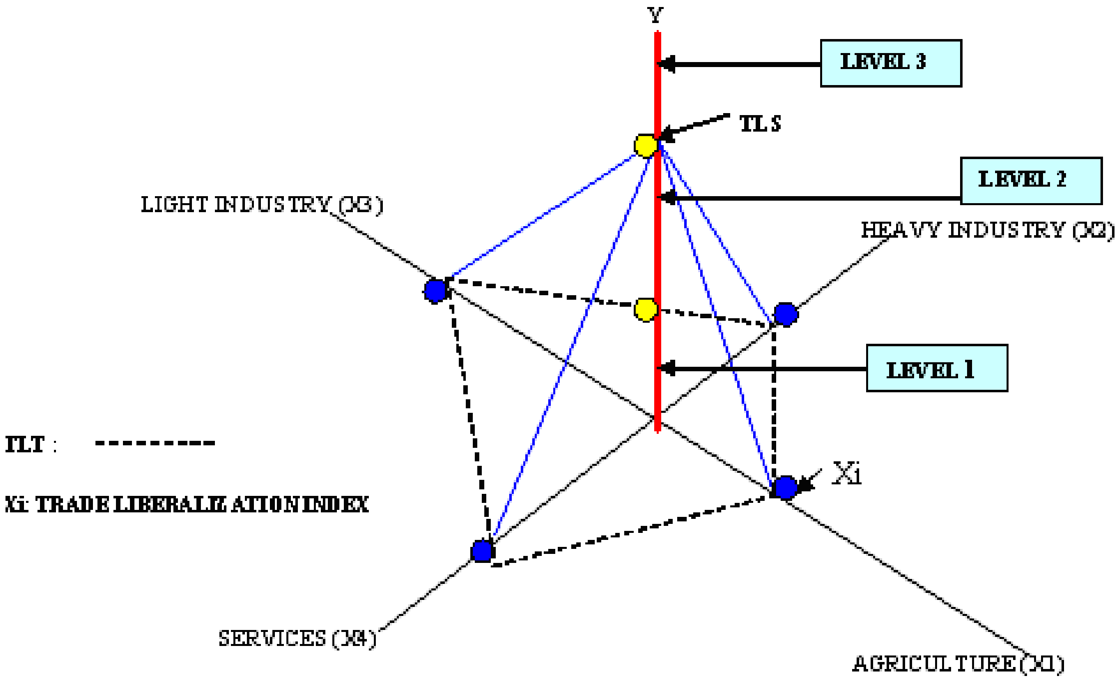
The analysis of the TLS index can provide a general idea or approximation of the stage of regional integration achieved in any region through time and space. The following is a suggested combination of the application of the FTP-approach incline in the measurement of the TLS index:

$$(3.)\quad Y = TLS = aX_1 + bX_2 + cX_3 + dX_4 \leq 1$$

3.1. a = 0.25, b = 0.25, c = 0.25, d = 0.25 = 1 => FTP homogeneous
3.2. a = 0.40, b = 0.20, c= 0.20, d = 0.20 = 1 => FTP agriculture Approach inclined
3.3. a = 0.20, b = 0.40, c = 0.20, d = 0.20 = 1 => FTP Heavy Industry Approach inclined
3.4. a = 0.20, b = 0.20, c = 0.40, d = 0.20 = 1 => FTP Light Industry Approach inclined
3.5. a = 0.20, b = 0.20, c = 0.20, d = 0.40 = 1 => FTP services Approach inclined

It must be highlighted that the above combination represents only several of many possibilities or permutations. This should draw attention to the flexibility of the TLS index in adapting to any situation or chosen policy mode. The TLS index presents an approximation of the development stage of trade liberalization concurrently based on a new concept of graphic representation (see Figure 5). This new concept of graphic representation consists of five axes, each of which has a positive value. In the case of this research, the value in each axis is represented by a percentage.

FIGURE 5:
THE FIGURE OF THE TRADE LIBERALIZATION STAGE (TLS) FIGURE



Once the axes of the figure are in place, the next step is to plot the four X_i indexes (agriculture, heavy industry, light industry, and services X_i indexes) in four of the axes respectively. These X_i indexes are independent variables. The total value of the four axes is equal to 1 (see Figure 5). The fifth axis, which is represented by Y and positioned in the center of the figure (among the other four axes), represents the dependent variable TLS index. This fifth axis is the convergent point of all the other four axes or more precisely, the four areas - agriculture, heavy industry, light industry and services - of the trade liberalization level index (X_i). The TLS index (Y) is depicted as follows in expression (4):

$$\textbf{(4)} \quad \mathbf{Y = F\,(X_1, X_2, X_3, X_4) \leq 1}$$

4.3. Concluding Remarks

This chapter has presented the methodology of the trade liberalization evaluation monitoring model (TLM-Model) as an alternative trade liberalization diagnostic. As such, it enables policy makers and researchers of trade issues to observe and analyze any country's trade liberalization trends and stages from a new perspective. The new series of indexes and graphs that are introduced in the TLM-Model are useful for the study of trade liberalization. This methodology is an effective means of studying the level of trade liberalization that a country or region demonstrates in its trade evolution.

CHAPTER 5

THE MULTI-LEVEL INVESTMENT FLOWS MONITORING MODEL (MIF-MODEL)

5.1. Introduction

For a long time, researchers, academics and policy makers have been using the concept of foreign direct investment (FDI) to explain the mobility of capitals across countries or regions under portfolio and stock market exchanges. According to this research, the FDI displays some limitations when it comes to analyzing investment flow mobility under different levels such as intra-state level, domestic level and intra-regional level. It makes sense to rethink this concept when there is the possibility to propose an additional classification to analyze the mobility of investment flows under a multi-level perspective. Hence, FDI's limitations have given rise to a new proposition: an alternative model called the multi-level investment flows monitoring model (MIF-Model).

5.2. The Multi-level Investment Flows Monitoring Model (MIF-Model)

The MIF-Model suggests that the intra-regional direct investment (IDI) needs to be separated from the foreign direct investment (FDI). The IDI is focused on the analysis of investment flow exchange among all member countries in the same trade bloc. At the same time, the MIF-Model also suggests the analysis of investment flow mobility under the intra-states level by the application of the intra-states direct investment (ISDI), and under the domestic level by the application of the domestic direct investment (DDI). The main objective in using the ISDI, DDI, IDI, TIF and IRP is to monitor different investment flow trends simultaneously. In fact, the past behavior and trend of all these types of investment can be analyzed in greater detail in the short, medium and long term. The new types of investment flow proposed by the MIF-Model are as follows:

a. The Intra-states Direct Investment (ISDI) and the Domestic Direct Investment (DDI)

The first indicator is called the intra-states direct investment (ISDI). It shows the mobility of investment flow among states in the same country. Therefore, the ISDI measurement is based on a large portfolio of investment(s) by local firm(s) in different states in the same country. We assume that the ISDI is the main pillar in building the domestic direct investment (DDI). The DDI is equal to the sum of all ISDI within a fixed period of time (see Expression 1 and Figure 1).

(1.) $$DDI = \sum_{i=1}^{\infty\ldots} ISDI_i$$

In fact, the DDI is defined as the formation of the total domestic capital by local firms in the same country through operation, establishment and expansion of operations in different states in the same country. The DDI is the function of a large number of ISDI (see expression 2 and Figure 1).

(2.) $DDI = f\,(ISDI_1, ISDI_2, \ldots, ISDI_\infty)$

b. The Intra-Regional Direct Investment (IDI)

The intra-regional direct investment or IDI (Ruiz Estrada, 2005) consists of the mobility of investment flow from one country to another country in the same region or geographical space under the implementation of any form of regional integration agreement such as free trade area, custom union, economic union, financial or technical cooperation agreement. Hence, the total IDI is equal to the sum of all IDI among all member countries in the same trade bloc (see Expression 3 and Figure 1). The basic condition for the good performance of IDI is that the DDI from some or all member countries in the same trade bloc are also necessarily strong.

(3.) $$IDI = \sum_{j=1}^{\infty\ldots} IDI_j$$

On the other hand, the IDI is always the function of each IDI member in the same trade bloc (See Expression 4 and Figure 1).

(4.) $$IDI_{member\text{-}i} = f(IDI_{member\text{-}1}, IDI_{member\text{-}2}, \ldots, IDI_{(member\text{-}n)})$$
$$i \text{ and } n = \{1,2,\ldots,n\}$$

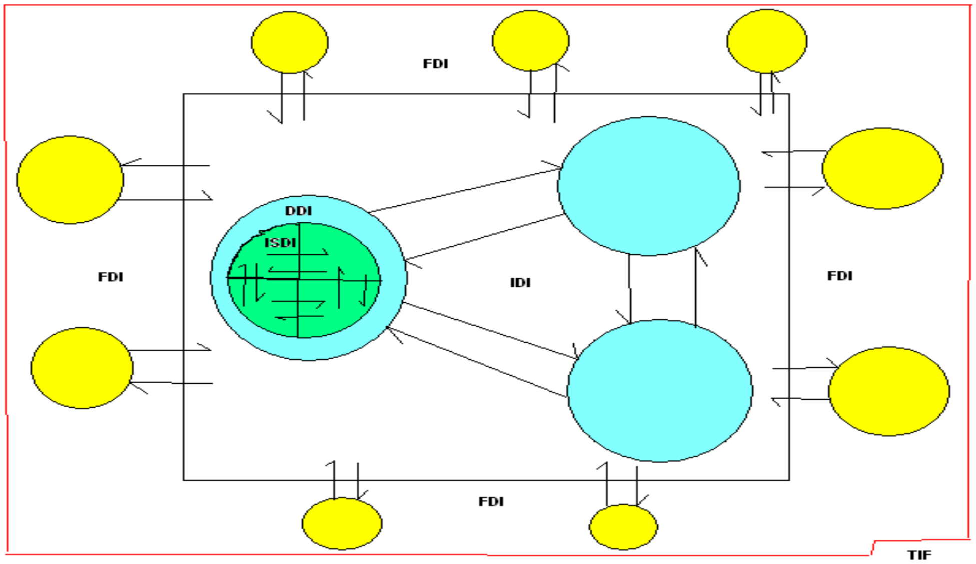
c. The Total Investment Formation (TIF)

The total investment formation (TIF) shows the total investment amount of any country or region. The TIF is equal to the total sum of the intra-states direct investment (ISDI), the domestic direct investment (DDI), the intra-regional direct investment (IDI) and the foreign direct investment (FDI) amounts (see Expression 5 and 6).

(5.) $$TIF = f(ISDI, DDI, IDD, FDI)$$

(6.) $$TIF = \sum_{i=1}^{\infty} DDI_i + \sum_{j=1}^{\infty} IDI_j + \sum_{k=1}^{\infty} FDI_k$$

Figure 1: The ISDI, DDI, IDI and FDI



d. The Investment Reception Performance (IRP)

In the measurement of the IRP based on the TIF, three indicators are used: domestic direct investment (DDI), intra-regional direct investment (IDI) and foreign direct investment (FDI). A constant coefficient – the investment constant growth approach inclines (I_k) - is also used concurrently (Ruiz Estrada, 2004). The I_k is represented by α, β, and λ in expression (7.) and is applied to each type of investment: domestic direct investment (DDI), intra-regional direct investment (IDI) and foreign direct investment (FDI). Each investment constant growth approach inclines I_k (α, β, or λ) has a limit that is equal to 1 [Refer to expression (7.)]. The weighted sum of the IRP cannot be more than 1. The application of the I_k is twofold. The first application is the I_k Homogeneous Interest. In this application, each I_k has the same level of importance in the analysis [Refer to expression (7.1.)]. The second application is the I_k incline. There are three possibilities in this application: the domestic direct investment (DDI) approach incline [refer to expression (7.2.)], the intra-regional direct investment (IDI) approach incline [refer to expression (7.3.)] and the foreign direct investment (FDI) approach incline [refer to expression (7.4.)].

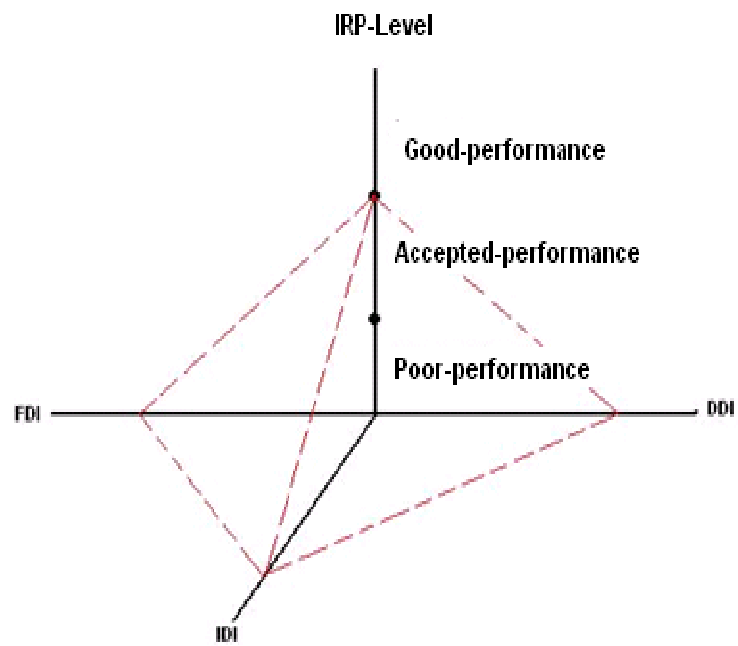
After the type of I_k to be applied has been determined, the IRP is measured according to expression (7). The IRP analysis may reveal one of three different scenarios, namely (a) poor performance investment reception stage ($0 \leq IRP \leq 0.33$), (b) acceptable performance investment reception stage ($0.34 \leq IRP \leq 0.66$) and (c) good performance reception stage ($0.67 \leq IRP \leq 1$) (see Figure 2). The analysis of the IRP can provide a general idea or approximation of the stage of investments reception achieved in any country or region through time and space. The following is a suggested combination of the application of the I_k in the measurement of the IRP:

$$(7.) \quad TIF = \sum_{i=1}^{\infty} DDI_i * \alpha + \sum_{j=1}^{\infty} IDI_j * \beta + \sum_{k=1}^{\infty} FDI_k * \lambda \leq 1$$

(7.1.) $\alpha = 0.33$, $\beta = 0.33$, $\lambda = 0.33 = 1 \Rightarrow I_K$ Homogeneous interest
(7.2.) $\alpha = 0.60$, $\beta = 0.20$, $\lambda = 0.20 = 1 \Rightarrow I_K$ DDI approach incline
(7.3.) $\alpha = 0.20$, $\beta = 0.40$, $\lambda = 0.20 = 1 \Rightarrow I_K$ IDI approach incline
(7.4.) $\alpha = 0.20$, $\beta = 0.20$, $\lambda = 0.40 = 1 \Rightarrow I_K$ FDI approach incline

It must be highlighted that the above combination represents only several of many possibilities or permutations. This should draw attention to the flexibility of the IRP in adapting to any situation or chosen policy mode. The IRP presents an approximation of the investment volumes from the intra-state, domestic, intra-regional and foreign level concurrently based on the application of the pyramid coordinate space. The pyramid coordinate space consists of four axes, each of which has a positive value (in the case of this research, the value in each axis is represented by a percentage). Once the axes of the P-coordinate space are in place, the next step is to plot the four X_i indexes (domestic, intra-regional and foreign level X_i indexes) in three of the axes respectively. These X_i indexes are independent variables. The total value of the three axes is equal to 1 (see Figure 2). The fourth axis, which is represented by Y and positioned in the center of the graph (among the other three axes) represents the dependent variable IRP. This fourth axis is the convergent point of all the other three axes or more precisely, the three areas - domestic, intra-regional and foreign level (X_i). The IRP (Y) is depicted as follows in expression (7).

Figure 2: Investment Reception Performance (IRP)



5.3. Concluding Remarks

The MIF-Model is focused on the monitoring of investment flow under a multi-level perspective. In order to do this, the MIF-Model has adopted new types of indicators: the intra-states direct investment (ISDI), the domestic direct investment (DDI), the intra-regional direct investment (IDI), the total investment formation (TIF) and the investment reception performance (IRP). The MIF-Model gives policy makers and researchers in international trade and macroeconomics issues the opportunity to observe and analyze the trends and stages of investment flow mobility in any country or region from a multi-level analytical perspective.

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CHAPTER 6

THE OPENNESS MONITORING METHODOLOGY (OM-METHODOLOGY)

6.1. Openness or Trade Liberalization Measure Literature Review

Over the past 25 years, many economists have tried to build alternative indicators to measure openness or trade orientation. It is important to mention that these different indicators have had a significant contribution to the study of openness up to now. Usually, a major part of this type of work applies cross-country comparative studies to explain the link between openness and growth, productivity or income distribution. These indicators are trade dependency ratios and rate of growth exports (Balassa, 1985); the heritage foundation index (Edwards, 1998a); Sachs and Warner openness index (1995); Leamer's openness index (Barro,1991); trade liberalization index (Lopez,1990); average coverage of NTB -QR- (Edwards, 1998b); black market premium (Harrison,1996); index of real exchange rate variability and index of real exchange rate distortion (Dollar, 1992).

After discussing these different indices, this research intends to go on to the next step, which is to present a new model for measuring openness entitled "the openness monitoring methodology (OM-Methodology)". The OM-Methodology (Ruiz Estrada and Yap, 2006) will study the link between openness growth and income growth. It incorporates a comparison of two growth rates (openness and income). The OM-Methodology offers to policy makers and researchers a new set of indicators to measure openness vulnerability, harmonization of openness and openness/income sensibility analysis.

Sebastian Edwards presented an interesting chapter entitled "Trade Policy, Growth and Income Distribution." This chapter applied different trade policy indices (e.g. deviation from actual trade Shares; trade liberalization index; Sachs and Warner Openness Index; QR; deviation of the black market rate; black market exchange rate premium and real exchange distortions and variation) and the coefficient of GINI to prove the link between openness and income distribution. Edwards concluded that there is no evidence linking either openness or trade liberalization to increases in inequality. The OM-Methodology concludes that there exists evidence that openness and income have a link but only in the case of the U.S. There are differences between the methodology applied by Sebastian Edwards (1997) and the OM-Methodology. Edwards uses different trade policy indices and income distribution (GINI coefficient) to prove the link between openness and income; on the other hand, the OM-Methodology uses the openness growth rate and income growth rate to prove the relationship between openness and income from a different angle. Our method of analysis will show different and new types of indicators and methodology to analyze openness and income as opposed to the traditional indices in the study of trade policy.

6.2. The Openness Monitoring Methodology (OM-Methodology)

The openness monitoring methodology (OM-Methodology) is a new analytical model for studying the impact of openness growth on the income growth in any country or region. Its application is not constrained with respect to the income level stage of the relevant country or region, regardless of whether it is at a high, middle or low income level. This model applies new types of indicators to show the evolution, sensitivity and harmonization of openness growth, as well as the effect of openness growth on the income growth in any type of country. It is generally a simple and flexible model.

There are two general objectives for the proposal of the openness growth monitoring methodology (OM-Methodology): (i) to quantify and analyze openness growth; (ii) to measure the impact of average openness growth rate ($\Delta\bar{O}$) on income growth rate (ΔY) in a specific period of time (in the short term). The OGM-Model will test-prove the following general hypotheses:

1. High openness growth does not necessarily generate income growth in any country in the short term.
2. The customs union scheme performs better than the free trade area scheme in terms of income growth.

The OM-Methodology is based on a series of steps/elements in its application to study openness growth and income growth:

(i) Degree of openness by production sector (O_i)
(ii) Average openness rate ($\bar{O}$)
(iii) Average openness growth rate ($\Delta\bar{O}$)
(iv) Harmonization of openness growth rate (HO)
(v) Income growth rate (ΔY)
(vi) Openness growth diamond diagram
(vii) The openness diamond graph
(viii) Openness/income growth rate (O:Y) sensitivity analysis (see Diagram 1).

Steps to Apply the OM-Model

Step 1: Measurement of Degree of Openness by Production Sector (O_i)

The degree of openness by production sector (O_i) will present the degree of openness in four different production sectors: agriculture, manufacturing, energy (fuel) and services. This indicator also shows the comparative degree of openness of different production sectors (e.g. more openness in the agriculture sector than the manufacturing sector). The first step in the application of the OM-Methodology is to measure the degree of openness by production sector (O_i) (see Diagram 10). The O_i is equal to the sum of real exports (Xi_{-FOB}) by production sector and the real imports (Mi_{-CIF}) by production sector divided by the real gross domestic product value (GDP_{-real}) (see Expression 1).

(1.) $$\sum_{i=1}^{4} O_i = (Xi_{-FOB} \text{ constant prices by production sector} + Mi_{-CIF} \text{ constant prices by production sector}) / \text{real GDP})$$

Degree of openness in the agriculture sector (O_a)

(1.1) $O_a = (X_{a\text{-real}} + M_{a\text{-real}}) / GDP_{-real}$

Degree of openness in the manufacturing sector (Om)

(1.2) $$O_m = (X_{m\text{-}real} + M_{m\text{-}real}) / GDP_{\text{-}real}$$

Degree of openness in the energy (fuel) sector (O_e)

(1.3) $O_e = (X_{e\text{-}real} + M_{e\text{-}real}) / GDP_{\text{-}real}$

Degree of openness in the services sector (O_s)

(1.4) $O_s = (X_{s\text{-}real} + M_{s\text{-}real}) / GDP_{\text{-}real}$

Analysis of Oi Rate Results

The results of the ΔOi reflect two possible scenarios:
(i) If the ΔOi is positive (+) or high, then the country has an open economy
(ii) If the ΔOi is negative (-) or low, then the country has a closed economy

Step 2: Measurement of Average Openness Rate (Ō)

The Ō is equal to the sum of the degree of openness (∑Oi) of all the production sectors divided by four (i.e. number of production sectors under analysis) (see Expression 3).

(3) $$\bar{O} = \sum(O_a + O_m + O_e + O_s)/4$$

Step 3: Measurement of Openness Growth Rate (ΔŌ)

The ΔŌ is equal to the average openness rate in a given period ($\bar{O}'$) minus the average openness rate of the previous period ($\bar{O}_o$) divided by the average openness rate of the previous period ($\bar{O}_o$) (see Expression 5).

(5.) $$\Delta \bar{A}O = \frac{(\bar{O}') - (\bar{O}_o)}{(\bar{O}_o)}$$

Analysis of ΔŌ Results

(i) If the ΔŌ Rate is high, then the country experiences a strong openness growth
(ii) If the ΔŌ Rate is low, then the country experiences a weak openness growth

Step 4: Measurement of Harmonization of Openness (HO)

HO is equal to the maximum degree of openness by production sector minus the minimum degree of openness by production sector in the same year divided by the average openness (Ō) (see Expression 4). This indicator also shows the trend of the liberalization process of any country from a general perspective. HO is useful in the making of policies that help to improve the harmonization of openness in all production sectors (see Diagram 1).

(4.) $$HO_i = (O_{i\text{-}Max}) - (O_{i\text{-}Min}) / (\bar{O})$$
$$i = 1,2,3,4$$

Analysis of HO Results

(i) If HO is equal to 3, then its openness growth is proportional
Proportional indicates a good openness in all production sectors.
(ii) If HO is equal to 2, then its openness growth is acceptable
Acceptable indicates a good performance, but no harmony to open all sectors in the same level.

(iii) If HO is equal to 1, then its openness growth is non-proportional.
Non-proportional indicates a non-balance in the openness of the different sectors of production.

The analysis of the HO Rate provides a general idea about the orientation of the trade policy in the trade liberalization process of any economy.

Step 5: Measurement of the Income Growth Rate (ΔY)

The ΔY is equal to the *per capita* GNI in a given period ($\Delta Y'$) minus the *per capita* GNI of the previous period (ΔY_o) divided by the *per capita* GNI of the previous period (ΔY_o) (See Expression 5). The *per capita* GNI (Y) income level is based on the World Bank data classification. These are high income[25], middle income[26] and low income[27] under the World Bank classification (2005).

(5.)
$$\Delta Y = \frac{(\Delta Y') - (\Delta Y_o)}{(\Delta Y_o)}$$

Analysis of the ΔY Rate Results

The results of the ΔY can reflect two possible scenarios:

(i) If ▲ΔY, then there is growth in income
(ii) If ▼ΔY, then income level remains unchanged

[25] "High-income country is a country having an annual gross national product (GNP) per capita equivalent to $9,361 or greater in 1998. Most high-income countries have an industrial economy. There are currently about 29 high-income countries in the world with populations of one million people or more. Their combined population is about 0.9 billion, less than one-sixth of the world's population. In 2003, the cutoff for high-income countries was adjusted to $9,206 or more". (citation?)

[26] "Middle-income country is a country having an annual gross national product (GNP) per capita equivalent to more than $760 but less than $9,360 in 1998. The standard of living is higher than in low-income countries, and people have access to more goods and services, but many people still cannot meet their basic needs. In 2003, the cutoff for middle-income countries was adjusted to more than $745, but less than $9,206. At that time, there were about 65 middle-income countries with populations of one million or more. Their combined population was approximately 2.7 billion". (citation?)

[27] "Low-income country is a country having an annual gross national product (GNP) per capita equivalent to $760 or less in 1998. The standard of living is lower in these countries; there are few goods and services; and many people cannot meet their basic needs. In 2003, the cutoff for low-income countries was adjusted to $745 or less. At that time, there were about 61 low-income countries with a combined population of about 2.5 billion people". (citation?)

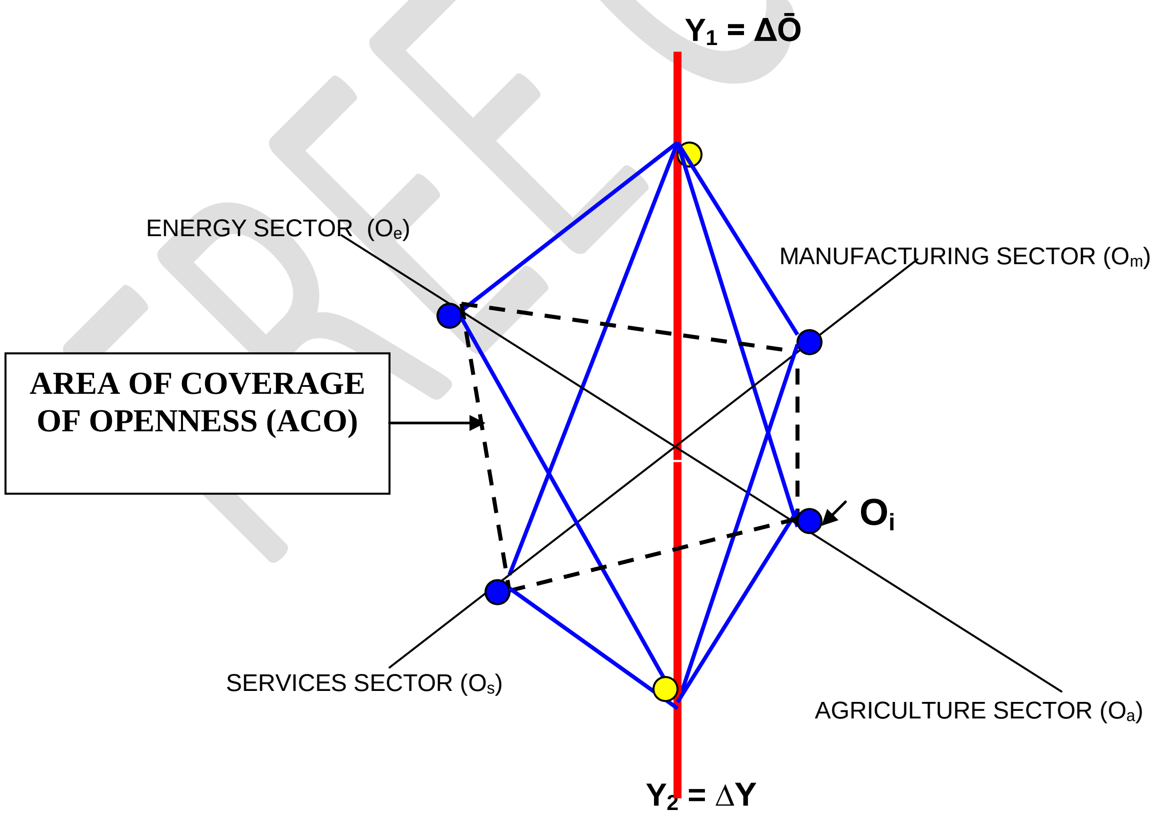
Step 6: Plotting of the Openness Diamond Graph

The openness diamond graph (see Diagram 1) presents a general idea about the current global development of trade liberalization based on a new concept of graphic representation (see Figure 1). This new concept of graphic representation consists of six axes, each of which has a positive value. In the case of this research, the value of four of these axes is represented by the degree of openness by production sector (O_i) (agriculture sector, industrial sector, energy sector, and services sector). These O_i indexes are independent variables (see Figure 1). They can be joined together to create a general area. This general area is called "the area of coverage of openness (ACO)". This area shows the dimension of openness from a general perspective. For comparison purposes, the ACO can be applied to different years for one country or two countries. The analysis of the ACO is based on the comparison of two periods or regions. In the case of this research chapter, two periods (i.e. first period and second period) are compared. The total ACO may present three possible scenarios, namely:

(a) Expansion (ACO' first period < ACO'' second period)
(b) Stagnation (ACO' first period = ACO'' second period)
(c) Contraction (ACO' first period > ACO'' second period).

The fifth and sixth axes are represented by the dependent variables Y_1 ($\Delta\bar{O}$) and Y_2 (ΔY). They are positioned in the center of the graph which is the meeting point of the other four axes.

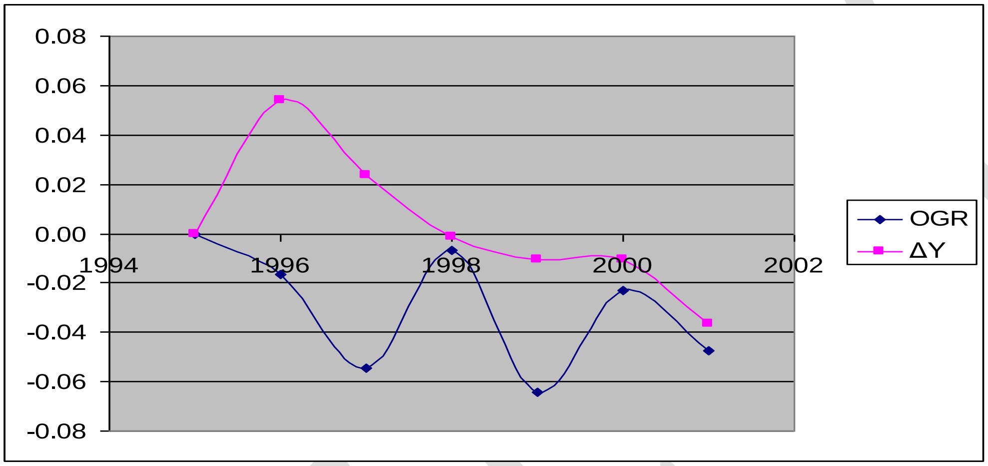
Figure 1:
The Openness Diamond Graph



Step 7: Creation of the Openness/Income Growth Rate (O:Y) Chart

Based on all the results of the average openness growth rate ($\Delta\bar{O}$) and income growth rate (ΔY) obtained from Step 3 and Step 5 respectively, a chart showing the trends of both openness growth and income growth is drawn. This chart serves the purposes of the next step (Step 8). The (O:Y) chart compares the trend of the average openness growth rate ($\Delta\bar{O}$) with the trend of the income growth rate (ΔY) (see Figure 2).

Figure 2: Openness/Income Growth Rate (O:Y) Chart (Fictitious data)



Step 8: Measurement of the Openness/Income Growth Rate (O:Y) Sensitivity Analysis

This indicator measures how sensitive an economy is under constant changes in its openness growth (see Diagram 1). Specifically, it measures the relationship between the average openness growth rate ($\Delta\bar{O}$) and the income growth rate (ΔY). Hence, it can be used to test if openness growth influences income growth in the country under study. It simultaneously compares the trend of average openness growth rate ($\Delta\bar{O}$) and income growth rate (ΔY) trends by year for the same country or between different countries.

The openness/income growth rate (O:Y) sensitivity analysis compares the trend of openness growth and income growth (see Expression 6) based on the openness/income growth rate (O:Y) chart (see Figure 2).

(6.) Openness/income growth sensitivity analysis rate (O:Y) = $\Delta\bar{O} : \Delta Y$

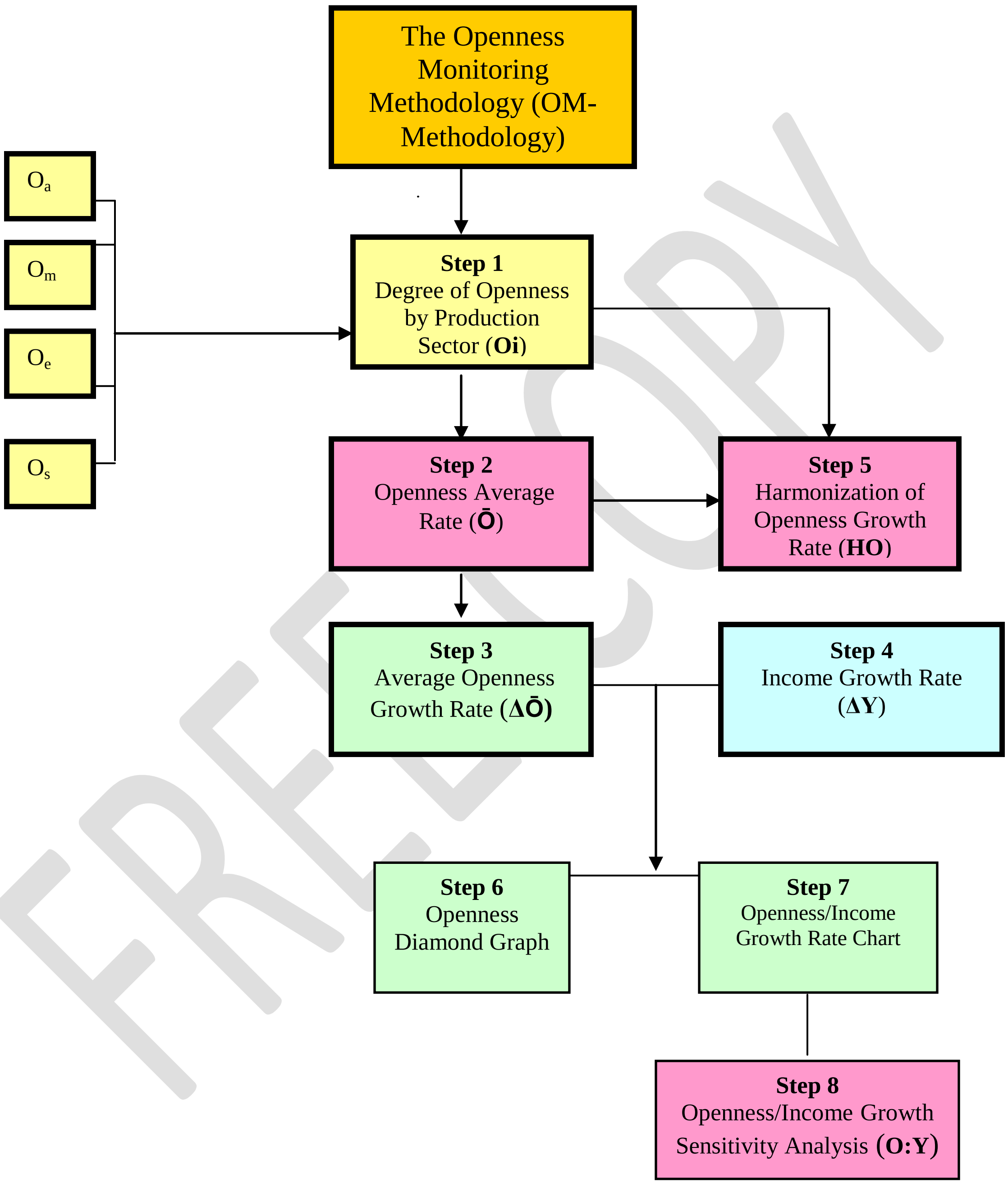
<u>Results of the (O:Y) Sensitivity Analysis</u>

The (O:Y) sensitivity analysis can reflect several possible scenarios:

(i) If ▲$\Delta\bar{O}$: ▲ΔY then the income has a high sensitivity to openness
(ii) If ▼ $\Delta\bar{O}$: ▼ΔY then the income has a high sensitivity to openness
(iii) If ▲ $\Delta\bar{O}$: ▼ΔY then the income has a low sensitivity to openness
(iv) If ▼ $\Delta\bar{O}$: ▲ΔY then the income has a low sensitivity to openness

($\Delta\bar{O}$) : average openness growth rate ▲: increase
(ΔY) : income growth rate ▼: decrease

Diagram 1
Steps to apply the Openness Monitoring Methodology (OM-Methodology)



6.6. Concluding Remarks

Chapter 6 offers an alternative analytical approach to study openness through a discussion of the openness monitoring methodology (OM-Methodology). This new analytical tool provides researchers with the ability to evaluate whether openness can generate income growth and decide, at the same time, which model of regional integration is more suitable for a particular region.

CHAPTER 7
THE GROSS DOMESTIC PRODUCT SURFACE (GDP-SURFACE)

7.1. Introduction to the Gross Domestic Product Surface: (GDP-Surface)

The construction of the GDP-Surface is based on the application of the 5-dimensional coordinate space (vertical position). The GDP-Surface is based on the use of the national income growth rate "ΔY" (endogenous variable) and four exogenous variables, which are the consumption growth rate"ΔX_1", investments growth rate "ΔX_2", government growth rate "ΔX_3" and net trade growth rate "(X-M) = ΔX_4" respectively, shown in the expressions below. For demonstration purposes, the following data is used: consumption growth rate (ΔX_1), investment growth rate (ΔX_2), government growth rate (ΔX_3) and net trade growth rate (ΔX_4) and the national income growth rate (ΔY) of the United States from 1928 to 2004 (NBER, 2008). Steps involved in the construction of GDP-Surface are as follows. The general function of the GDP-Surface is equal to:

$$(1.) \qquad \Delta Y = f\,(\Delta X_1, \Delta X_2, \Delta X_3, \Delta X_4)$$

To measure each growth rate, the following expressions are used:

$$(2.1.)\ \Delta X_1 = [(X_{1\text{-Final period}}) - (X_{1\text{-Initial period}}) / (X_{1\text{-Final period}})] \text{ x } 100\%$$
$$(2.2.)\ \Delta X_2 = [(X_{2\text{-Final period}}) - (X_{2\text{-Initial period}}) / (X_{2\text{-Final period}})] \text{ x } 100\%$$
$$(2.3.)\ \Delta X_3 = [(X_{3\text{-Final period}}) - (X_{3\text{-Initial period}}) / (X_{3\text{-Final period}})] \text{ x } 100\%$$
$$(2.4.)\ \Delta X_4 = [(X_{4\text{-Final period}}) - (X_{4\text{-Initial period}}) / (X_{4\text{-Final period}})] \text{ x } 100\%$$
$$(2.5.)\ \Delta Y = [(Y_{\text{Final period}}) - (Y_{\text{Initial period}}) / (Y_{\text{Final period}})] \text{ x } 100\%$$

The GDP-Surface suggests the application of four vectors to show the magnitude and direction of each **Δ**Xi (i = 1, 2, 3, 4) to build the platform of the surface at the bottom of the 5-dimensional coordinate space (vertical position). We have four initial vectors at ground-level of the 5-dimensional coordinate space represented by $\boldsymbol{\ell_1}$, $\boldsymbol{\ell_2}$, $\boldsymbol{\ell_3}$, $\boldsymbol{\ell_4}$ (see Figure 1).

$$(3.1.) \qquad \ell_1 = \overrightarrow{\Delta X_1 \Delta X_2}$$

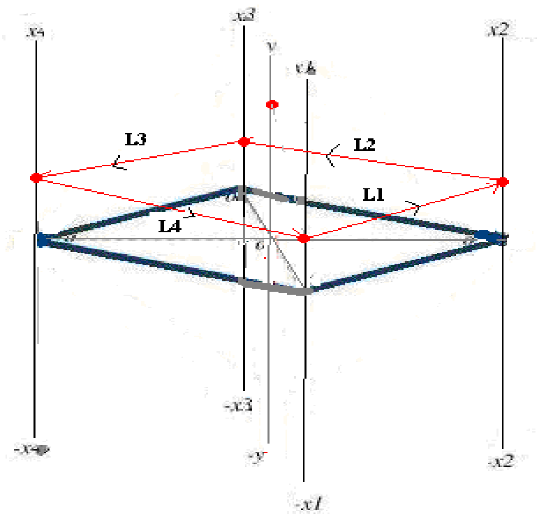
$$(3.2.) \qquad \ell_2 = \overrightarrow{\Delta X_2 \Delta X_3}$$

$$(3.3. \qquad \ell_2 = \overrightarrow{\Delta X_3 \Delta X_4}$$

$$(3.4.) \qquad \ell_4 = \overrightarrow{\Delta X_4 \Delta X_1}$$

Figure 1

The GDP-Surface Platform



The next step is to find the vectors to join ΔX_1, ΔX_2, ΔX_3, ΔX_4 with ΔY respectively to build the main structure of the GDP-Surface (see Figure 2).

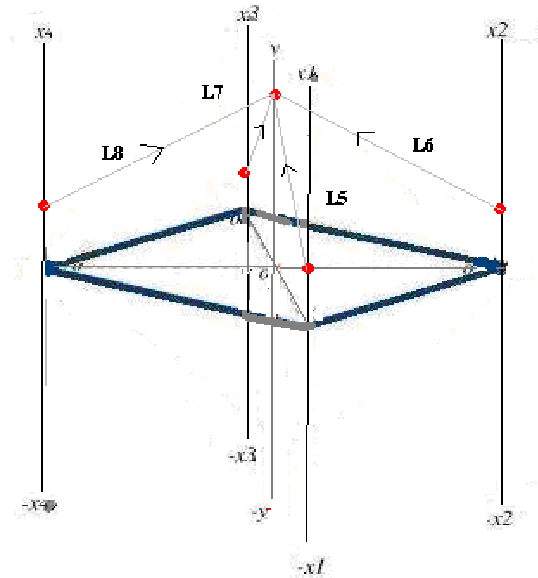
(4.1.) $\ell_5 = \overrightarrow{\Delta X_1 \Delta Y}$

(4.2.) $\ell_6 = \overrightarrow{\Delta X_2 \Delta Y}$

(4.3.) $\ell_7 = \overrightarrow{\Delta X_3 \Delta Y}$

(4.4.) $\ell_8 = \overrightarrow{\Delta X_4 \Delta Y}$

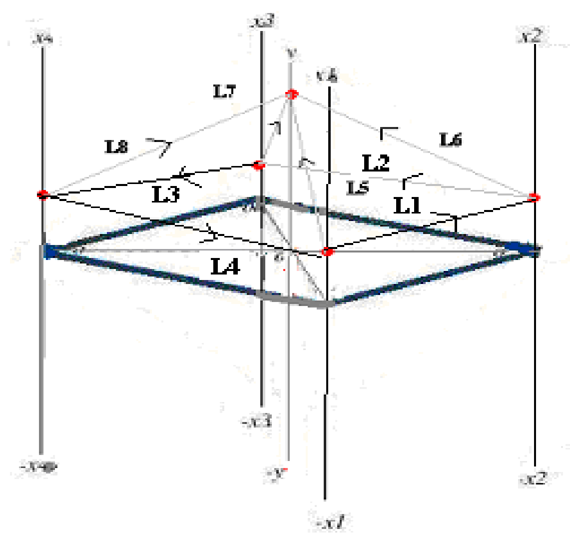
Figure 2: The Main Structure of the GDP-Surface



Finally, the GDP-Surface is the sum of all vectors from vector $\boldsymbol{\ell}_1$ until vector $\boldsymbol{\ell}_8$ (see Figure 3).

(5.) The GDP-Surface = $\overrightarrow{\ell_1 + \ell_2 + \ell_3 + \ell_4 + \ell_5 + \ell_6 + \ell_7 + \ell_8}$

Figure 3: The GDP-Surface



The results of the GDP-Surface reflect three possible levels of performance:

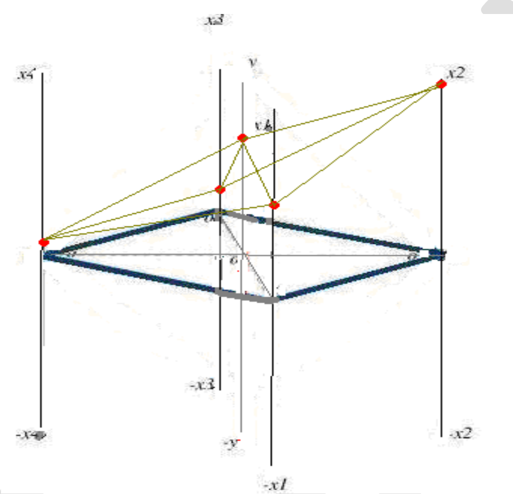
Level 1: Stable Macroeconomic Performance

If the GDP-Surface is located within the positive quadrant of the 5-dimensional coordinate space (vertical position) then the GDP-Surface shows stable macroeconomic performance (see Figure 4).

(6.) $+\Delta Y = f\ (+\Delta x_1 , +\Delta x_2 , +\Delta x_3, +\Delta x_4)$

Figure 4

GDP-Surface: Stable Macroeconomic Performance

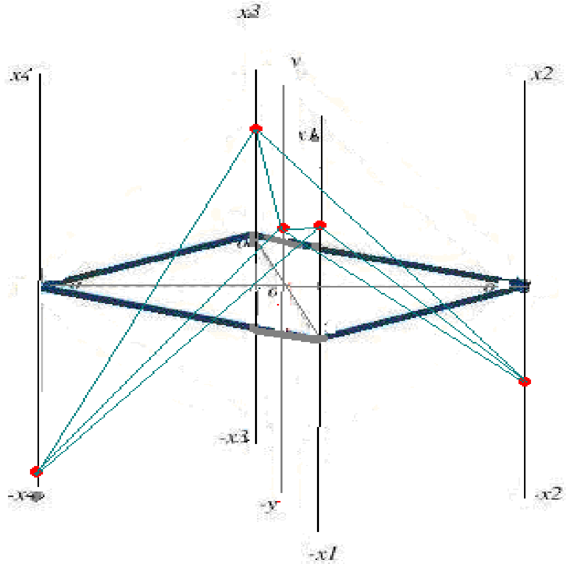


Level 2: Unstable Macroeconomic Performance

If the GDP-Surface is located between the positive and negative quadrant of the 5-dimensional coordinate space (vertical position) then the GDP-Surface shows unstable macroeconomic performance (see Figure 5).

(6.) $+/-\Delta Y = f\ (+/-\ \Delta x_1 , +/-\ \Delta x_2 , +/-\ \Delta x_3, +/-\ \Delta x_4)$

Figure 5
GDP-Surface: Unstable Macroeconomic Performance

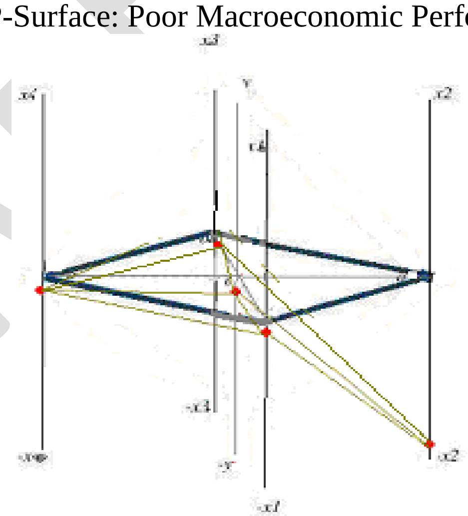


Level 3: Poor Macroeconomic Performance

If the GDP-Surface is located in the negative quadrant or is equal to zero of the 5-dimensional coordinate space (vertical position) then the GDP-Surface shows poor macroeconomic performance (see Figure 6).

$$(7.)\qquad -\Delta Y = f\,(-\Delta x_1\,, -\Delta x_2\,, -\Delta x_3, -\Delta x_4) \text{ or } 0 = f\,(0, 0, 0, 0)$$

Figure 6
GDP-Surface: Poor Macroeconomic Performance



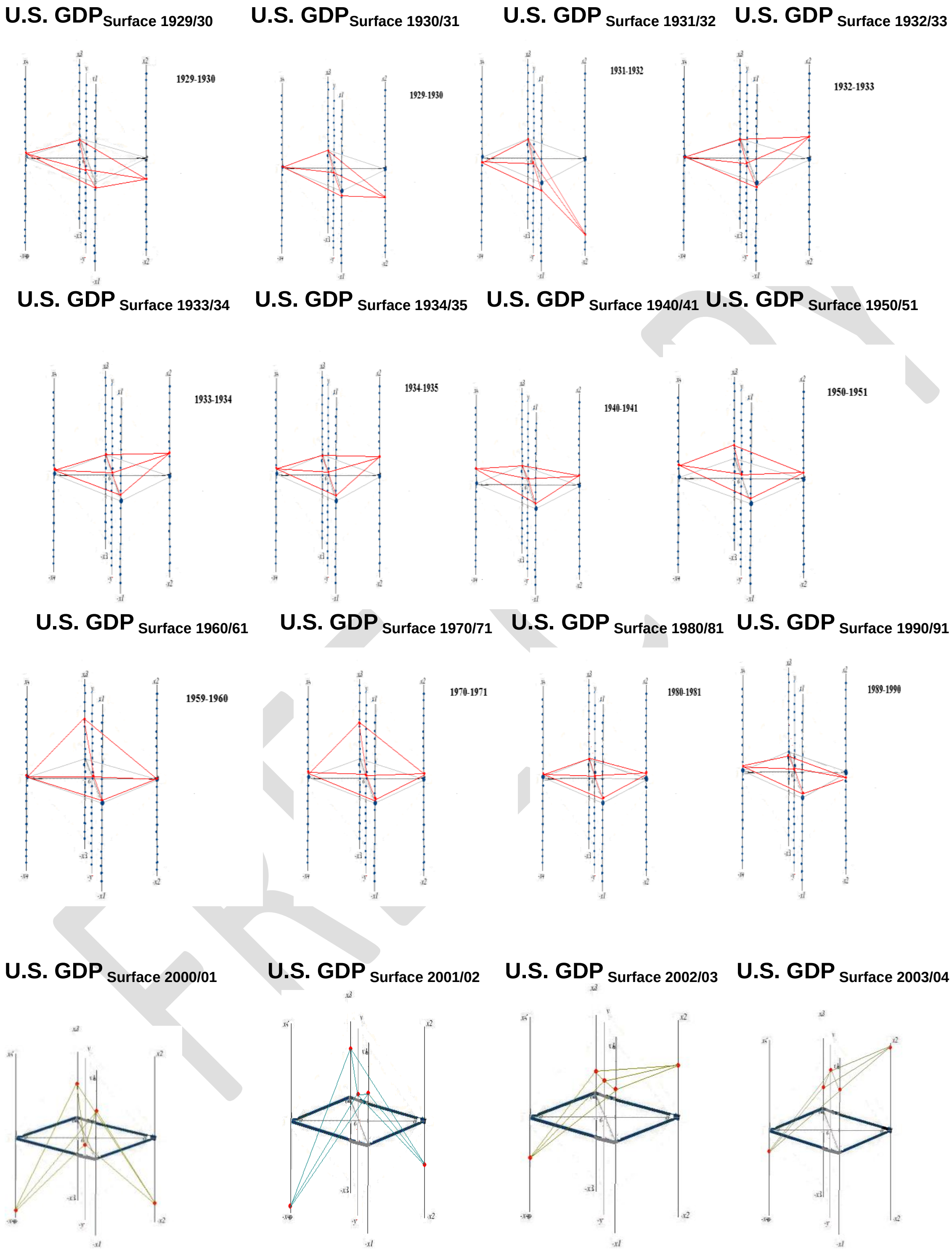
7.2. GDP-Surface: The U.S. GDP Historical Trend from 1928 until 2004

The GDP-Surface shows how the national income growth rate "ΔY" or endogenous variable is affected by four exogenous variables, which are consumption growth rate"ΔX_1", investments growth rate "ΔX_2", government growth rate "ΔX_3" and net trade growth rate "(X-M) = ΔX_4" simultaneously. All variables move along their respective axes simultaneously on the same 5-dimensional coordinate space (vertical position). The GDP-Surface shows how the consumption growth rate (ΔX_1), investment growth rate (ΔX_2), government growth rate (ΔX_3), net trade growth rate (ΔX_4) and the national income growth rate (ΔY) of the United States (U.S.) moves in different directions simultaneously within the 5-dimensional coordinate space (vertical position). If we observe the U.S. GDP-Surface period by period from 1928 to 2004 (NBER, 2008), the GDP-Surface shows different displacements within the 5-dimensional coordinate space (vertical position).

Between 1928 and 2004, the U.S. GDP-Surfaces at Level 1 or stable macroeconomic performance are located within forty periods: 1933/34, 1934/35, 1935/36, 1936/37, 1938/39, 1939/40, 1940/41, 1942/43, 1947/48, 1950/51, 1954/55, 1955/56, 1958/59, 1959/60, 1960/61, 1962/63, 1963/64, 1967/68, 1968/69, 1969/70, 1970/71, 1971/72, 1972/73, 1973/74, 1974/75, 1975/76, 1976/77, 1977/78, 1981/1982, 1982/1983, 1983/1984, 1984/85, 1985/86, 1986/87, 1991/1992, 1992/1993, 1993/1994, 1995/96, 1996/97 and 1998/1999 (see Figure 7). Level 1 or stable macroeconomic performance is characterized by positive results in all four broad categories of spending (ΔX_1, ΔX_2, ΔX_3, ΔX_4) and the national income growth rate (ΔY).

The U.S. GDP-Surfaces at Level 2 or unstable macroeconomic performance are located in forty periods: 1928/29, 1929/30, 1930/31, 1931/32, 1932/1933, 1937/38, 1941/42, 1942/43, 1943/44, 1944/45, 1945/46, 1946/47, 1947/48, 1948/49, 1949/50, 1951/52, 1952/53, 1953/54, 1956/57, 1957/58, 1961/62, 1964/65, 1965/66, 1966/67, 1967/68, 1978/79, 1979/80, 1980/81, 1982/83, 1987/88, 1988/89, 1989/90, 1990/91, 1994/95, 1997/98, 1999/2000, 2000/01, 2001/02, 2002/03 and 2003/04 (See Figure 7). The GDP-Surfaces at Level 2 or unstable macroeconomic performance is characterized by non-proportional results, comprising both positive and negative growth rate values. Therefore, the unstable macroeconomic performance does not necessarily generate a negative impact on the national income growth rate "ΔY" in the long term. If we generate a successive slide show based on the use of each GDP-Surface, period by period, we can observe how the GDP-Surface maintains a constant movement in the same 5-dimensional coordinate space (vertical position). It is possible to observe a multi-dimensional and dynamic view of the GDP-Surface historical trend of United States economy in constant movement.

Figure 7:
United States GDP-Surface from 1928 to 2004



Source: NBER (2008)

7.3. Concluding Remarks

The advantage of using the GDP-Surface is that we can readily visualize multivariable events from a multidimensional perspective. The construction of the GDP-Surface can only be possible by the use of the 5-dimensional coordinate space (vertical position). The 5-dimension coordinate space (vertical position) shows, from a global context, the behavior of any economic phenomena. It is based on the visualization of a large number of exogenous variables (X_1, X_2, X_3 … ∞) and a single endogenous variable (Y) in the same graphical space.

CHAPTER 8
THE MACROECONOMIC GRAPHIC SENSOR SYSTEM (MGS-SYSTEM)

8.1. INTRODUCTION

The basic idea of building the macroeconomic graphic sensor system (MGS-System) is to show different macroeconomic scenarios based on the use of multi-dimensional graphs that move constantly in real-time. If some of these multi-dimensional graphs show an erratic behavior pattern, then the MGS-System immediately provides an alert about possible failure(s) in some or all macroeconomic scenarios in the same graphical space.

The failure(s) location depends on the multi-dimensional graph position within its respective coordinate space. If the MGS-System finds some or many failure(s) in the multi-dimensional graph, then the MGS-System starts to take action(s) by searching for possible solutions (or economic policies) to solve some or many of these failure(s) simultaneously. These solutions (or economic policies) originate from a large number of databases. To find possible solutions (or economic policies) to solve some or many failure(s) depends on the series of parameters that are established in each axis on the multi-dimensional coordinate space respectively. Hence, the selection of possible solution(s) (or economic policies) depends on the multi-dimensional graph position. The final solution(s) is selected according to lower risks or a less vulnerable economic impact among a large number of possible solutions. This research has three specific objectives.

The first specific objective of this research is the application of a basic form of database analysis based on the application of a default random process. The default random process will choose the best solution(s) (or economic policy) within a large database compiled from successful economic models, theoretical frameworks and econometric models and simulations applied to economics. It is based on the parameters which are established into each axis in the 5-dimensional coordinate space (vertical position).

The second specific objective is the application of Econographicology (Ruiz Estrada, 2007), which is based on a new group of multidimensional graphs under the application of multidimensional coordinate spaces presented by: the pyramid coordinate space (five axes and infinite axes); the diamond coordinate space (ten axes and infinite axes); the 4-dimensional coordinate space (vertical position and horizontal position); the 5-dimensional coordinate space (vertical position and horizontal position); the infinity-dimensional coordinate space (general approach and specific approach); the inter-linkage coordinate space; the cube-wrap coordinate space; and the mega-surface coordinate space. These multiple-dimensional graphs facilitate the easy understanding of any economic phenomena by presenting it in graphic form from a comprehensive multidimensional perspective.

Finally, this research will present a flow chart to explain the construction and implementation of the macroeconomic graphic sensor system (MGS-System). The idea of building the MGS-System is to offer an alternative graphical tool to policy makers, academics, and international institutions to obtain a series of possible solutions to solve different economic problems.

8.2. THE MGS-SYSTEM THEORETICAL FRAMEWORK

The macroeconomic graphic sensor system (MGS-System) has five basic phases. The first phase is the constant input and storage of large amounts of information (quantitative or qualitative); the second phase is the visualization of multi-dimensional graphs in real-time; the third phase is to provide an alert of possible failure(s) in different economic scenarios in the same graphical space; the fourth phase is to search for a possible set of solution(s) (or economic policies) according to the multidimensional graph position within its respective multi-dimensional coordinate space; and the fifth phase is to produce the final report with a short list of recommendation(s) or suggestion(s) to solve the irregular or erratic behavior of the multi-dimensional graph.

FIRST PHASE: The Input and Storage of Information

The first phase is divided into two sections: Input and Storage (see Diagram 1: Stage 1).

INPUT SECTION

The first section proposes that the MGS-System is comprised of many different types of information input of (I_{Xi}) from different resources (see Expression 1). The information input (I_{Xi}) can be classified into quantitative and qualitative respectively, but also by positive (+) or negative (-) values, shown by expression 1:

$$(1.)\quad I_{Xi} = f\,(+/-I_{X1}\,,\ +/-I_{X2}\,,\ \ldots,\ +/-I_{X\infty\ldots}) \equiv I_{Xi} = f\,(+/-I_{Xi}) \text{ thus } i = 1,2,\ldots,\infty$$

STORAGE SECTION

The second section in the first phase explains how the types of information input (I_{Xi}) is recorded in different databases (DB_{Xi}) thus i = 1,2,… ∞ (see Expression 2).

$$(2.)\quad DB_{Xi} = f\,(DB_{X1}<+/-I_{X1}>,\ DB_{X2}<+/-I_{X2}>, \ldots,\ DB_{x\infty}<+/-I_{X\infty}>_{\ldots})$$

SECOND PHASE: The Visualization of Multi-Dimensional Graphs

The visualization of multi-dimensional graphs in real-time (See Diagram 1: Stage 2) is based on constant information input (I_{xi}) in each axis (X_i) respectively from different database (DB_{Xi}) resources. Each input of information (I_{xi}) is always interconnected with its respective axis (X_i). All multi-dimensional graphs in the MGS-System are always running in real-time, all the time (see Expression 3.)

$$(3.)\quad MD = (X_1{:}\,[+/-I_{x1}],\ X_2{:}[+/-I_{x2}]\,,\ \ldots,\ X_\infty{:}[+/-I_{x\infty}]_{\ldots})$$

THIRD PHASE: The Alert of Possible Failure(s)

The third phase provides an alert of possible failures (See Diagram 1: Stage 3). This depends on the position of the multi-dimensional graph within its multi-dimensional coordinate space. If the information is located in the negative $-X_{i\,=}\,[-I_{Xi}]$ quadrant, then the MGS-System will provide an alert about possible failures (see Expression 4 and 5)

$$(4.)\quad \text{If } -X_1{:}\,[-I_{X1}],\ -X_2{:}[-I_{X2}]\,,\ \ldots\ldots\ldots,\ -X_\infty{:}[-I_{X\infty}]_{\ldots}$$
$$\text{then } -X_1{:}\,[\text{»Alert«}],\ -X_2{:}[\text{»Alert«}]\,,\ \ldots,\ -X_\infty{:}[\text{»Alert«}]$$

In fact, if any type of information input is located in the negative quadrant $-X_i$:[$-I_{Xi}$] of the coordinate space in the MGS-System, then this input of negative information ($-I_{Xi}$) will be called "***failure(s)***". Therefore, if the MGS-System finds any failure ($-I_{xi}$), then it immediately starts to search (☼) for its possible solution (S_{xi}), according to expression 6.

(5.) $S_{xi} = -I_{X1} \text{ ☼ } S_{X1} : -I_{X2} \text{ ☼ } S_{X2} : \ldots : -I_{X\infty} \text{ ☼ } S_{X\infty}$

FOURTH PHASE: The Set of Solution(s) (or Economic Policies)
The fourth phase is divided into two sections: the database of final solutions, and solutions (see Diagram 1: Stage 4).

<u>THE DATABASE OF FINAL SOLUTIONS</u>
The general database of final solutions is equal to the interconnection (╦) of a large number of databases (DB_{Xi}) and each database has a large number of possible solutions (S_{Xi}) (see Expression 7).

$$(7.)\ DB_{Xi} = X_1{:}\left[\sum_{X_1=1}^{\infty} DB_{X1} \langle S_{X1} \rangle\right] \text{ ╦ } X_2{:}\left[\sum_{X_2=1}^{\infty} DB_{X2} \langle S_{X2} \rangle\right] \text{ ╦ } \ldots \text{ ╦ } X_\infty\left[\sum_{X_\infty=1}^{\infty} DB_{X\infty} \langle S_{X\infty} \rangle\right]$$

<u>THE FINAL SOLUTIONS</u>
The choice of the final solution (FS_{Xi}) is equivalent to the multi-connection (╬) of a long list of possible solutions (S_{Xi}) (see Expression 8 and 8.1.), where each solution (S_{xi}) depends on the multi-dimensional graphical position within its respective 5-dimensional coordinate space (vertical position) (see Diagram 1: Stage 4). Hence, the establishment of parameters in each axis plays an important role in the process of finding suitable solution(s) (economic policies) in the MGS-System.

(8.)

$$FS_{X1} = -I_{X1:1} \cap S_{X1:1} \rightarrow DB_{x1:1} \text{ ╬ } FS_{1:2} = -I_{X1:2} \cap S_{X1:2} \rightarrow DB_{x:1:2} \text{ ╬ } \ldots \text{ ╬ } FS_{X1:\infty} = -I_{X1:\infty} \cap S_{X1:\infty} \rightarrow DB_{x1:\infty}$$
$$FS_{X2} = -I_{X:2:1} \cap S_{X2:1} \rightarrow DB_{x2:1} \text{ ╬ } FS_{2:2} = -I_{X:2:2} \cap S_{X2:2} \rightarrow DB_{x:2:2} \text{ ╬} \ldots \text{ ╬ } FS_{X2:\infty} = -I_{X:2:\infty} \cap S_{X:2:\infty} \rightarrow DB_{x2:\infty}$$
$$. \qquad . \qquad . \qquad . \qquad .$$
$$FS_{X\infty} = -I_{X:\infty:\infty} \cap S_{X\infty:\infty} \rightarrow DB_{x:\infty:\infty} \text{ ╬ } FS_{\infty:\infty} = -I_{X:\infty:\infty} \cap S_{X\infty:\infty} \rightarrow DB_{x:\infty:\infty} \text{ ╬} \ldots \text{ ╬ } FS_{2:\infty} = -I_{X:\infty:\infty} \cap S_{X:\infty:\infty} \rightarrow DB_{x:\infty:\infty}$$

(8.1.) If $FS_{Xi} \equiv f\,(-I_{Xi})$ then each $-I_{Xi}$ finds its solution within its DB_{xi} respectively

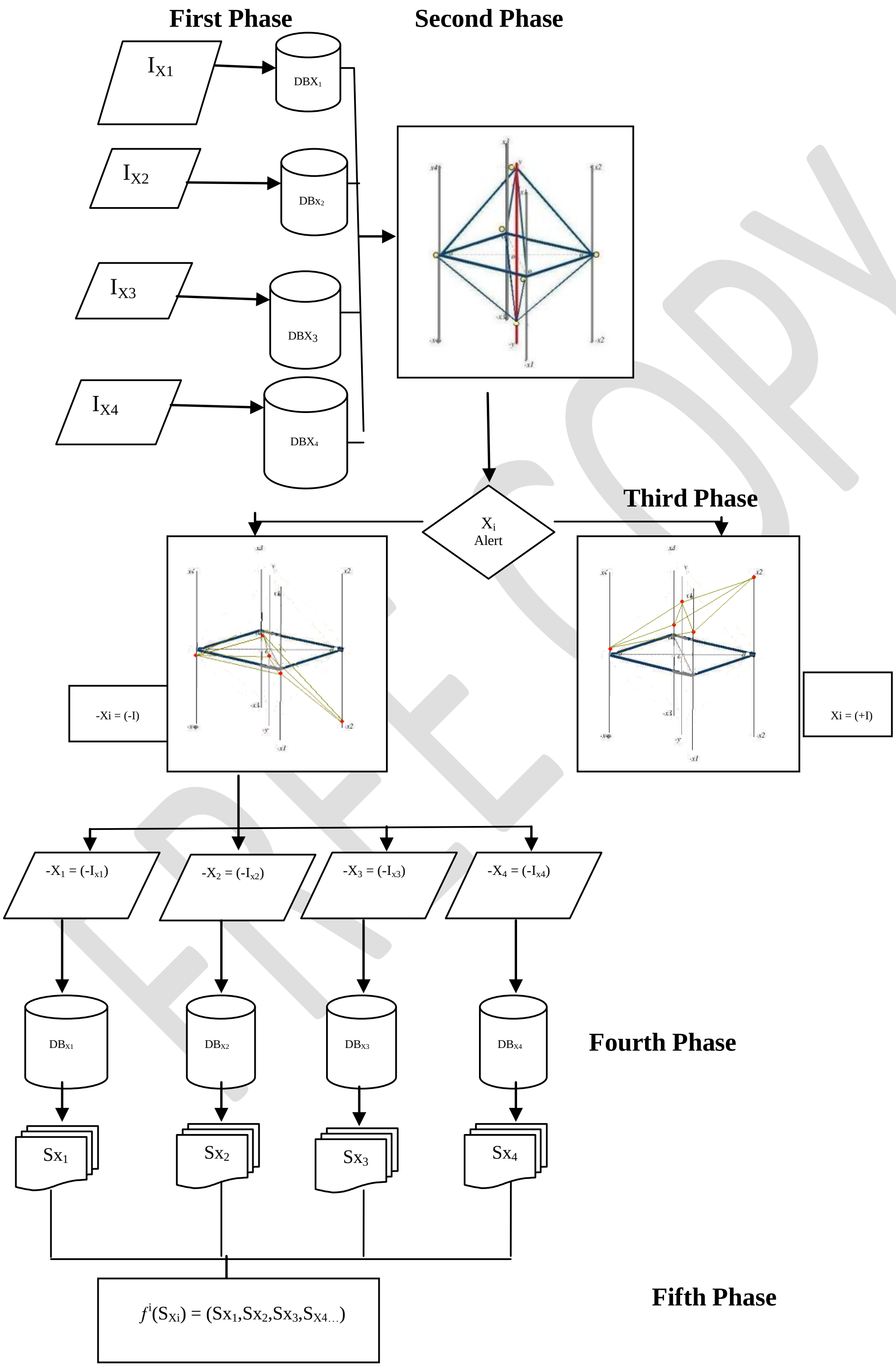
FIFTH PHASE: The final output
The final output (FO) (see Diagram 1: Phase 5) comes from the last partial differentiation (f^i) from the large list of solutions (S_{xi}). In fact, the MGS-System starts to apply partial differentiation (f^i) from the first group of solutions until it arrives at the final solution. The idea is to debug the system (◊) until we arrive at the best solution (or best economic policy) with less risk and less vulnerability (see Expression 9).

(9.)
$$f(S_{X1}) = Sx_1 \lozenge Sx_2 \lozenge \ldots \lozenge Sx_\infty$$
$$f\,(S_{x2})' = Sx_1 \lozenge Sx_2 \lozenge \ldots \lozenge Sx_\infty$$
$$f\,(S_{X3})'' = Sx_1 \lozenge Sx_2 \lozenge \ldots \lozenge Sx_\infty$$
$$. \quad = \quad . \quad . \quad . \quad .$$

. = ...
. = ...

$f(S_{Xi})^i = 0$ thus $i = 1,2\ldots\infty$

DIAGRAM 1:
The Macroeconomic Graphic Sensor System (MGS-System)



8.3. Concluding Remarks

The macroeconomic graphic sensor system (MGS-System) is a powerful visual analytical tool for policy makers, central banks and academics because it makes it possible to observe complex economic scenarios interact simultaneously in the same graphical space. The idea is to demonstrate that economics is complex and dynamic, not a simple or static 2-dimensional phenomenon. Additionally, the MGS-System is also the first proposal for an artificial intelligence policy maker in economics.

CHAPTER 9

THE EXTERNAL SECTOR DEVELOPMENT INDEX (SX_i)

9.1. Introduction

For many decades, economists and policy makers have been using a variety of analytical tools in the study of external sector behavior in different countries and regions. The most common analytical tools applied in such studies so far are the terms of trade (ToT)[28] and the openness index (O_i)[29]. This chapter introduces a new index to measure the external sector of any country or region from a different analytical perspective. This new index is called "the external sector development index (SX_i)". The SX_i is strongly affiliated with the openness index (O_i). The difference between these two indices is that the measurement of SX_i replaces absolute values by growth rates (or relative values), in which these growth rates are trade volume growth rate (ΔT = ∑export growth rate plus ∑import growth rate), foreign direct investment growth rate (ΔFDI) and gross domestic product growth rate (ΔGDP). The SX_i analysis will also introduce a new variable called "the external sector main variable (ES_i)". The ES_i is equal to the trade volume growth rate (ΔT) plus the foreign direct investment growth rate (ΔFDI) (see Diagram 1). However, the three indicators (ToT, O_i and SX_i) have different objectives and analytical focus, but they share something in common in that all these indicators will evaluate the external sector of any country (see Table 1).

TABLE 1:

Comparison of Terms of Trade, Openness and External Sector Development Index (SX_i)

Concept	Measures	Function	Advantage	Disadvantage
Terms of Trade **-ToT-**	**X Price/M Price** **X = Export Index Price** **M = Import Index Price**	To study the relationship between export price ratio and import price ratio to find the deteriorating terms of trade among countries	Permits the visualization of the relationship between various international prices in the international market	Difficult to be applied to many countries and goods simultaneously
Openness **-Oi-**	**TV/GDP x 100%** **TV = X+M**	To measure the level of trade liberalization and the orientation of trade policy	Gives a general idea about how open an economy is in its international trade	Focused on studying how open an economy is from the specific point of view of trade
External Sector Development **-SX_i-**	**$ES_i/\Delta GDP x100\%$** **$ES_i = \Delta T + \Delta FDI$**	To measure the level of trade liberalization and investment mobility simultaneously	Observes the trends of the external sector from the perspective of the international trade sector and the finance sector simultaneously	Difficult to monitor FDI mobility in the short term

[28] The terms of trade (ToT) is considered an analytical tool which can explain the relationship between the ratio of export prices (export index price = IP_x) and the ratio of import prices (import index price = IP_m) to find the deteriorating terms among countries (Balassa, 1985 and Haberler, 1952). However, ToT continues to be used by many experts on international trade to explain the behavior of the external sector of any country.

$$ToT = IP_x/IP_m \times 100\%$$

[29] The openness index (O_i), on the other hand, studies the relationship between the total trade volume (i.e. Exports plus Imports) and GDP (Edwards, 1998a). It measures the level of trade liberalization as well as the orientation of the trade policy of any country. The objective of the O_i is to show how much participation the external sector (export plus imports) has on the GDP as a whole, or how open an economy is to the international markets.

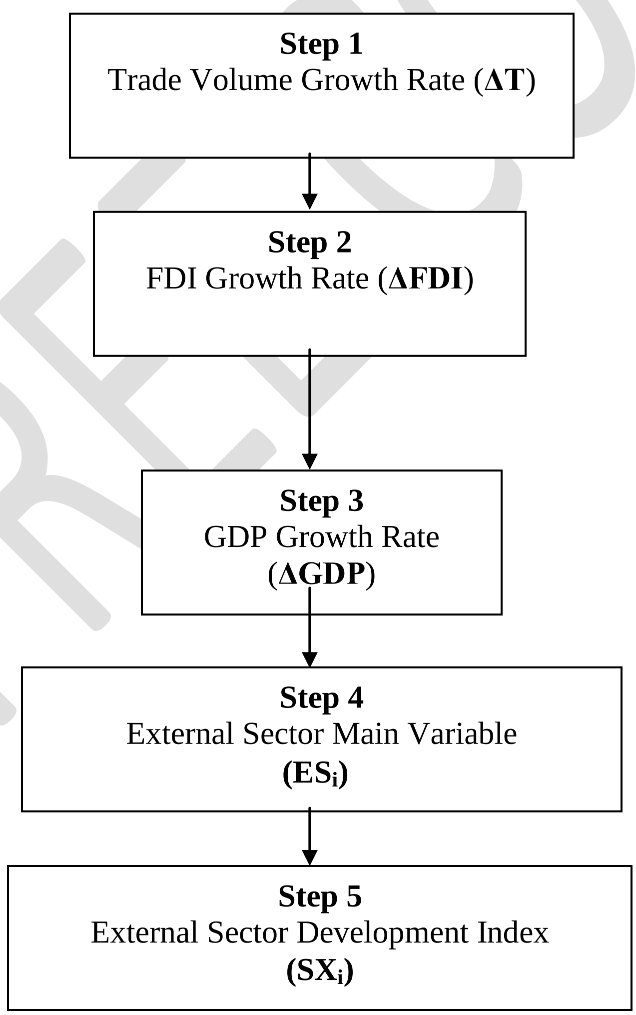
$$O_i = X+M/GDP \times 100\%$$

9.2. The External Sector Development Index (SX_i)

The objective of the external sector development index (SX_i) is to observe the external sector behavior of any economy from a new angle of analysis based on three basic variables: trade volume growth rate (ΔT), foreign direct investment growth rate (ΔFDI) and GDP growth rate (ΔGDP).

The external sector of the SX_i is represented by two specific growth rates: trade volume growth rate (ΔT) and the foreign direct investment growth rate (ΔFDI). This part of the research maintains that the trade volume is equal to the sum of exports flow (FOB) plus imports flow (CIF) in US$ per year. On the investment side, it is represented by the variation of the FDI growth rate between two years. The idea to include the FDI growth rate (ΔFDI) and trade volume growth (ΔT) together into the study of the external sector is basically to analyze the external sector as a whole. The computation of the SX_i Index requires four preceding steps detailed below (see Diagram 1).

DIAGRAM 1:
PROCEDURE TO MEASURE THE EXTERNAL SECTOR DEVELOPMENT INDEX (SX_i)



9.2.1. Step 1: Trade Volume Growth Rate (ΔT)

The trade volume growth rate (ΔT) is the difference between the trade volume of a given year in millions of US$ $(X+M)_{n+1}$ and the trade volume of the previous year in millions of US$ $(X+M)_n$ divided by the trade volume of the previous year in millions of US$ $(X+M)_n$.

(1.1.) $$\Delta T = \frac{(X+M)_{n+1} - (X+M)_n}{(X+M)_n}$$

9.2.2. Step 2: Foreign Direct Investment Growth Rate (ΔFDI)

The foreign direct investment growth rate (ΔFDI) is the difference between the foreign direct investment volume of a given year in millions of US$ $(FDI)_{n+1}$ and the foreign direct investment of the previous year in millions of US$ $(FDI)_n$ divided by the foreign direct investment of the previous year in millions of US$ $(FDI)_n$.

(1.2.) $$\Delta FDI = \frac{(FDI)_{n+1} - (FDI)_n}{(FDI)_n}$$

9.2.3. Step 3: GDP Growth Rate (ΔGDP)

The domestic product growth rate (ΔGDP) is equal to the domestic product growth of a given year in millions of US$ $(GDP)_{n+1}$ minus the domestic product growth of the previous year in millions of US$ $(GDP)_n$ divided by the domestic product growth of the previous year in millions of US$ $(GDP)_n$.

(1.3.) $$\Delta GDP = \frac{(GDP)_{n+1} - (GDP)_n}{(GDP)_n}$$

9.2.4. Step 4: External Sector Main Variable (ES_i)

The external sector main variable (ES_i) is equal to the sum of trade volume growth rate (ΔO) and foreign direct investment growth rate (ΔFDI) (see Table 2).

(1.4.) $ES_i = \Delta T + \Delta FDI$

Possible results

If any value is located within ES_{i+} then this value is included in the category of acceptable performance in the external sector. If any value is located within ES_{i-} or ESi = 0 then this value is included in the category of weak external sector performance.

TABLE 2: Possible Combinations of ΔT and ΔFDI to Obtain ES_i

ΔFDI/ΔT	+ΔT	-ΔT	ΔT = 0
+ΔFDI	$\Delta T + \Delta FDI = ES_{i+}$	▲(-ΔT) + ▼ΔFDI = ES_{i}- ▼(-ΔT) + ▲ΔFDI = ES_{i+}	$0 + (\Delta FDI) = ES_{i+}$
-ΔFDI	▲ΔT + ▼(-ΔFDI) = ES_{i+} ▼ΔT + ▲(-ΔFDI) = ES_{i-}	▲(-ΔT) + ▼(-ΔFDI) = ES_{i}- ▼(-ΔT) + ▲(-ΔFDI) = ES_{i}-	$0 + (-\Delta FDI) = ES_{i-}$
ΔFDI = 0	$\Delta T + 0 = ES_{i+}$	$-\Delta T + 0 = ES_{i-}$	$0 + 0 = ES_i0$

▲ = High ▼ = Low ΔFDI = Foreign Direct Investment Growth Rate
ΔT = Trade Volume Growth Rate (-) = Negative and (+) = Positive
ES_i = External Sector Main Variable 0 = Zero

9.2.5. Step 5: External Sector Development Index (SX_i Index)

The external sector development index (SX_i) is equal to the external sector main variable (ES_i) divided by the GDP growth rate (ΔGDP)

$$SXi = \frac{ES_i}{\Delta GDP} \quad (1.5.)$$

Analysis of the SX_i Results

High Vulnerability

If the ES_i and ΔGDP are located in these parameters ($+ES_i/+\Delta GDP$) or ($-ES_i/-\Delta GDP$) or ($ES_i = 0$ / $\Delta GDP = 0$), then the SXi can be classified in the category of high vulnerability (see Table 3). The ES_i and GDP in this category are moving in the same direction, showing the strong connection between these two values (ES_i and GDP).

Normal Vulnerability

If the ES_i and ΔGDP are located in these parameters ($+ES_i$ /$-\Delta GDP$) or ($+ES_i$ / 0), then the SX_i can be classified in the category of normal vulnerability (see Table 3). The category of normal vulnerability shows how the ES_i grows more rapidly than the GDP, and this result will show how the external sector depends on the world trade trend, but also that it cannot be affected so greatly under the GDP growth rate.

Low Vulnerability

If the ES_i and GDP are located in these parameters ($-ES_i$ / $+\Delta GDP$) or ($-ES_i/0$) or ($0/+\Delta GDP$) or ($0/-\Delta GDP$), then the SX_i can be classified in the category of low vulnerability (see Table 3). The category of low vulnerability shows how the ES_i growth is slower than the GDP growth rate; this result will show clearly that the external sector is not a key factor when it comes to affecting the GDP growth rate of any country.

TABLE 3
SX_i Cycle Levels

ΔGDP / ES_i	**$+\Delta GDP$**	**$-\Delta GDP$**	**$\Delta GDP=0$**
$+ES_i$	**Level 1.1** **High Vulnerability** **$+ES_i/+\Delta GDP = +SX_i$** **Acceptable performance**	**Level 1.2** **Normal Vulnerability** **$+ES_i/-\Delta GDP = -SX_i$** **Weak performance**	**Level 1.3** **Normal Vulnerability** **$+ES_i/0 = SX_i = \infty$** **Acceptable performance**
$-ES_i$	**Level 2.1** **Low Vulnerability** **$-ES_i/+\Delta GDP = -SX_i$** **Weak performance**	**Level 2.2** **High Vulnerability** **$-ES_i/-\Delta GDP = +SX_i$** **Acceptable performance**	**Level 2.3** **Low Vulnerability** **$-ES_i/0 = SX_i = \infty$** **Weak performance**
$ES_i=0$	**Level 3.1** **Low Vulnerability** **$0/+\Delta GDP = SX_i = 0$** **Weak performance**	**Level 3.2** **Low Vulnerability** **$0/-\Delta GDP = SX_i = 0$** **Weak performance**	**Level 3.3** **High Vulnerability** **$0/0 = SX_i = 0$** **Weak performance**

Variables:
▲ = High ▼ = Low ΔGDP = Foreign Direct Investment Volume Growth Rate
ES_i = External Sector Main Variable (-) = Negative and (+) = Positive 0 = Zero

9.3. Application of the External Sector Development Index (SX_i)

The external sector development index (SX_i) will analyze ASEAN-5's (Indonesia, Malaysia, Philippines, Singapore, Thailand) and China's external sector performance and vulnerability between 1986 and 2001 respectively through application. The reason for applying the SX_i is to observe performance, vulnerability and SX_i cycles. The objective for applying the SX_i Index is to observe how trade and investment growth together can affect growth of the GDP. The reason for incorporating FDI growth together with trade volume growth is to observe how both variables can be affected by possible deep international trade or financial crises. Specifically, the SX_i is applied to the ASEAN-5 members, as well as China, to observe the effect of the 1997 financial crisis on these countries. The application of SX_i to the above countries shows that the countries most affected by the 1997 financial crisis were the Philippines SX_{i-1998} = -23 (see Figure 5), Singapore SX_{i-1997} = -20 (see Figure 2), Thailand SX_{i-1997} = -6 (see Figure 4), Malaysia SX_{i-1997} = -4 (see Figure 3), Indonesia SX_{i-1997} = -3 (see Figure 1) and China SX_{i-1997} = 0 (see Figure 6).

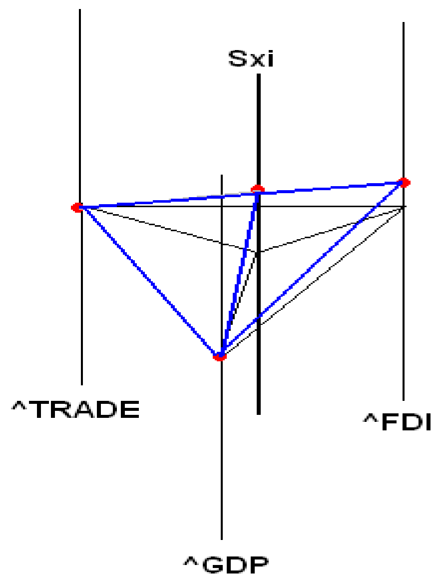
We can observe clearly that the financial crisis strongly affected the Philippines (1997), Singapore (1997-1998), Thailand (1997-1998), Indonesia (1997) and Malaysia (1997). In the case of China (1998), this country was affected but not at the same level among the ASEAN-5 members. The results show how strong the dependency is on the external sector of ASEAN-5 members and China; these countries are highly vulnerable to financial and world trade crises. In the period of 1986-2001, the external sector of ASEAN-5 members and China present an acceptable external sector performance, but irregularities in external sector behavior between 1986 and 2001 can be detected in two ASEAN-5 members: the Philippines (low participation of the external sector on the world trade) and Singapore (high exposure of the external sector on the world trade). China shows the best performance of its external sector compared to many ASEAN-5 members between 1986 and 2001.

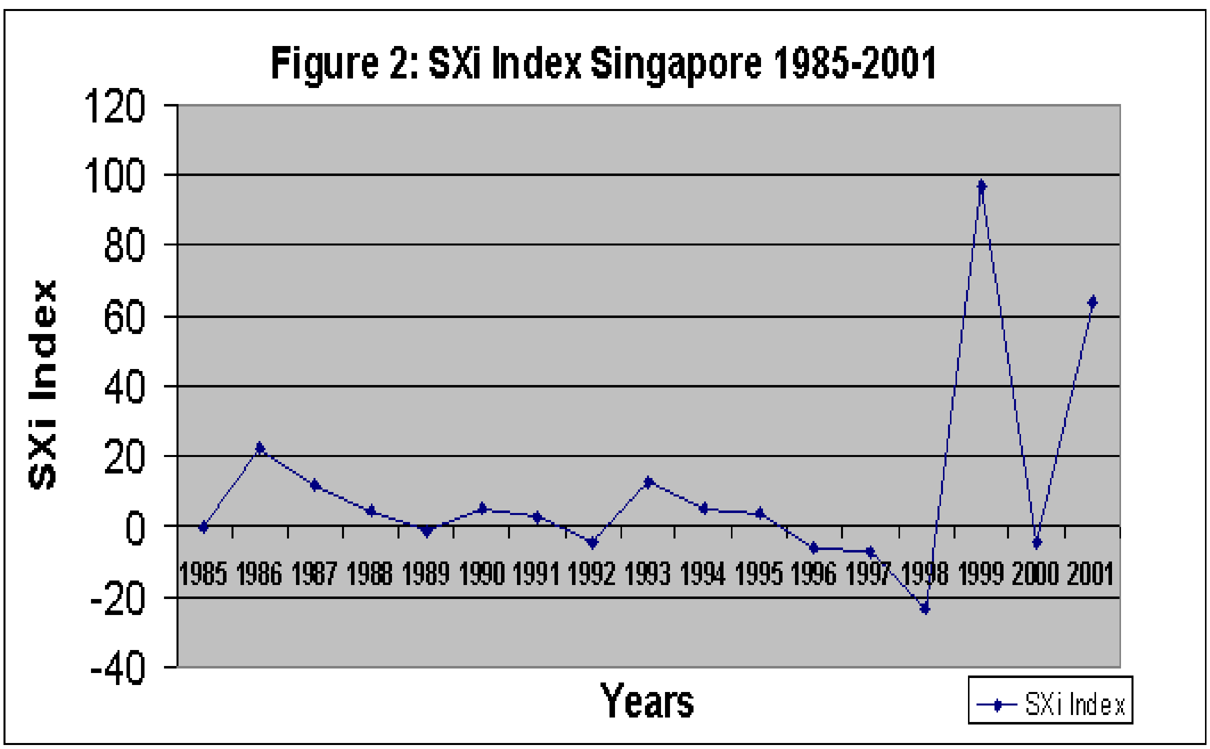
On other hand, this part of this research is interested in demonstrating whether the ES_i and GDP growth have a correlation. The results show that in China (r = 0.68), Malaysia (r = 0.67) and Indonesia (r = 0.77), there exists a strong correlation between the ES_i and GDP; in the case of Singapore (r = 0.30), Thailand (r = 0.23) and Philippines (r = -0.23), there is a lower or negative correlation. This shows that China, Malaysia and Indonesia have a high dependency on the performance of its external sector on international trade, together with FDI growth. Thailand and Singapore have been classified in the category of normal vulnerability; the normal vulnerability of Thailand is caused by its lower trade volume and FDI, but in the case of Singapore (low correlation), which also demonstrates normal vulnerability, this is due to different proportions of growth between trade volume and FDI growth. The Philippines shows a negative correlation between the ES_i and GDP growth; it shows low vulnerability of the external sector, where its trade volume growth and FDI growth are slow and small.

In the SX_i cycles between 1986 and 2001 (16 years) among these ASEAN-5 members and China, we observe that the SX_i cycles have these results: China shows the best performance, it is located in Level 1.1 (15 years) and Level-2.1 (1 year). Among ASEAN-5 members the SXi cycles show that Malaysia is in Level-1.1 (12 years), Level 2.2 (3 years) and Level 1.2 (1 year). In other hand Indonesia and Thailand show close behavior in their SX_i cycles: Indonesia has Level 1.1 (11 years), Level 2.2 (4 years), and Level 1.2 (1 year), whereas Thailand is located in Level-1.1 (11 years), Level-2.2 (1 year), Level 2.1 (1 year) and Level 1.2. (3 years). In the specific case of Singapore, this country is located in Level 1.1 (9 years), Level 2.2 (1 year), Level 2.1 (5 years) and Level 1.2 (1 year). The reason why Singapore shows different results in its SX_i cycles originates from its high dependency on the international markets, especially with the United States of America. The Philippines is located in Level 1.1 (8 years), Level 1.2 (5 years), and Level 2.1 (3 years), which originates from the low participation of its external sector in the world economy, because of its small amount of export products with high added value to the international markets.

Source: World Bank 2009

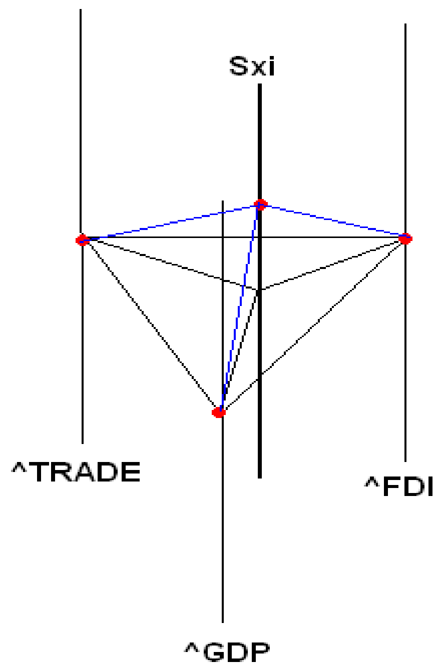
Average SXi Index: Indonesia 1985-2001

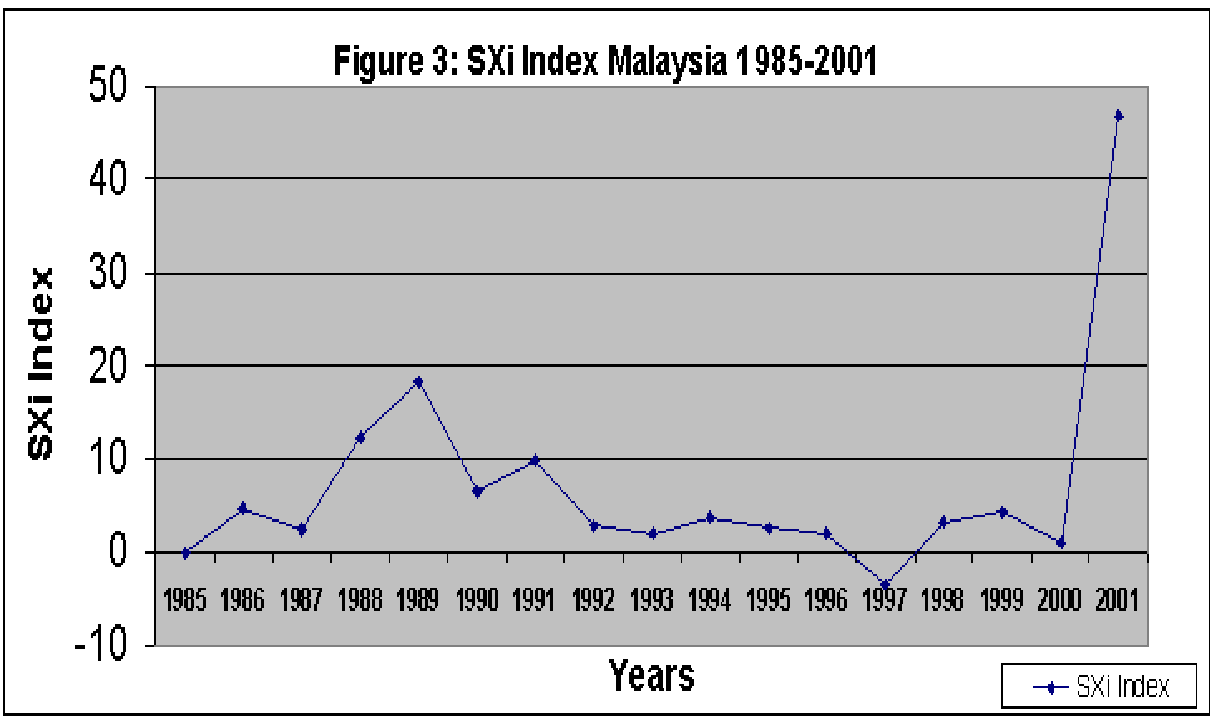




Source: World Bank 2009

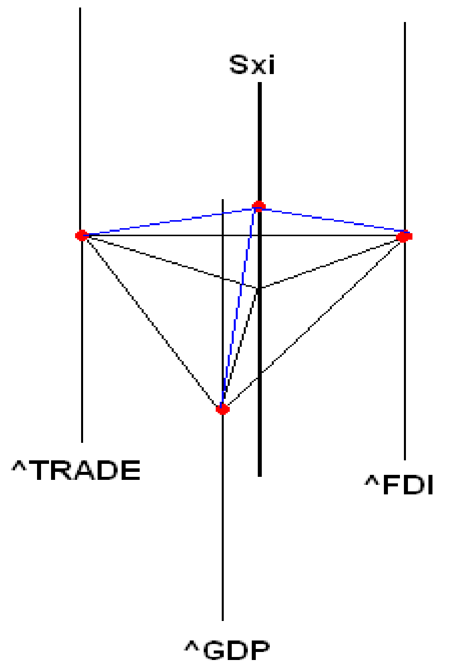
Average SXi Index: Singapore 1985-2001





Source: World Bank 2009

Average SXi Index: Malaysia 1985-2001



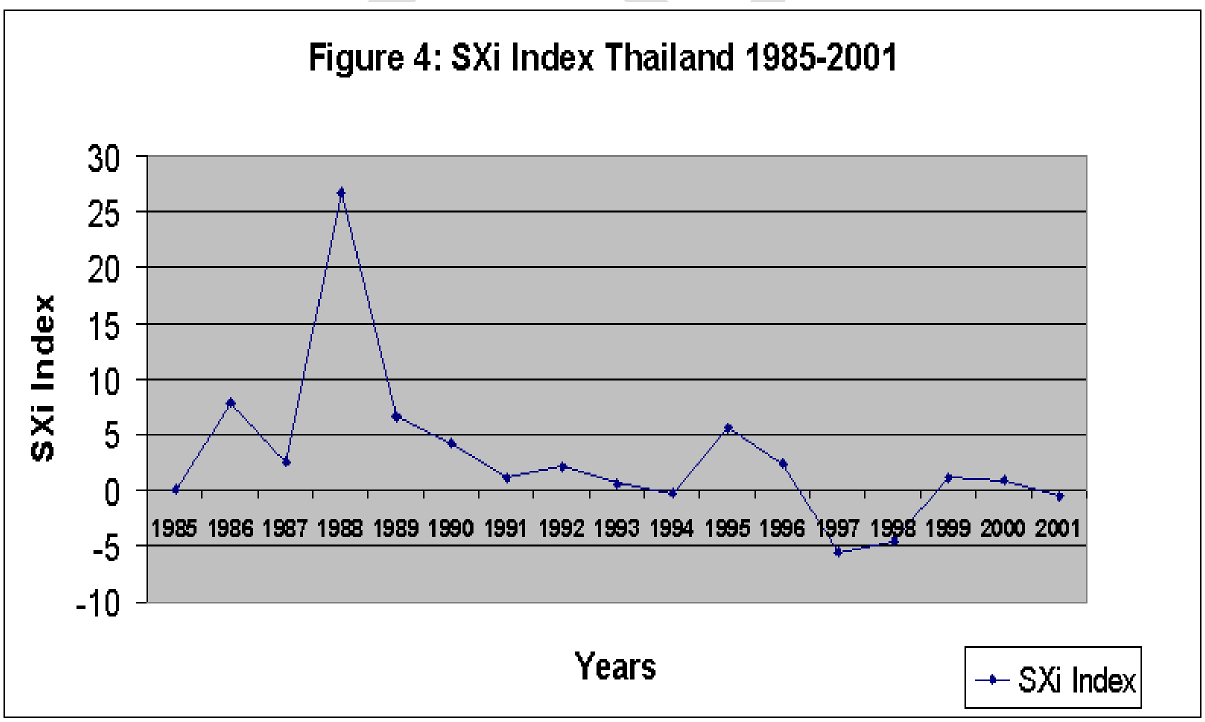
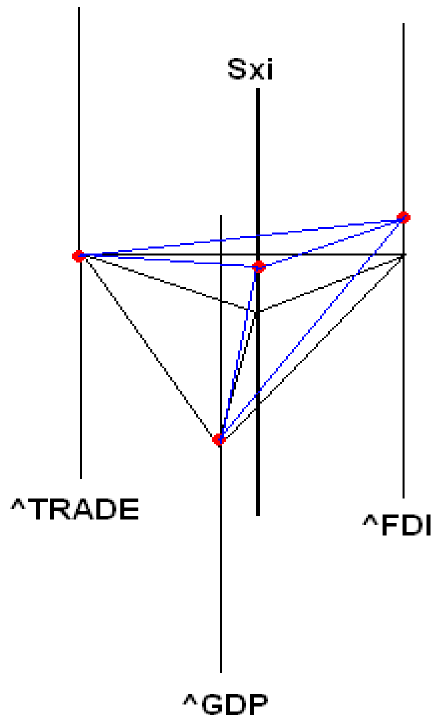
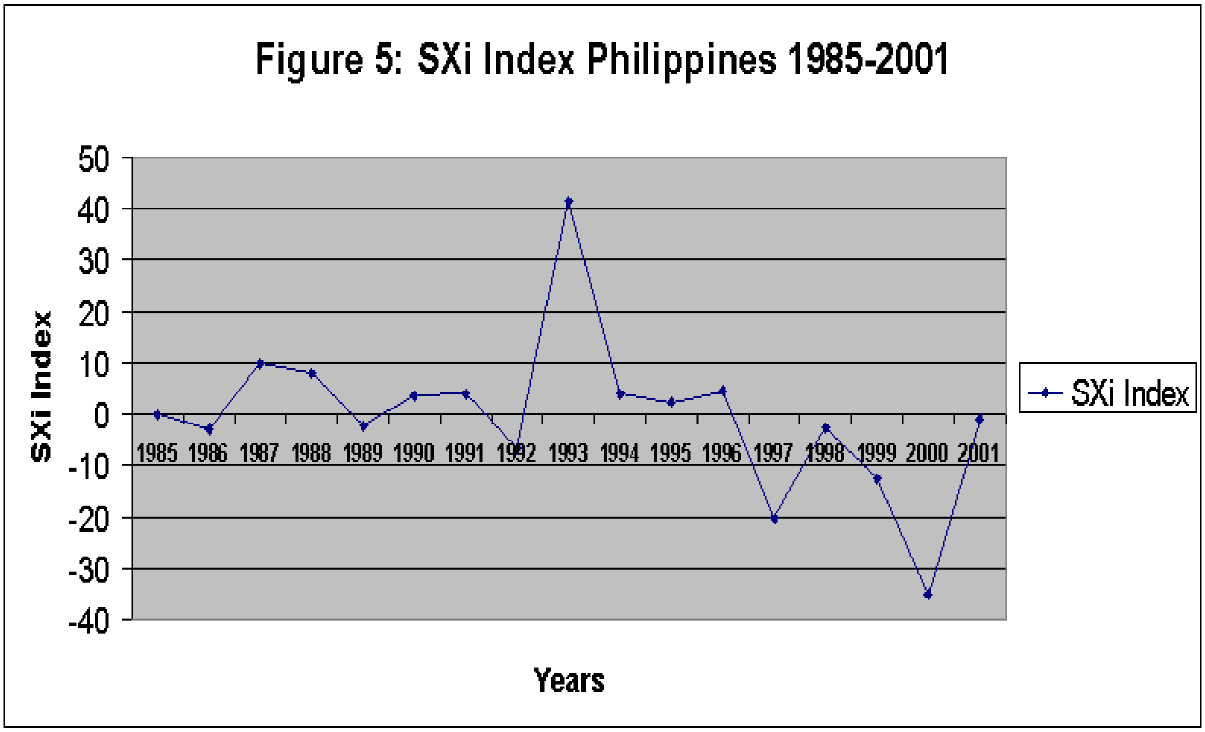


Figure 4: SXi Index Thailand 1985-2001

Source: World Bank 2009

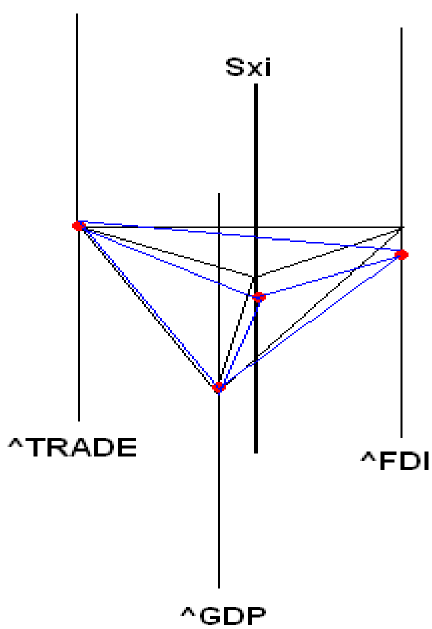
Average SXi Index: Thailand 1985-2001

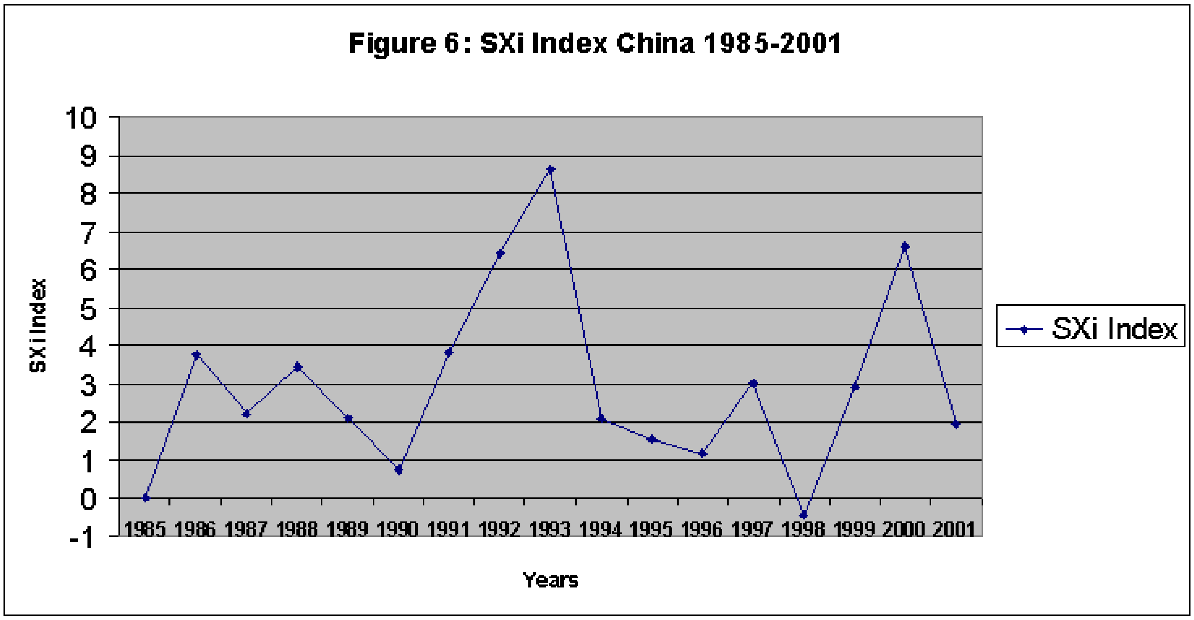




Source: World Bank 2009

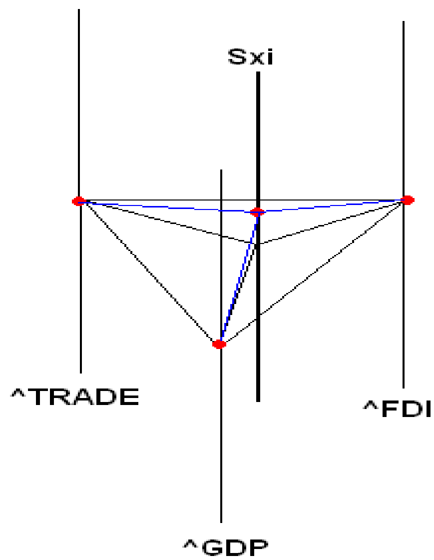
Average SXi Index: Philippines 1985-2001





Source: World Bank 2009

Average SXi Index: China 1985-2001



9.4. Concluding Remarks

With the application of the external sector development index (SXi) to the study of trade liberalization and openness, we observe that trade volume and FDI volume growth need to be joined into a single variable in order to study the external sector of any country or region. This single variable will be called the external sector main variable (ES_i). The external sector development index (SXi) can thus be used as an alternative index to study trade liberalization cycles effectively. In fact, the SXi can be considered a complementary analytical tool together with terms of trade (ToT) and the openness index (O_i).

CHAPTER 10
UNKNOWN DIMENSIONS IN THE STUDY OF MARKET BEHAVIOR

10.1. Introduction

In the study of economics, market behavior is based on the use of the spply and demand laws of interaction represented graphically by the traditional supply and demand curves. As far as the application of the analytical graphical method in economics is concerned, the major contribution of Antoine Augustin Cournot must be mentioned. Cournot (1838) derived the first formula for the rule of supply and demand as a function of price. He was also the first economist to draw these supply and demand curves on a graph. Cournot believed that economists should utilize graphs only to establish probable limits and express less stable facts in more absolute terms. He further held that the practical use of mathematics in economics involves not only strict numerical precision, but also graphical visualization. In fact, Cournot suggest the use of the first quadrant of the 2-dimensional Cartesian coordinate system by drawing two linear functions to represent demand and supply curves in the same graphical space. Besides Cournot, other innovative economists who contributed to these analytical graph systems in economics over time were Leon Walras, Vilfredo Pareto, Alfred Marshall and Francis Ysidro Edgeworth (McClelland, 1975). The main idea behind applying supply and demand laws into the study the market behavior, is to find the market equilibrium among a large possible combination between two specific variables, i.e. the price commodity (exogenous variable) and quantity (endogenous variable) into a fixed period of time and space. The mythical part here is how different economic agents (buyers and sellers) react or overreact unconditionally according to the unexpected behavior of the price commodity behavior on the quantity demanded and supplied.

In fact, the study of market equilibrium can be divided into partial and general market equilibrium. At the same time, partial market equilibrium is divided by linear modeling and non-linear modeling from a mathematical and graphical perspective. Basically, partial market equilibrium by linear modeling is based on the analysis of a single commodity and three variables: quantity-demanded (Q_d), quantity-supplied (Q_s) and the price commodity (P). This specific model is represented by two linear equations. The main characteristic of the demand linear equation (see Expression 1) is that the slope is always negative (downward) because price and quantity-demanded move in opposite directions; if the price decreases, the quantity-demanded increases, and vice versa. The supply linear equation (see Expression 2) shows that the slope is positive (upward) because price and quantity move in the same direction. This means that if the price increases, the quantity-supplied increases, and vice versa. Additionally, the price commodity equilibrium (P^*) is generated by the elimination of variables from the identity $Q_d = Q_s$ (see Expression 3). Furthermore, quantity equilibrium (Q^*) is the result of replacing the price equilibrium (P^*) into the quantity-demanded equation (Q_d) (see Expression 4). Finally, the market equilibrium (ε) is represented by expression 5.

(1.) $Q_d = \alpha - \beta P$
(2.) $Q_s = -\pi + \lambda P$
(3.) $Q_d = Q_s \Rightarrow P^*$

(4.) $Q^* = Q_d = \alpha - \beta P^*$

(5.) $\varepsilon = (P^*, Q^*)$

However, partial market equilibrium by non-linear modeling is represented by the application of a linear equation (see Expression 7) and nonlinear equation (see Expression 6) to represent the quantity-demanded function (Q_d) and the quantity-supplied function (Q_s). Initially, we must find the price equation by the construction of a single equation (see Expression 8). Subsequently, we find the price commodity equilibrium (P^*) based on the application of the quadratic formula (see Expression 9) into the single equation or price equation. Hence, we consider only the positive final value from the quadratic function because only positive values are economically admissible. The last step is to replace the price commodity equilibrium (P^*) into the quantity-demanded function (Q_d) to find the final quantity equilibrium (Q^*), shown in expression 10.

(6.) $Q_d = \alpha - P^2$

(7.) $Q_s = \lambda P - \pi$

(8.) $f(P) = Q_d + Q_s$

(9.) $P_1^*, P_2^* = \frac{-b \pm (b^2 - 4ac)^{1/2}}{2a} \Rightarrow P_1^*, P_2^* \cap \mathbb{R}_+$

(10.) $Q^* = Qd = Q_d = \alpha - (P^*)^2$

(11.) $\varepsilon = (P^*, Q^*)$

It is important to mention that the partial market equilibrium assumes the use of the *Ceteris Paribus* assumption. The idea is to isolate the less important variables from the study of the market behavior and focus our attention on two specific variables only: price commodity (P) and the quantity (Q). In fact, price commodity (P) is the only variable that can affect quantity; we leave the rest of variables frozen for a while until a series of experimental combinations between price commodity (P) and quantity (Q) have been made. Nevertheless, general market equilibrium is based on the idea of a multi-commodity market. The idea is to include more commodities into the analysis, represented by n-equations, into the quantity-demanded function (see Expression 12) and the quantity-supplied function (see Expression 13). Hence, market equilibrium is represented by expression 14. But also is important to remark upon the fact that the general market equilibrium also uses the *Ceteris Paribus* assumption within its model.

(12.) $Qd_i = Qd_i (P_1, P_2, \ldots, P_\infty) \quad i = 1,2,\ldots.\infty$

(13.) $Qs_i = Qs_i (P_1, P_2, \ldots, P_\infty) \quad i = 1,2,\ldots.\infty$

(14.) $\varepsilon_i = (P_1, P_2, \ldots, P_\infty) = 0$

Afterwards, a short review of the supply and demand model was carried out. Now the question is whether the classic analysis of supply and demand can adequately keep up with the quickly-changing behavior of the market as a whole. We suggest that market behavior needs to be studied by examining the interaction of a large number of sub-markets. At the same time, all sub-markets are in a permanent state of dynamic imbalance under the application of the *Omnia Mobilis* assumption.

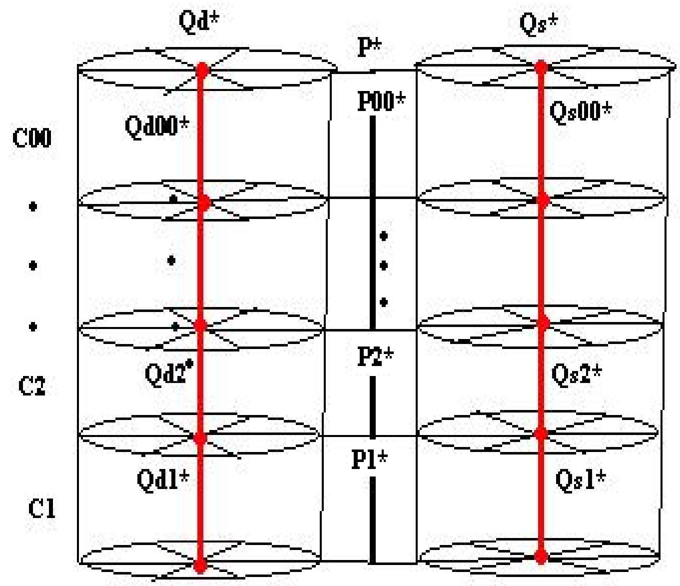
In fact, the market can be considered as a multidimensional system that interacts and works in perfect harmony without any restrictions or conditions. Our idea of equilibrium is totally different from the traditional classic view because equilibrium is a state of synchronized imbalance that can appear unexpected throughout an unlimited time. The state of synchronized imbalance is considered a fleeting momentum, which originates from the relaxation (or less instability) of all sub-markets. It depends on economic, social, political, technological, and environmental conditions, market structures, institutions and the behavior of economic agents. In the same chapter, we suggest the uses of the state of dynamic imbalance (DIS) that can help to explain possible unexpected market behavior. Hence, the state of dynamic imbalance is not a state of chaos; it is an unconditional and unexpected complex sensitive reaction of a large number of sub-markets that is generated by different institutions, economic agents, economic, political, social, technological, and environmental forces simultaneously under uncertain non-rational behavior. Therefore, all sub-markets do not necessarily need to be in equilibrium simultaneously, because all sub-markets can keep in a state of dynamic imbalance. Moreover, all sub-markets can experience, at any time, a state of synchronized imbalance, which is a short fleeting transitional state, and thus unpredictable and spontaneous.

Therefore, the market equilibrium is not a static and isolated phenomenon; it is a transitional and evolutionary state that cannot be arbitrarily controlled and determined. We need to remember that the study of the market equilibrium is not a natural phenomenon that can be measured or demonstrated exactly by science. In this particular case, the market equilibrium can be considered a state of dynamic imbalance, where the interaction among humans must be satisfied that necessities always change according to different periods of the history.

10.2. The Analysis of Market Behavior under the Application of the State of Dynamic Imbalance (DIS)

The analysis of market behavior under the application of the state of dynamic imbalance is led by the construction of the quantity-demanded equilibrium (Q_d^*) (see Expression 15) and quantity-supplied equilibrium (Q_s^*) (See Expression 16), Hence, the interaction between the Q_d^* and Q_s^* is to find the price commodity equilibrium (P^*) for any commodity. The measurement of quantity-demanded equilibrium (Q_d^*) depends on the interaction of a large amount of variables without any restriction(s) in number or classification (See Expression 15), but the case of partial market equilibrium shows that its major restriction is only that commodity price (P) can affect quantity (Q). Therefore, we try to account for the major number of variables that can affect the quantity-demanded equilibrium (Q_d^*). From a graphical perspective, the quantity-demanded equilibrium (Q_d^*) is the vertical axis among all sub-axes located in the bottom part of each sub-level respectively. All these sub-axes in the bottom part of each sub-level are connected directly to the quantity-demanded equilibrium (Q_d^*) by straight lines until the demand surface can be built by sub-level, where each sub-level represents a specific commodity in the market. If we join all sub-levels together, we can generate a large cylinder, assuming that each sub-axis is within its sub-level apply growth rates (Δ) in real time (☼) (see Figure 1). Additionally, we apply the *Omnia Mobilis* assumption to generate the relaxation of all variables that can potentially affect the demanded quantity equilibrium (Q_d^*). This is because we avoid isolating some variables that the *Ceteris Paribus* assumption considers less important.

Figure 1
Quantity-Demanded Equilibrium (Qd*), Quantity-Supplied Equilibrium (Qd*) and Price Commodity Equilibrium (P*)



On the other hand, the quantity supplied equilibrium (Q_s^*) also accounts for a large number of variables. We would like to clarify here that the number of variables is the same as the quantity-demanded equilibrium (Q_d^*) but with different classifications respectively. Therefore, into the quantity-demanded equilibrium (Q_d^*) and quantity supplied equilibrium (Q_s^*) play an infinity number of variables that keep in constant change(s) within its sub-coordinate systems all the time until the final price commodity equilibrium (P^*) appears. This is visualized graphically in Figure 2.

We also assume that the price commodity equilibrium (P^*) (see Expression 17) is result of the stress or relaxation of all variables interacting within the quantity-demanded equilibrium (Q_d^*) and the quantity-supplied equilibrium (Q_s^*). There are two possible scenarios. Firstly, if all quantity-demanded equilibrium (Q_d^*) and quantity-supplied equilibrium (Q_s^*) variables are relaxed, then the price commodity equilibrium (P^*) becomes lower. Secondly, if all quantity-demanded equilibrium (Q_d^*) and quantity-supplied equilibrium (Q_s^*) variables are stressed, then the price commodity equilibrium (P^*) becomes higher. The stress or relaxation of variables is based on the contraction or expansion of all variables that can affect quantity the demanded equilibrium (Q_d^*) and quantity supplied equilibrium (Q_s^*). The behavior of the quantity-demanded equilibrium (Q_d^*) and quantity-supplied equilibrium (Q_s^*) constantly experience "the umbrella effect". This means that if all variables suffer stress (or the umbrella surface is closed) then the price commodity equilibrium (P^*) becomes higher, or that if all variables suffer relaxation (i.e. the umbrella surface is open), the price commodity equilibrium (P^*) becomes lower according to Figure 2. From a graphical perspective the price commodity equilibrium (P^*) is a vertical axis located between the supply and demand surfaces. We can also observe in Figure 2 that each commodity has its specific sub-level, quantity-demanded equilibrium (Q_d^*) and quantity-supplied equilibrium (Q_s^*), together with its specific price commodity equilibrium (P^*).

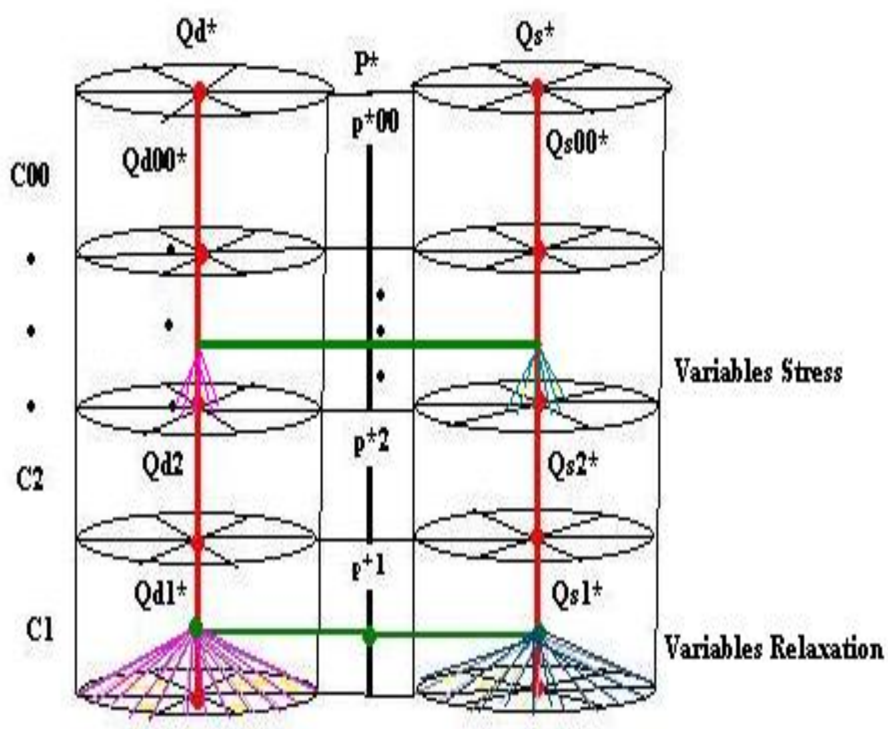
(15.) $Q_d^* = Q_d^* (☼\Delta V_1, ☼\Delta V_2,\ldots,☼\Delta V_\infty)$

(16.) $Q_s^* = Q_s^* (☼\Delta V_1, ☼\Delta V_2,\ldots,☼\Delta V_\infty)$

(17.) $☼Q_d^* \approx ☼P^* \approx ☼Q_s^*$

Figure 2

The Supply Surface and the Demand Surface



10.3. **Concluding Remarks**

This chapter concludes that the market is composed of a large number of sub-markets in a state of dynamic imbalance. Therefore, if all sub-markets keep in a state of dynamic imbalance, the momentum of this state of synchronized imbalance can appear within different sub–markets simultaneously. The momentum of the state of synchronized imbalance results from the relaxation of all sub-markets without the imposition of any restriction such as the *Ceteris Paribus* assumption. In fact, the momentum of the state of synchromized imbalance is a fleeting and unpredictable leak momentum that can appear spontaneously among all sub-markets at any time. Furthermore, the price commodity equilibrium (P^*) depends upon the relaxation or stress of all the variables that affect the quantity-demanded equilibrium (Q_d^*) and the quantity-supplied equilibrium (Q_s^*).

CHAPTER 11
SUPPLY & DEMAND SURFACES

11.1. Introduction

For centuries, many economists have had the opportunity to use different graphical methods to explain various economic phenomena based on the application of 2-dimensional or, so far, 3-dimensional coordinate spaces. These are cases whereby the analytical graph system is used in economics, where the form of the graph gives an idea of the possible class of the functions describing the relationship between *X* and *Y* variables. As far as the application of the analytical graphical method in economics is concerned, it is necessary to mention the major contribution of Antoine Augustin Cournot (1838). Cournot derived the first formula for the rule of supply and demand as a function of price. He was also the first economist to draw these .supply and demand curves on a graph (2-dimensional view). Cournot believed that economists should utilize graphs only to establish probable limits and express less stable facts in more absolute terms. He further held that the practical use of mathematics in economics involves not only strict numerical precision, but also graphical visualization.

This chapter focuses on introducing a new graphical method called supply and demand surfaces. The rationale of supply and demand surfaces revolves around the efficacy of multidimensional graphs in the storage of meta-database and the visualization of multi-variable data behavior based on the application of multi-dimensional coordinate spaces. The construction of supply and demand surfaces is based on the application of the infinity dimensional coordinate space.

11.2. Supply and Demand Surfaces:
11.2.1. Introduction

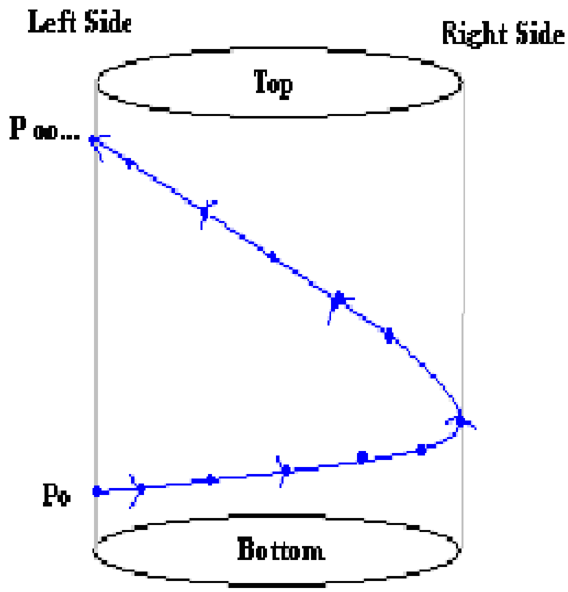
The optical visualization of supply and demand curves using a 2-dimensional format continues to be used by economists today. The demand curve shows the inverse relationship between prices and quantity-demanded for any good or service, represented on a simple graph. This graph shows the relationship between price and quantity-demanded according to the law of demand, as seen in the downward slope effect. The supply curve shows the amount of a certain goods or service that producers make available for each possible price during a specific period of time. The supply curve shows that price and quantity-supplied is proportional according to the law of supply, seen in the upward slope effect (McConnell and Brue, 2002).

To build the supply and demand surfaces, five basic steps are required:

a. First Step: The General Real Prices Curve (GP-Curve)

The initial stage in the construction of the general prices curve starts by the creation of the first quadrant in the infinity dimensional coordinate space under the general approach; this construction of the first quadrant is based on joining each price line or each "Y_i" axis $(Y_0, Y_1, Y_2, Y_3 \ldots Y_\infty)$ until all price lines or all "Y_i" axes together generate a single cylinder (or the first quadrant) on the top of the infinity dimensional coordinate space under the general approach, where each price line has values between 0 and ∞…Thereafter, each value price is plotted on each price line. Finally, if we proceed to join each value price plotted in each price line on the first quadrant of the infinity dimensional coordinate space under the general approach from the bottom left side of the quadrant (**Po**) to the top right side (**P∞…**) then we can begin observing the general prices curve. The general prices curve has an upward slope trend (see Figure 1). We conclude that the GP-curve behavior shows a geometrical progression and no arithmetic progression according to the traditional supply and demand curve from a 2-dimensional view.

Figure 1:
General Prices Curve



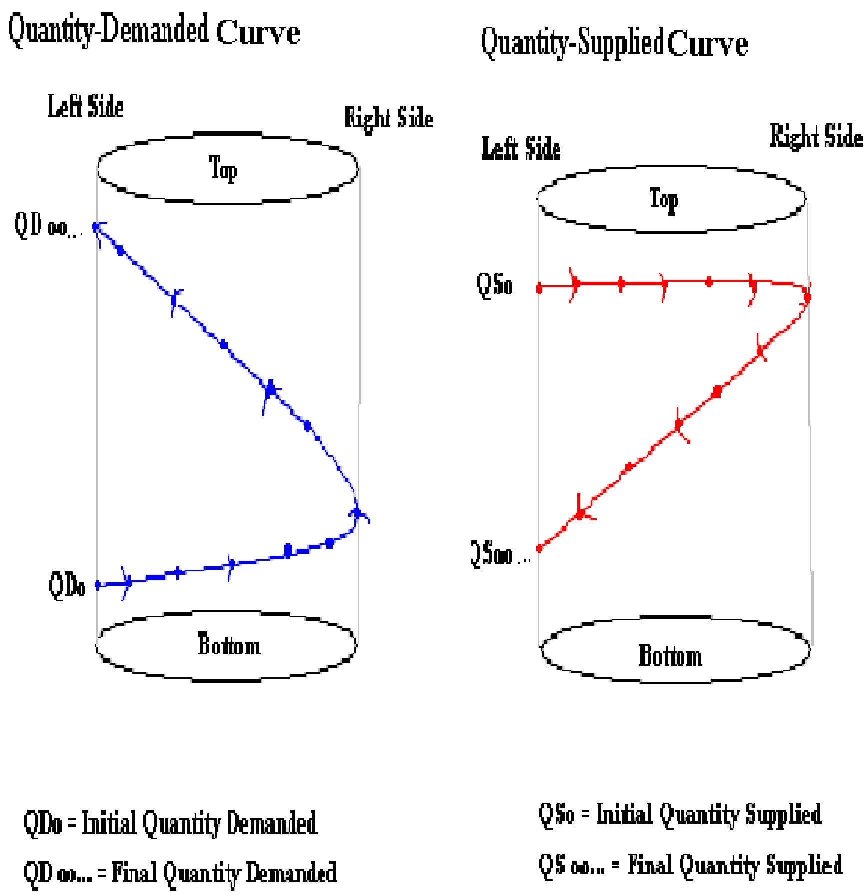
b. Second Step: Quantity-Demanded and Quantity-Supplied Curves

The second quadrant of the infinity dimensional coordinate space under the general approach shows the quantity-demanded and quantity-supplied curves. The quantity-demanded curve is plotted from the bottom left side ($\mathbf{QD}_o$) to the top right side ($\mathbf{QD}_{\infty...}$) in the second quadrant of the infinity coordinate space under the general approach (See figure 2). The quantity-demanded curve shows an upward slope trend.

A second scenario is when the quantity-supplied curve is plotted from the top left side ($\mathbf{QS_o}$) to the bottom right side ($\mathbf{QS}_{\infty...}$) in the second quadrant of the infinity dimensional coordinate space under the general approach. The quantity-supplied curve shows a downward slope trend (see Figure 2).

Figure 2:

Quantity-Demanded and Quantity-Supplied Curves

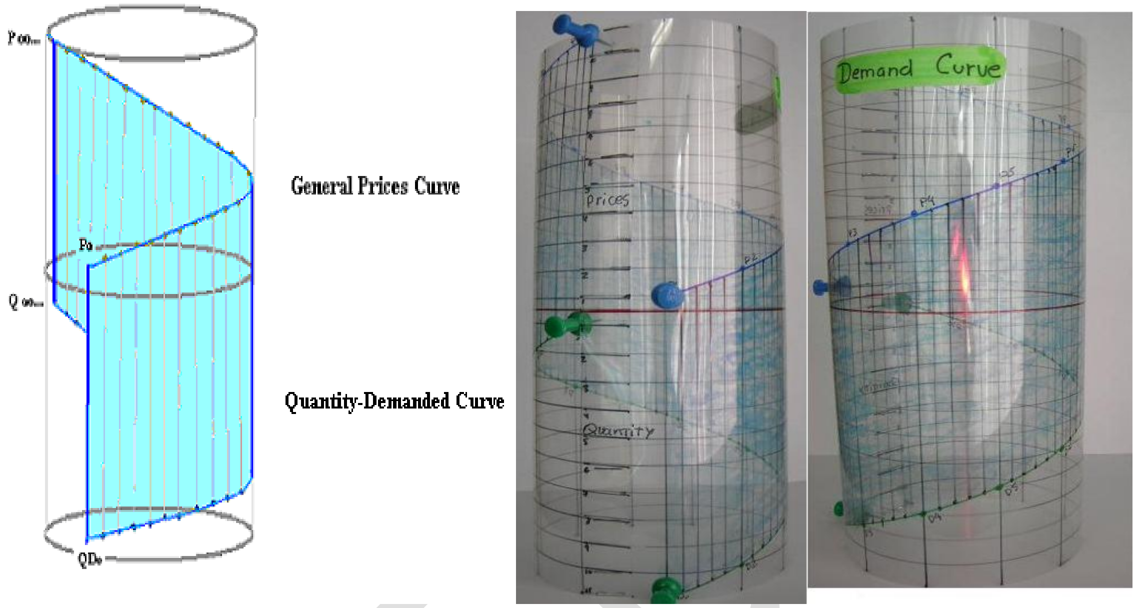


c. Third Step: The Demand Surface

Our classic visualization of the demand curve is one where the quantity-demanded is determined on the horizontal axis "X" and price on the vertical axis "Y". In the case of the demand surface, this is fixed between two quadrants in the infinity dimensional coordinate space under the general approach. However, to build the demand surface, we need to follow a series of steps: the first step is the construction of the general real prices curve from P_o to $P_{\infty\ldots}$; the second step is to build the quantity-demanded curve from QD_o to $QD_{\infty\ldots}$ Finally, the construction of the demand surface is based on joining each real price value from the general price curve with each value of the quantity-demanded curve respectively. We can observe that the demand surface looks like a large band with linear spiral behavior (see Figure 3). The demand surface continues to follow the law of demand: all else being equal, as prices fall, the quantity-demanded rises, and as prices rise, the quantity-demanded falls. The demand surface shows a downward slope trend into the infinity dimensional coordinate space under the general approach.

The difference between the demand curve from the 2-dimensional approach and the demand surface is that the 2-dimensional demand curve only offers one buyer and one type of goods or service into its analysis. Using the demand surface, however, opens the possibility of visualizing many buyers (an infinite number of buyers) and many goods or services at different levels of price.

Figure 3
The Demand Surface

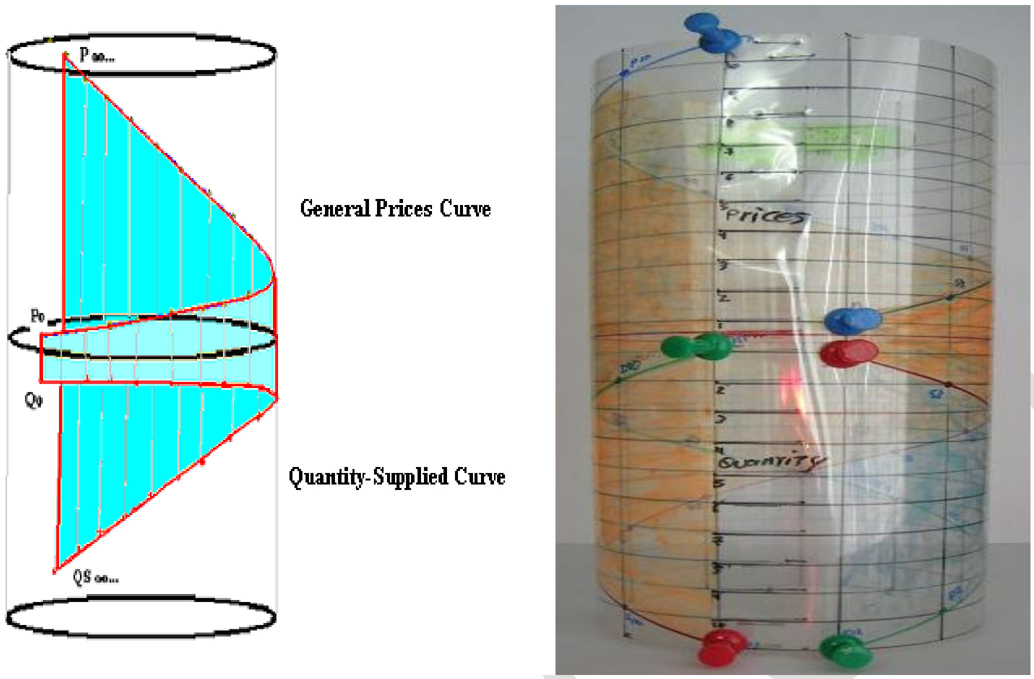


d. Fourth Step: The Supply Surface

The supply surface follows similar steps to those of the demand surface. The supply surface continues to follow the law of supply: as prices rise, the quantity-supplied rises; as prices fall, the quantity-supplied falls. The supply surface continues to have an upward slope trend, but with a different graphical representation from the 2-dimensional approach. The construction of the supply surface involves a series of steps: the first step is the creation of the general prices curve from P_o to $P_{\infty\ldots}$; the second step is the construction of the quantity-supplied curve from QS_o to $QS_{\infty\ldots}$ Finally, the supply surface is based on joining each real price value from the general real prices curve with each value of the quantity-supplied curve located under the second quadrant in the infinity coordinate space respectively. We can observe that the supply surface looks like a large band with spiral behavior with an upward slope trend (see Figure 4).

The difference between the supply curve from the 2-dimensional approach and the supply surface is that the supply curve from the 2-dimensional approach only offers one seller and one type of goods or service into its analysis. On the other hand, the supply surface opens the possibility of visualizing many sellers (an infinite number of sellers) and many goods or services at different levels of price.

Figure 4
The Supply Surface

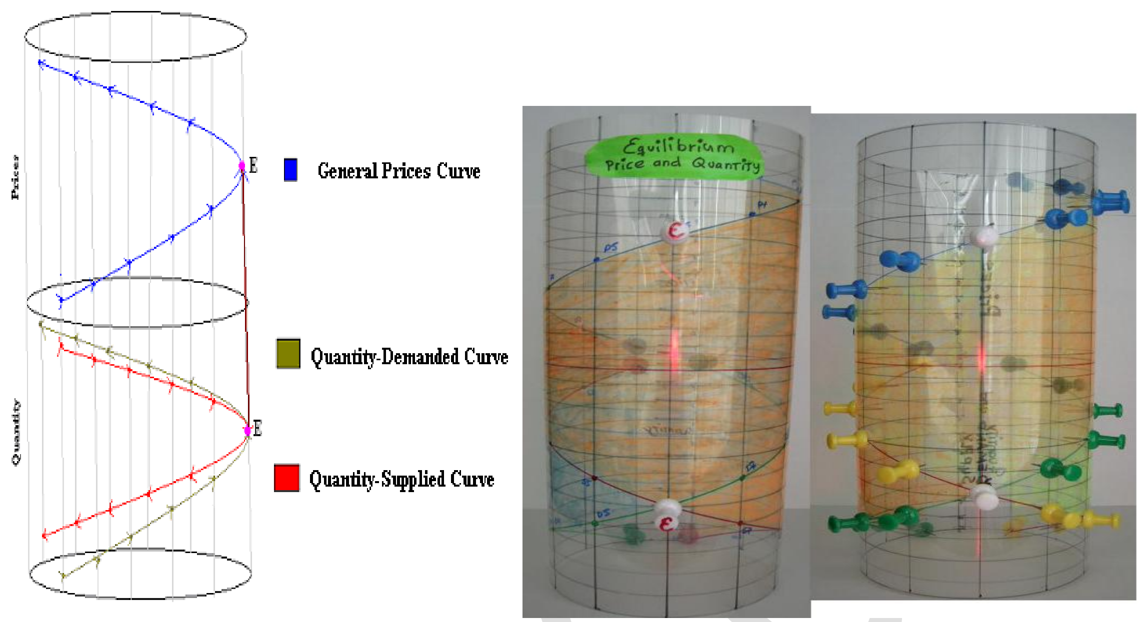


e. Fifth Step: The Multi-dimensional Market Equilibrium

When the first cylinder (general real prices curve) is joined on the top to the bottom of the second cylinder (quantity-demanded and quantity-supplied curves), we get a single cylinder divided into two cylinders. The first cylinder is what affects the behavior of all values on the second cylinder shared by quantity-demand and quantity-supplied curves simultaneously.

The multi-dimensional market equilibrium can be visualized when supply and demand surfaces intercept at some point between the first and second quadrant of the infinity coordinate space under the general approach. Finally, the interception point between these supply and demand surfaces is when specific price and quantity value is joined among both quadrants of the infinity dimensional coordinate space under the general approach (see Figure 5).

Figure 5
The Multi-dimensional Market Equilibrium



11.3. Concluding Remarks

According to this research, multidimensional graphs offer a new opportunity to visualize economics from a new perspective of analysis from a multi-dimensional view. We can prove that the infinity dimensional coordinate space under the general approach offers an alternative multi-dimensional coordinate space to facilitate the study of any economic phenomena, whether at macro-level or micro-level, and whether the analyses are short-term or long-term. To sum up, multi-dimensional graphs seem set to play an important role in research as well as in the teaching-learning process of economics through the series of new methods and techniques of constructing graphs detailed throughout this chapter.

We can observe that with supply and demand surfaces:

- ✓ The behavior of prices in the long run has a geometrical progression (spiral line) and no arithmetic progression (single line) trend according to the 2-dimensional view
- ✓ Two long bands with a spiral trend represent the supply and demand curves from the multi-dimensional view, but in the case of the 2-dimensional view, these are represented by two single lines.
- ✓ Prices can affect the quantity demanded and supplied, but quantity demanded and supplied can affect price behavior at the same time.
- ✓ The application of multi-dimensional graphs can help to reduce the application of the *Ceteris Paribus* assumption into economic analysis in the short and long term.
- ✓ The supply and demand surfaces can show how many markets interact simultaneously, and which different markets these are.

CHAPTER 12
THE GENERAL ECONOMIC STRUCTURES COMPOSITION MODEL (GESC-MODEL)

12.1. Introduction

This chapter will introduce a new form of graphical and analytical economic modeling called the general economic structure composition model (GESC-Model). The general economic structures composition model (GESC-Model) has basically three specific objectives.

- The first objective is to present a new set of macroeconomic indicators generated by the economic base -EB- and the general economic structures -GES's-. These indicators are totally different from the classic analysis of gross domestic product (GDP), because the GESC-Model includes the GDP into its accounting.

- The second specific objective is the construction of multi-dimensional graphs and a single prototype in order to observe the complex composition, dynamic evolution and size of the economic base (EB) (see Figure 2 and Prototype 2) and each general economic structure (GES) (see Figure 1 and Prototype 1) of any country into the same coordinate space.

- The third objective is to maximize the use of information given by the balance of payments. The information offered by the balance of payments will be divided by general items and sub-items. Additionally, each general item and sub-item from the balance of payments uses growth rates between two periods of time (last year and present year) to build the EB and GES macroeconomic indicators.

However, the GESC-Model theoretical framework is supported by the use of the infinity dimensional coordinate space under the general approach and the DNA helix structure (Watson and Crick, 1953). The infinity dimensional coordinate space opens the possibility of generating a multi-dimensional visual effect to observe the economic base (EB) and several numbers of general economic structures (GESs) in the same coordinate space and time. Each general economic structure (GES) is formed by a large number of structures: the main economic structure (M), economic sub-structures (S), economic micro-structures (Mi), economic nano-structures (N) and economic JI-structures (JI) at different levels (L) and periods of time (T) (see Expression 1). Finally, the economic base (EB) (see Expression 2) is equal to the interconnection of all economic general structures (GESs) (see Expression 2). The GESC-Model assumes that the economic base (EB) applies the *Omnia Mobilis* assumption (Ruiz Estrada, Yap and Nagaraj, 2008) to justify the interconnection of all GESs in the same coordinate space. Moreover, the idea considers the use of the DNA helix structure in the construction of the GESC-Model.

12.2. Introduction to the General Economic Structure Composition Model (GESC-Model)

The general economic structures composition model (GESC-Model) is based on a set of macroeconomics indicators generated by the economic base -EB- and general economic structures -GES's-. Additionally, the GESC-Model offers a set of multi-dimensional graphs and a single prototype. Basically, the single prototype shows a cylinder; around the cylinder exists a spiral line, to which is attached a large number of general economic structures (GESs). Each general economic structure (GES) is formed by joining together different main economic structure (M), economic sub-structures (S), economic mini-structures (Mi), economic nano-structures (N) and economic JI-structures (JI) (see Prototype 1). This prototype can show the size, composition and evolution of the economic base (EB) (see Prototype 2) under the union of all GESs in the same graphical space. The GESC-Model assumes that the economic base (EB) and all general economic structures (GESs) can experience different sizes or states within its structures such as expansion, contraction and stagnation. These different sizes or states in all general economic structures (GESs) depend upon the behavior of different growth rates running into the main economic structure (M), economic sub-structures (S), economic mini-structures (Mi), economic nano-structures (N) and economic JI-structures (JI) (see Expression 1). The process of drawing each general economic structure (GES) by level (L) and period of time (T) is based on enclosing the main economic structure (M), economic sub-structures (S), economic mini-structures (Mi), economic nano-structures (N) into a large circle until we arrive at the last economic JI-structure (JI) (see Figure 1). The main reason to separate each general economic structure (GES) is to observe this specific period of time (T) in the respective analysis (see Figure 2). Nevertheless, the size of each structure at different levels (L) and periods of time (T) depend on the growth rates (Δ). The growth rates (Δ) play an important role in defining the diameters of each main economic structure (M), economic sub-structures (S), economic mini-structures (Mi), economic nano-structures (N) and economic JI-structures (JI) by level (L) and time (T) respectively.

12.3. Model

In the initial stage of the GESC-Model, this model assumes that each level of structure sizes (main economic structure -M-, economic sub-structures -S-, economic mini-structures -Mi-, economic nano-structures -N- and economic JI-structures -JI-) are influenced by its growth rates (Δ) respectively (see Expression 2). Additionally, the changes of all growth rates (Δ) at different levels of structures will directly affect each GES size. GES sizes can determine if expansion, contraction or stagnation exists between two periods of time, making it possible to observe how all these changes at different level of structures can strike within each GES behavior and finally affect the economic base (EB) in the same coordinate space. The GESC-Model also assumes that each general economic structure (GES) has a single dependent growth rate and "n" number of independent growth rates at the same time; each independent growth rate has "n" number of sub-independent growth rates, "n" number of mini-independent growth rates, "n" number of nano-independent growth rates and "n" number of JI-independent growth rates (see Expression 1). Moreover, the economic base (EB) is limited by "n" number of GESs that are changing from the first period of time (T_o) from the bottom of the prototype until the last period of time (T_n) on the top of the prototype (see Prototype 2). Hence, all the general economic structures (GESs) are interconnected (╬) and follow successively the same spiral line attached to the cylinder. All these growth rates are constantly changing in different magnitudes of time (see Expression 2). The GESC-Model also assumes that time is not linear; it has a spiral behavior within the economic analysis. Therefore, the general economic structures composition model (GESC-Model) will analyze the economy of any country as a whole from a multi-dimensional perspective.

(1.) The general economic structure (GES):

$$\Delta Ji_{L:T:S:SS:MS:NS:JI}$$
$$\Vert$$
$$\Delta N_{L:T:S:SS:MS:NS}$$
$$\Vert$$
$$\Delta Mi_{L:T:S:SS:MS}$$
$$\Vert$$
$$\Delta S_{L:T:S:SS}$$
$$\Vert$$
$$\Delta Ji_{L:T:S:SS:MS:NS:JI} = \Delta N_{L:T:S:SS:MS:NS} = \Delta Mi_{L:T:S:SS:MS} = \Delta S_{L:T:S:SS} = \Delta M_{L:T:S} = \Delta S_{L:T:S:SS} = \Delta Mi_{L:T:S:SS:MS} = \Delta N_{L:T:S:SS:MS:NS} = \Delta Ji_{L:T:S:SS:MS:NS:JI}$$
$$\Vert$$
$$\Delta S_{L:T:S:SS}$$
$$\Vert$$
$$\Delta Mi_{L:T:S:SS}$$
$$\Vert$$
$$\Delta N_{L:T:S:SS:MS:NS}$$
$$\Vert$$
$$\Delta Ji_{L:T:S:SS:MS:NS:JI}$$

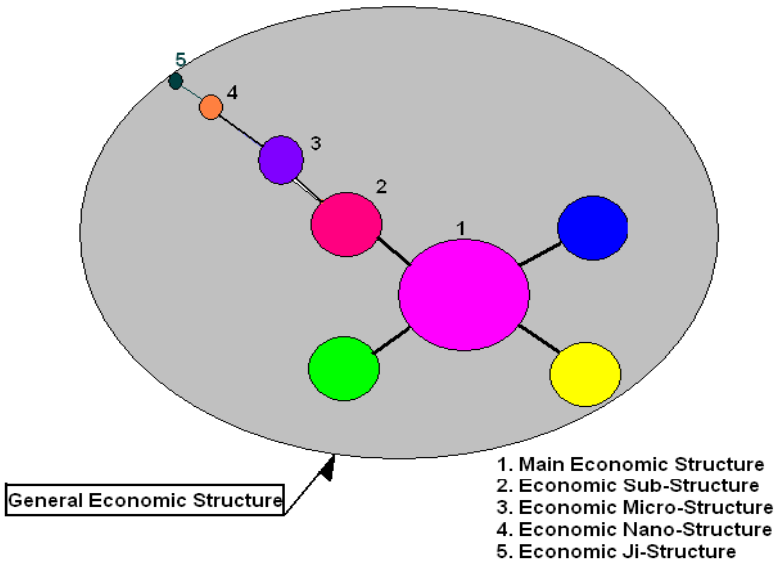
(2.) The economic base (EB):

$$\Delta JI_{0:0:0:1:0:0} \qquad\qquad \Delta JI_{\infty:\infty:\infty:1:\infty:\infty}$$
$$\Vert \qquad\qquad \Vert$$
$$\Delta N_{0:0:0:1:0:0} \qquad\qquad \Delta N_{\infty:\infty:\infty:1:\infty:\infty}$$
$$\Vert \qquad\qquad \Vert$$
$$\Delta Mi_{0:0:0:1:0} \qquad\qquad \Delta Mi_{\infty:\infty:\infty:1:\infty}$$
$$\Vert \qquad\qquad \Vert$$
$$\Delta S_{0:0:0:1} \qquad\qquad \Delta S_{\infty:\infty:\infty:1}$$
$$\Vert \qquad\qquad \Vert$$
$$\Delta N_{0:0:0:4:0:0} = \Delta Mi_{0:0:0:4:0} = \Delta S_{0:0:0:4} = \Delta M_{0:0:0} = \Delta S_{0:0:0:2} = \Delta Mi_{0:0:0:2:0} = \Delta N_{0:0:0:2:0:0} \text{ ╬..╬ } \Delta N_{\infty:\infty:\infty:4:\infty:\infty} = \Delta Mi_{\infty:\infty:\infty:4:\infty} = \Delta S_{\infty:\infty:\infty:4} = \Delta M_{\infty:\infty:\infty} = \Delta S_{\infty:\infty:\infty:2} = \Delta Mi_{\infty:\infty:\infty:2:\infty} = \Delta N_{\infty:\infty:\infty:2:\infty:\infty}$$
$$\Vert \qquad\qquad \Vert$$
$$\Delta S_{0:0:0:3} \qquad\qquad \Delta S_{\infty:\infty:\infty:3}$$
$$\Vert \qquad\qquad \Vert$$
$$\Delta Mi_{0:0:0:3:0} \qquad\qquad \Delta Mi_{\infty:\infty:\infty:3:\infty}$$

$$\begin{array}{ccc} \| & & \| \\ {}_{\Delta}N_{0:0:0:3:0:0} & & {}_{\Delta}N_{\infty:\infty:\infty:3:\infty:\infty} \\ \| & & \| \\ {}_{\Delta}JI_{0:0:0:3:0:0:0} & & {}_{\Delta}JI_{\infty:\infty:\infty:3:\infty:\infty:\infty} \end{array}$$

$$EB = {}_{\Delta}GES_{0:0:0} ╬ \ldots\ldots\ldots\ldots ╬ {}_{\Delta}GES_{\infty:\infty:\infty}$$

Figure 1:
The General Economic Structure (GES)



Prototype 1:
The General Economic Structure (GES)

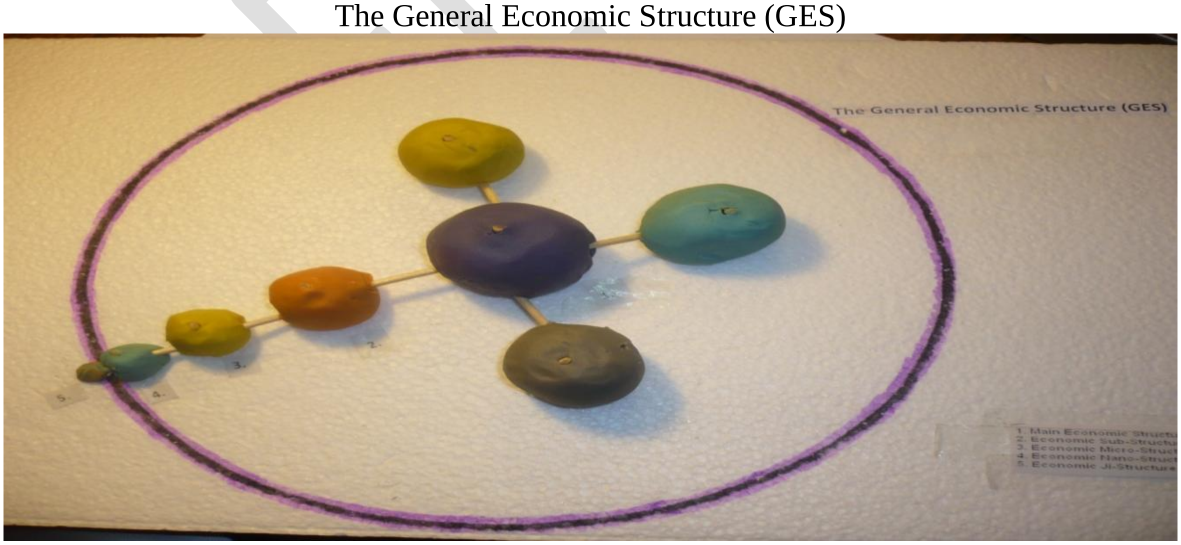
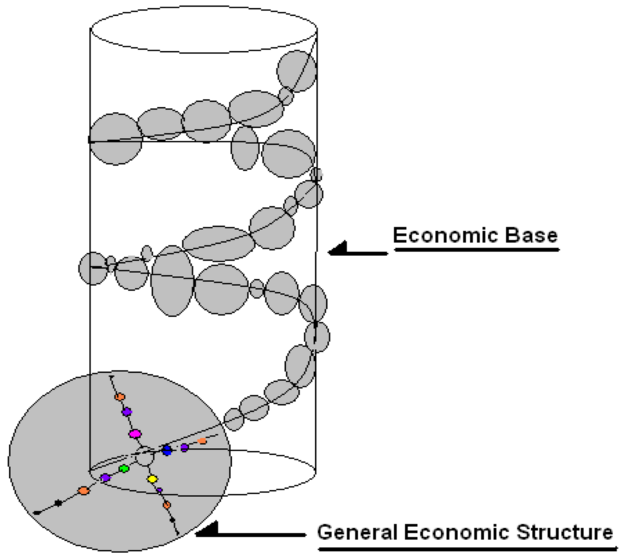


Figure 2:
The Economic Base (EB)



Prototype 2:
The Economic Base (EB)

12.4. Concluding Remarks

The general economic structures composition model (GESC-Model) offers a set of alternative macroeconomic indicators and multidimensional graphical modeling under the construction of multidimensional graphs and a single prototype. It provides a way to easily visualize the composition, size and evolution of each general economic structure (GES) and the economic base (EB) of any country.

CHAPTER 13
THE MEGA-SPACE DISTRIBUTED LAG MODEL

13.1. Introduction

Basically, the use of the distributed lag model (see Expression 1) in regression and time series analysis shows how the endogenous variable is affected by a large number of exogenous variables in different periods of time. But the evaluation of the final impact of the exogenous variable(s) on the endogenous variable does not occur immediately, because all exogenous variables can experience unpredictable behavior over short or long periods of time. Hence, the endogenous variable under a specific period of time is directly affected by the behavior of several exogenous variables distributed over (K+1) periods of time (Mirer, 1995).

$$(1.)\quad Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \ldots + \beta_j X_{t-j} + \ldots + \beta_k X_{t-k} + u_t$$

Moreover, the basic general distributed lag model has originated a number of alternative approaches such as the polynomial distributed lag model (Ullah and Raj, 1980), the geometric lag model (Franses and Oest, 2007), the Koyck model (Koyck, 1954), the almon lag model (Almon, 1965) and the multi-dimensional distributed lag model (Wahba, 1969). Almost all these models attempt to explain the behavior of multi-variable economic phenomena based on the use of deep mathematical and econometric theoretical frameworks. From a graphical perspective, all distributed lag models apply only 2-dimensional graphical modeling techniques to observe the complex behavior of dynamic economic phenomena in different periods of time in the same graphical space.

Among all alternative distributed lag models, this research found Grace Wahba's 1969 paper entitled "The estimation of the coefficients in a multidimensional distributed lag model" most interesting. Wahba proposes a multi-dimensional theoretical framework scheme for the general distributed lag model based on the use of matrices and vectors to generate a multi-dimensional effect. Therefore, while the idea of a multi-dimensional focus on the distributed lag model is not entirely new, the multi-dimensional distributed lag model proposed by Grace Wahba does not show any multi-dimensional graphical modeling scheme to observe the behavior of a large number of variables in different economic scenarios that interact together simultaneously in the same graphical space. Wahba's paper continues to use the 2-dimensional graphical modeling that in my opinion is not sufficient to accurately keep up with the behavior of multi-dimensional scenarios as a whole.

My research proposes an alternative distributed lag model approach together with an alternative multi-dimensional graphical modeling under the application of the infinity dimensional coordinate space under the specific approach; this alternative distributed lag model is called "the mega-space distributed lag model".

13.2. The Mega-Space Distributed Lag Model

The mega-space distributed lag model function is formed by infinite general-variables (GV), sub-variables (SV), micro-variables (MV) and JI-variables (JIV) (see expression 2.5) that change constantly in different speeds of time. Basically, from a graphical view, the drawing of any distributed lag function using the 2-dimensional coordinate space makes it only possible to visualize a small picture of a specific statistical or econometric analysis. On the contrary, the mega-space distributed lag model function requires the use of a multi-dimensional coordinate space. The multi-dimensional coordinate space is applied to the mega-space distributed lag model. It is called the infinity coordinate space (specific approach) (See Figure 1). The application of the infinity coordinate space (specific approach) can help to visualize a large number of distributed lag functions simultaneously in the same picture.

Basically, the drawing of a large number of distributed lag functions in different spaces into the infinity coordinate space (specific approach) requires certain conditions. First, a single point plotted on the infinity dimensional coordinates space (specific approach) is called "T-dot". **The** second condition is that two T-dots cannot occupy the same space at the same time. The third condition is that each T-dot deals within its general-space, sub-space and micro-space respectively. The fourth condition is that different T-dots can experience different types of time: these times are partial times and constant times. The type of time is related by the plotting of the T-dot into its micro-space; for example, the moment we plot our T-dot can be considered a partial time, but after we plot the next T-dot, the first T-dot plotted becomes transformed into constant time. The fifth condition is that each micro-space keeps its specific distributed lag function (see Figure 2) according to the general-space and sub-space (see Expression 2.5).

In fact, the first distribution lag function in the mega-space distribution lag model starts from general-space "0", sub-space "0" and micro-space "0" until we arrive at the general-space "∞", sub-space "∞" and micro-space "∞" (see Figure 2). All lag distributed functions in different micro-spaces under different general-space and sub-space levels apply the *Omnia Mobilis* assumption (Ruiz Estrada, Yap and Nagaraj, 2008), which helps in the relaxation of a large number of variables in our multi-dimensional analysis. We would like to insert a reminder at this point that each general-space is formed by an infinite number of sub-spaces, and each sub-space is formed by infinite micro-spaces, and finally each micro-space keeps running infinite T-dots (see Figure 1 and 2). Usually, the T-dots originate from the JI-variables. If we join all these T-dots by straight lines within their micro-space, we can visualize a scatter graph that shows the trend of any distribution lag function. Additionally, we would like to reiterate that within the mega-space distribution lag model exists an infinite number of micro-spaces that show different distribution lag functions to observe different trends in full movement simultaneously (see Figure 2).

Moreover, the final output of the mega-space distribution lag model is based on the result of a single determinant (Δ) from a large matrix "m" by "n" (see Expression 2.6). The large matrix takes into account the final results of all distribution lag functions from different micro-spaces under different general levels and sub-levels of analysis. The final output (determinant) will be called "the JIM-coefficient". The JIM-coefficient can be considered as the compacted final output (result) from the mega-space distribution lag model.

General-Space "n"

(2.1) $Y^{n}_{tp(GV:SV:MV:JIV)}=\alpha_{(GV:SV:MV:JIV)}+\beta^{L0}_{(GV:SV:MV:JIV)}X^{tp/0}_{(GV:SV:MV:JIV)}+\beta^{L1}_{(GV:SV:MV:JIV)}X^{tp/1}_{(GV:SV:MV:JIV)-1}+\ldots+\beta^{L\infty}_{(GV:SV:MV:JIV)}X^{tp/\infty}_{(GV:SV:MV:JIV)-n}+u^{tk}_{(GV:SV:MV:JIV)}$

Where
JIV = {0, 1, 2 . . . ∞}
n = {0, 1, 2 . . . ∞}

Therefore,
(2.2) $E\,/U^{tk}/ = K_o$
(2.3) $Var\,(U^{tk}) = \sigma^{i}_{(GV:SV:MV:JIV)}$
(2.4) $Cov(U^{tk}, U^{tk}_{s}) = \sigma^{i}_{(GV:SV:MV:JIV)}$

General model
(2.5.)
General-Space 0
Sub-Space 0:

$SV_0=Y^{0}_{tp(0:0:0)}=\alpha_{(0:0:0)}+\beta^{L0}_{(0:0:0:0)}X^{tp/0}_{(0:0:0:0)}+\beta^{L1}_{(0:0:0:1)}X^{tp/1}_{(0:0:0:1)-1}+\ldots+\beta^{L\infty}_{(0:0:0:\infty)}X^{tp/\infty}_{(0:0:0:0:\infty)-n}+u^{tk}_{(0:0:0)}$ ® ... ®
$Y^{0}_{tp(0:0:1)}=\alpha_{(0:0:1)}+\beta^{L0}_{(0:0:1:0)}X^{tp/0}_{(0:0:1:0)}+\beta^{L1}_{(0:0:1:1)}X^{tp/1}_{(0:0:1:1)-1}+\ldots+\beta^{L\infty}_{(0:0:1:\infty)}X_{tp/\infty(0:0:1:\infty)-n}+u^{tk}_{(0:0:1)}$ ®... ®
$Y^{\infty}_{tp(0:0:\infty)}=\alpha_{(0:0:\infty)}+\beta^{L0}_{(0:0:\infty:0)}X^{tp/0}_{(0:0:\infty:0)}+\beta^{L1}_{(0:0:\infty:1)}X^{tp/1}_{(0:0:\infty:1)-1}+\ldots+\beta^{L\infty}_{(0:0:\infty:\infty)}X^{tp/\infty}_{(0:0:\infty:\infty)-n}+u^{tk}_{(0:0:\infty)}$. . .

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.
.

Sub-Space ∞:

$SV_{\infty}=Y^{*}_{tp(0:\infty:0)}=\alpha_{(0:\infty:0)}+\beta^{L0}_{(0:\infty:0:0)}X^{tp/0}_{(0:\infty:0:0)}+\beta^{L1}_{(0:\infty:0:1)}X^{tp/1}_{(0:\infty:0:1)-1}+.+\beta^{L\infty}_{(0:\infty:0:\infty)}X^{tp/\infty}_{(0:\infty:0:\infty)-n}+u^{tk}_{(0:\infty:0)}$ ® ... ®
$Y^{0}_{tp(0:\infty:1)}=\alpha_{(0:\infty:1)}+\beta^{L0}_{(0:\infty:1:0)}X^{tp/0}_{(0:\infty:1:0)}+\beta^{L1}_{(0:\infty:1:1)}X^{tp/1}_{(0:\infty:1:1)-1}+\ldots+\beta^{L\infty}_{(0:\infty:1:\infty)}X^{tp/\infty}_{(0:\infty:1:\infty)-n}+u^{tk}_{(0:\infty:1)}$ ®... ®
$Y^{\infty}_{tp(0:\infty:\infty)}=\alpha_{(0:\infty:\infty)}+\beta^{L0}_{(0:\infty:\infty:0)}X^{tp/0}_{(0:\infty:\infty:0)}+\beta^{L1}_{(0:\infty:\infty:1)}X^{tp/1}_{(0:\infty:\infty:1)-1}+\ldots+\beta^{L\infty}_{(0:\infty:\infty:\infty)}X^{tp/\infty}_{(0:\infty:\infty:\infty)-n}+u^{tk}_{(0:\infty:\infty)}$

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.
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General-Space ∞
Sub-Space 0:

$SV_0=Y^{*}_{tp(\infty:0:0)}=\alpha_{(\infty:0:0)}+\beta^{L0}_{(\infty:0:0:0)}X^{tp/0}_{(\infty:0:0:0)}+\beta^{L1}_{(\infty:0:0:1)}X^{tp/1}_{(\infty:0:0:1)-1}+.+\beta^{L\infty}_{(\infty:0:0:\infty)}X^{tp/\infty}_{(\infty:0:0:0:\infty)-n}+u^{tk}_{(\infty:0:0)}$ ®... ®
$Y^{0}_{tp(\infty:1:1)}=\alpha_{(\infty:1:1)}+\beta^{L0}_{(\infty:1:1:0)}X^{tp/0}_{(\infty:1:1:0)}+\beta^{L1}_{(\infty:1:1:1)}X^{tp/1}_{(\infty:1:1:1)-1}+\ldots+\beta^{L\infty}_{(\infty:1:1:\infty)}X^{tp/\infty}_{(\infty:1:1:\infty)-n}+u^{tk}_{(\infty:1:1)}$ ® ... ®
$Y^{\infty}_{tp(\infty:\infty:\infty)}=\alpha_{(\infty:\infty:\infty)}+\beta^{L0}_{(\infty:\infty:\infty:0)}X^{tp/0}_{(\infty:\infty:\infty:0)}+\beta^{L1}_{(\infty:\infty:\infty:1)}X^{tp/1}_{(\infty:\infty:\infty:1)-1}+.+\beta^{L\infty}_{(\infty:\infty:\infty:\infty)}X^{tp/\infty}_{(\infty:\infty:\infty:\infty)-n}+u^{tk}_{(\infty:\infty:\infty)}$. . .

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.

Sub-Space ∞:

$SV_{\infty}=Y^{*}_{tp(\infty:\infty:0)}=\alpha_{(\infty:\infty:0)}+\beta^{L0}_{(\infty:\infty:0:0)}X^{tp/0}_{(\infty:\infty:0:0)}+\beta^{L1}_{(\infty:\infty:0:1)}X^{tp/1}_{(\infty:\infty:0:1)-1}+.+\beta^{L\infty}_{(\infty:\infty:0:\infty)}X^{tp/\infty}_{(\infty:\infty:0:\infty)-n}+u^{tk}_{(\infty:\infty:0)}$ ® ... ®
$Y^{0}_{tp(\infty:\infty:1)}=\alpha_{(\infty:\infty:1)}+\beta^{L0}_{(\infty:\infty:1:0)}X^{tp/0}_{(\infty:\infty:1:0)}+\beta^{L1}_{(\infty:\infty:1:1)}X^{tp/1}_{(\infty:\infty:1:1)-1}+.+\beta^{L\infty}_{(\infty:\infty:1:\infty)}X^{tp/\infty}_{(\infty:\infty:1:\infty)-n}+u^{tk}_{(\infty:\infty:1)}$®....®
$Y^{\infty}_{tp(\infty:\infty:\infty)}=\alpha_{(\infty:\infty:\infty)}+\beta^{L0}_{(\infty:\infty:\infty:0)}X^{tp/0}_{(\infty:\infty:\infty:0)}+\beta^{L1}_{(\infty:\infty:\infty:1)}X^{tp/1}_{(\infty:\infty:\infty:1)-1}+.+\beta^{L\infty}_{(\infty:\infty:\infty:\infty)}X^{tp/\infty}_{(\infty:\infty:\infty:\infty)-n}+u^{tk}_{(\infty:\infty:\infty)}$

(2.6.)

$$\Delta = \left[\begin{array}{c} GV_0 = SV_0 \circledR SV_1 \circledR \ldots \circledR SV_{\infty\ldots} \\ \vdots \\ GV\infty = SV_0 \circledR SV_1 \circledR \ldots \circledR SV_{\infty\ldots} \end{array}\right]$$

Variables:
GV = General variable, SV = Sub-variable, MS = Micro-variable, JIV= JI-variable, tp = Partial Time, tk = Constant Time, ® = Window refraction

Figure 1
The Infinity Coordinate Space

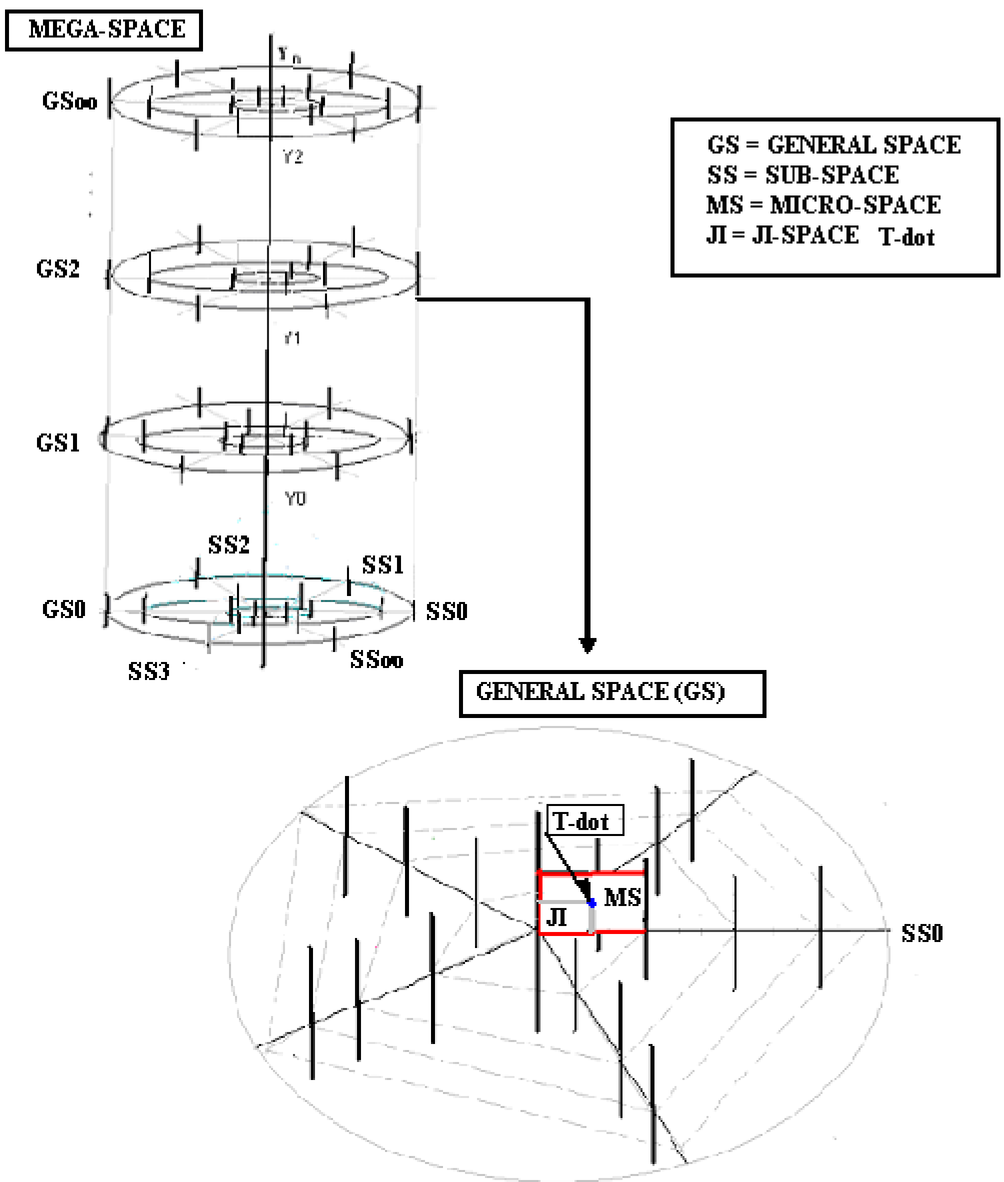
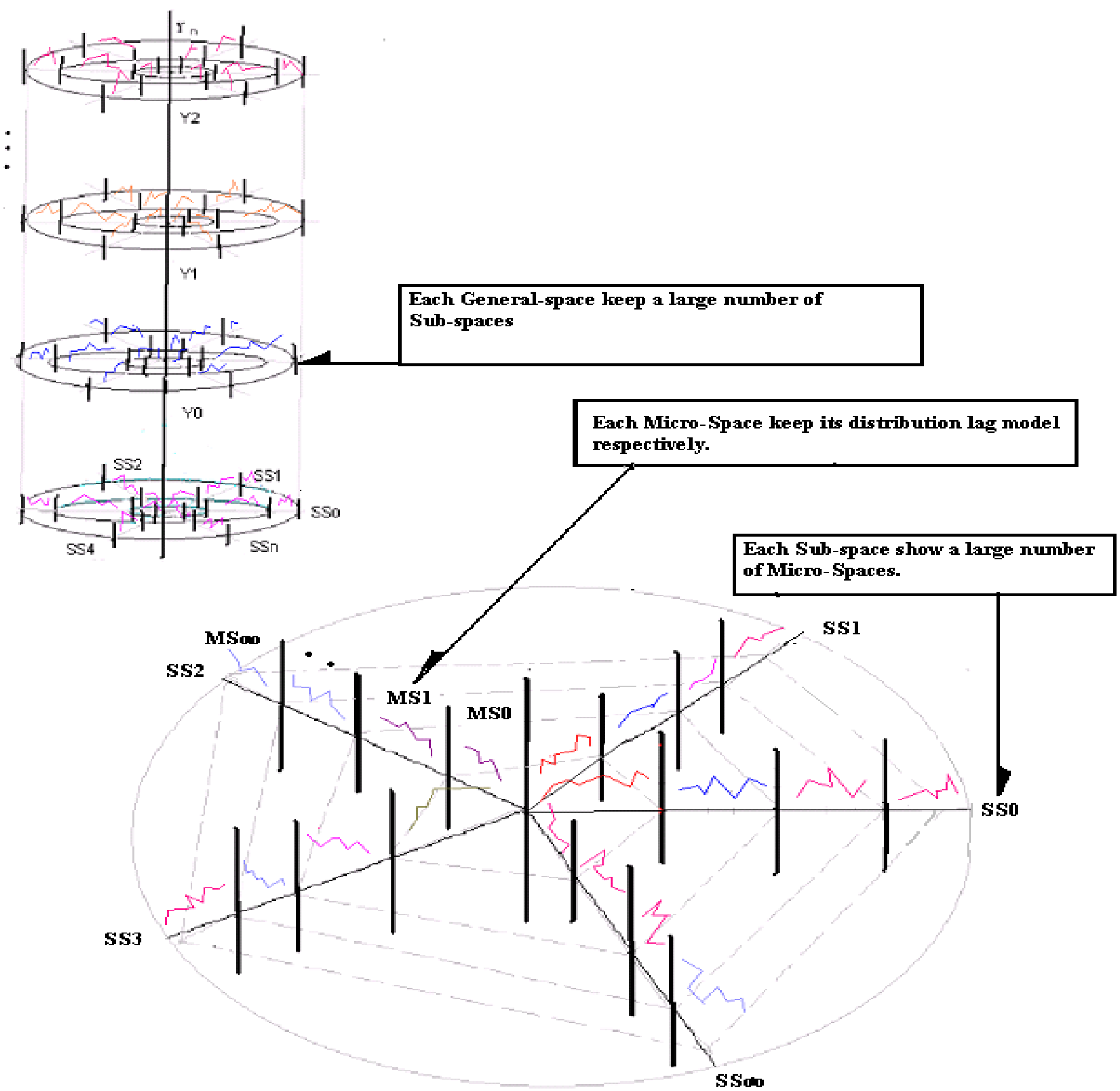


Figure 2
The Mega-Space Distributed Lag Model



13.3. Concluding Remarks

This research concludes that is possible to visualize a large number of distributed lag functions in the same graphical space, and that this is impossible to be observed using the 2-dimensional graphical modeling. Therefore, this research proposes an alternative general distributed lag model entitled "the mega-space distributed lag model". The final objective is to provide a multi-dimensional econometric theoretical framework and multi-dimensional graphical modeling that permits researchers to analyze and visualize multi-variable time series or regressions simultaneously in the same graphical space.

CHAPTER 14
IS THE MARKET IN A STATE OF DYNAMIC IMBALANCE?

14.1. Introduction

In the study of market equilibrium from a partial or general view using different theories, models and theorems, these are represented graphically in 2-dimensions under the application of the Cartesian plane coordinate system (X,Y). Partial equilibrium shows how the exogenous variable "Y-axis" (price) can directly affect the endogenous variable "X-axis" (quantity demand) in the same graphical space. The partial equilibrium analysis by Marshall (1890) is supported by the assumption of *Ceteris Paribus* (all other things [being] the same). The idea of applying the *Ceteris Paribus* assumption is to insulate the endogenous variable "X" (quantity demand) from the rest of the variables (different prices and products) which can affect it. On other hand, the general equilibrium assumes that different prices and a large number of products need to be in equilibrium in its initial stage, according to Léon Walras (1874). But we can also observe that the general equilibrium from a graphical point of view continues to depend strongly on the application of the 2-dimensional Cartesian plane.

Moreover, the application and use of 3-dimensional graphs and 3-dimensional manifolds have become more common among academics and researchers to explain and analyze market equilibrium. Therefore, this research is focused on applying multi-dimensional Cartesian spaces to facilitate the visualization of complex theories, models and theorems related to market equilibrium from a multi-dimensional viewpoint. However, our analysis takes into consideration the graphical visualization of the IS-LM model by Hicks and Allen (1934); Hicks and Allen developed a large number of pictorial diagrams to demonstrate economic principles and techniques in economic analysis. The idea of building the IS-LM model originates from the unclear Keynesian theory which never makes clear the relationship between the goods market and the money market. According to Hicks and Allen, the goods market and money market need to achieve equilibrium simultaneously.

The IS curve represents the equilibrium of the goods market and the LM curve shows the equilibrium of the money market respectively (Pressman, 2006). If we analyze the graphical display of both curves in the 2-dimensional Cartesian plane, the IS curve (goods market) needs to be drawn on two different 2-dimensional Cartesian planes separately. First, the 2-dimensional Cartesian plane shows the relationship between interest rate (exogenous variable) and investment (endogenous variable). Second, the 2-dimensional Cartesian plane is fixed by the IS curve (goods market), based on the relationship between interest rate (exogenous variable) and output level (endogenous variable). The LM curve (money market) is also drawn on two different 2-dimensional Cartesian planes. The first 2-dimensional Cartesian plane in the construction of the LM curve is based on the relationship between interest rate (exogenous variable) and money supply/demand (endogenous variable) and the second is based on the relationship between interest rate (exogenous variable) and output level (endogenous variable). Finally, we observe that in the initial state of building, these two curves (IS-LM) are plotted separately in different 2-dimensional Cartesian planes in the first quadrant. Therefore, we cannot observe different steps in the construction of each curve (or market) in the same space and time; each curve (or market) can only be displayed separately. However, it is possible to visualize both markets in equilibrium until both curves (IS-LM curves) join within the same 2-dimensional Cartesian plane. The IS-LM curve from a graphical view can also help to visualize the effect of fiscal policy on the goods market performance through the IS curve allocation in its quadrant.

On the other side, the monetary policy effect on the money market performance can be observed through the LM curve allocation into its 2-dimensional Cartesian plane respectively. In fact, this chapter proposes the application of the inter-linkage coordinate space to join all curves (or sub-markets) in the same coordinate space to visualize the market behavior as a whole. The inter-linkage coordinate space will provide the possibility of generating a multi-dimensional visual effect to observe all or some possible changes of all sub-markets (goods sub-market, money sub-market, exports sub-market, labor sub-market and technological sub-market) in the same space and time. Finally, the inter-linkage coordinate space can show eleven independent variables and fifteen dependent variables in the same coordinate space. At the same time, the inter-linkage coordinate space offers the possibility to observe clearly how a large number of exogenous variables interact with the endogenous variable simultaneously.

14.2. The Application of the Inter-Linkage Coordinate Space in the Graphic Modeling of the Market in a State of Dynamic Imbalance:

The inter-linkage coordinate space accommodates five sub-markets in the same coordinate space. The five sub-markets are fixed into five general axes (A_0, A_1, A_2, A_3 and A_4) at different perimeter levels (PL_0, PL_1, PL_2 and PL_3…) and a large number of windows refractions[30] (W_0, W_1 ,…, W_n …). We assume that the market is divided by five sub-markets: good sub-market -IS curve-, money sub-market -LM curve-, exports sub-market -PE curve-, labor sub-market -IL curve- and technological sub-market IT curve- respectively. The main reason to dismember the market into five sub-markets is to visualize how different sub-markets work together simultaneously. However, the reason for excluding the exports sub-market (PE curve) and technological sub-market (IT curve) from the goods sub-market (IS curve) is due to the necessity of observing, separately, the dynamicity and vulnerability of the exports sub-market and technological sub-market. Another reason to take out exports and technological sub-markets from the goods sub-market is in order to propose an alternative graphical modeling to be applied on policy modeling, implementation, evaluation and monitoring. This approach demonstrates a different analytical approach from the traditional IS-LM model (goods market and money market). The idea of dismembering the exports sub-market and technological sub-market from the goods sub-market by parts is to gain a better understanding of the exports sub-market and technological sub-market behavior independently. Finally, the last assumption in this approach is that all sub-markets are in a state of permanent movement, all the time, in the same space (graph). Therefore, the inter-linkage coordinate space is able to generate this multi-dimensional effect in order to visualize several numbers of sub-markets in the same time and space.

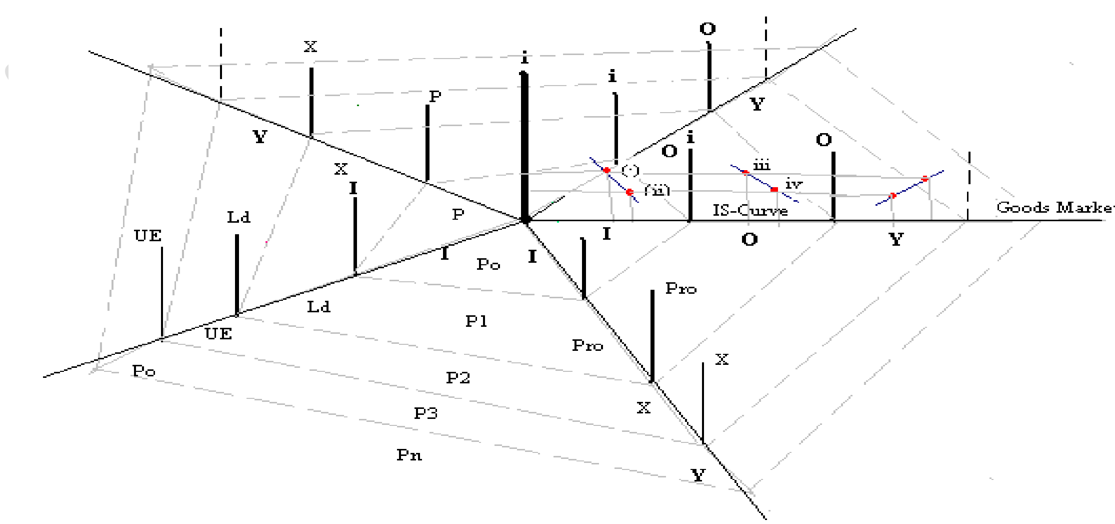
[30] The Window Refraction Space is a concept based on the joining of different quadrants in the same vector address.

a. The Goods Sub-Market Analysis under the General Axis 0 (A_0): IS Curve

The first analysis section is the study of the goods sub-market under the general axis (A_0). The A_0 is divided by three windows refractions (see Expression 1). The first window refraction on the general axis 0 (A_0) shows the relationship between the interest growth rate (i) and the investment growth rate (I) in order to build the first curve; the same curve moves in different positions within the same window refraction continuously. The changes within the same curve or different positions of the curve in the first window refraction depend on the interest growth rate (i) behavior. To show some examples about possible changes in the same curve in the first window refraction on the A_0, we would like to mention two possible scenarios: (i) the first scenario is that if the interest growth rate (i) increases then the investment growth rate (I) falls; (ii) the second scenario is that if the interest growth rate (i) decreases then the investment growth rate (I) rises. The second window refraction on A_0 exhibits the construction of the IS curve, which is based on the relationship between the interest growth rate (i) and the output growth rate (O). Moreover, the IS curve shows two scenarios: (iii) the first scenario is that if the interest growth rate (i) increases then the output growth rate (O) falls; and (iv) the second scenario is that if the interest growth rate (i) decreases then the output growth rate (O) rises (see Figure 1). Finally, the A_0 shows the relationship between the income growth rate (Y) under different levels of output growth rates (O). The IS curve assumes that it is in a permanent movement within its windows refraction respectively, based on the application of the *Omnia Mobilis* assumption (everything is moving) by Ruiz Estrada, Yap and Nagaraj (2008). The IS curve in the short or long term can find at any time its "*momentum of balance synchronization stage"* together with the other four sub-markets (i.e. money sub-market -LM curve-, exports sub-market -PE curve-, labor sub-market -IL curve- and technological sub-market -IT curve-). The goods sub-market under the general axis 0 (A_0) is fixed in three different windows refractions:

(1.) $A_0 = /I = f\ (i)/ ® / O = f\ (i)/ ® / Y = f\ (O)/$

Figure 1: The Goods Sub-Market Analysis under the General Axis 0 (A_0): IS Curve



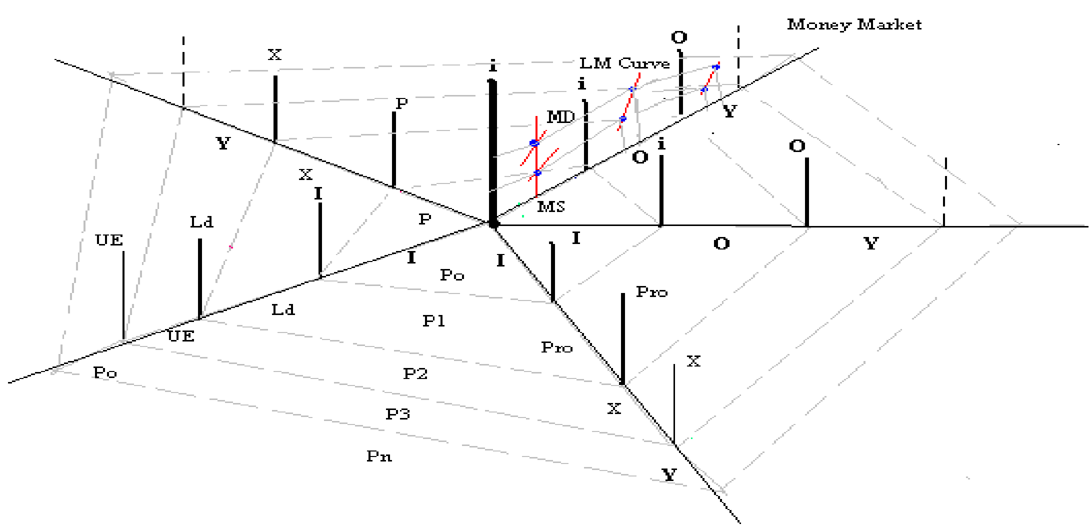
b. The Money Sub-Market Analysis under the General Axis 1 (A_1): LM Curve

The second analysis is based on the application of the LM curve to study the money sub-market. The construction of the LM curve is based on three windows refraction spaces (see Figure 2). The first window refraction space represents the relationship between the interest growth rate (i) and the money supply/demand growth rates (Ms/d). Basically, this chapter applies a basic assumption in the construction of LM curve: the money supply growth rate and the money demand growth rate are in a state of permanent imbalance all the time. Therefore, the money supply growth rate does not necessarily need to be equal to the money demand growth rate. The second window refraction space, on the other hand, shows the relationship between the interest growth rate (i) and the output growth rate (O) upon which the LM curve is constructed. The LM curve (money sub-market) shows an infinite number of possibilities located in different places within the second window refraction in the short or long term. To simplify the LM curve (or money sub-market) behavior, the LM curve can show two scenarios: (i) the first scenario is that if the interest growth rate (i) increases then the output growth rate (O) rises; (ii) the second scenario is that if the interest growth rate (i) decreases then the output growth rate (O) falls respectively. In the same general axis 1 (A_1), the third window refraction includes the relationship between the income growth rate in different levels of output (see Expression 2).

The LM curve can find its "*momentum of balance synchronization stage"* together with the IS, PE, IL and IT curves simultaneously. The *momentum of balance synchronization stage* depends on the relaxation of these five sub-markets which originate from the behavior of the economic, social, political, technological, and natural & environmental forces. Therefore, the LM curve is moving all the time (it never stops) within its windows refraction. It is based on the application of the *Omnia Mobilis* assumption to simulate a real time environment. The money sub-market under general axis 1 (A_1) is fixed into the three windows refractions:

(2.) $A_1 = /M_{d/s} = f\ (i)/ ® /O = f\ (i)/ ® /Y = f\ (O)/$

Figure 2: The Money Sub-Market Analysis under the General Axis 1 (A_1): LM Curve

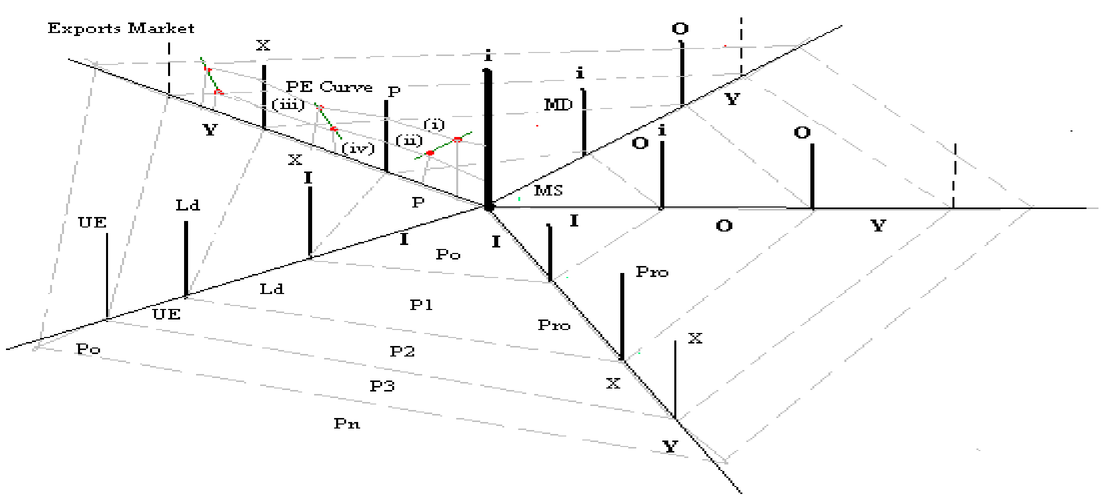


c. The Exports Sub-Market Analysis under the General Axis 2 (A_2): PE Curve

The third section of the MFP-Cartesian Space shows the analysis of the exports sub-market through the production/exports (PE) curve (see Figure 3). The PE curve explains how the interest growth rate (i) can affect the production growth rate (P) and the exports growth rate (X) respectively. We assume that the three windows refractions apply the *Omnia Mobilis* assumption in order to keep all the windows refraction on A_2 in permanent movement within the same space and time. To show some simple examples about possible scenarios, and how the interest growth rate (i) can affect on the production growth rate (P) and the exports growth rate (X) behavior, the first window refraction space shows the relationship between the interest growth rate (i) and the total production growth rate (P). The total production growth rate (P) is equal to the total sum of the agriculture output growth rate, the industry output growth rate and the services output growth rate respectively. The relationship between the interest rate/total production growth rates can show two possible effects. (i) The first effect is that if the interest growth rate (i) increases then the total production growth rate (P) falls. And (ii) the second effect is that if the interest growth rate (i) decreases then the total production growth rate (P) rises. The second window refraction space shows the production/exports (PE) curve based on the relationship between the total production growth rate (P) and the exports growth rate (X). (iii) If the total production growth rate (P) increases then the exports growth rate (X) rises, or (iv) if the total production growth rate (P) decreases then the exports growth rate (X) falls in the economy (See Figure 3). The last window refraction in the same general axis 2 (A_2) shows the relationship between the income growth rate (Y) at different levels of exports growth rate (X) (see Expression 3). Finally, the PE curve also searches for its "*momentum of balance synchronization stage"* at any time together with the IS, LM, IL and IT curves simultaneously. The exports sub-market under the general axis 2 (A_2) is fixed in three windows refractions:

(3.) A_2 = /P =f (i)/ ® /X = f (P)/ ® / Y = f (X)/

Figure 3: The Exports Sub-Market Analysis under the General Axis 2 (A_2): PE Curve



d. The Labor Sub-Market Analysis under the General Axis 3 (A_3): IL Curve

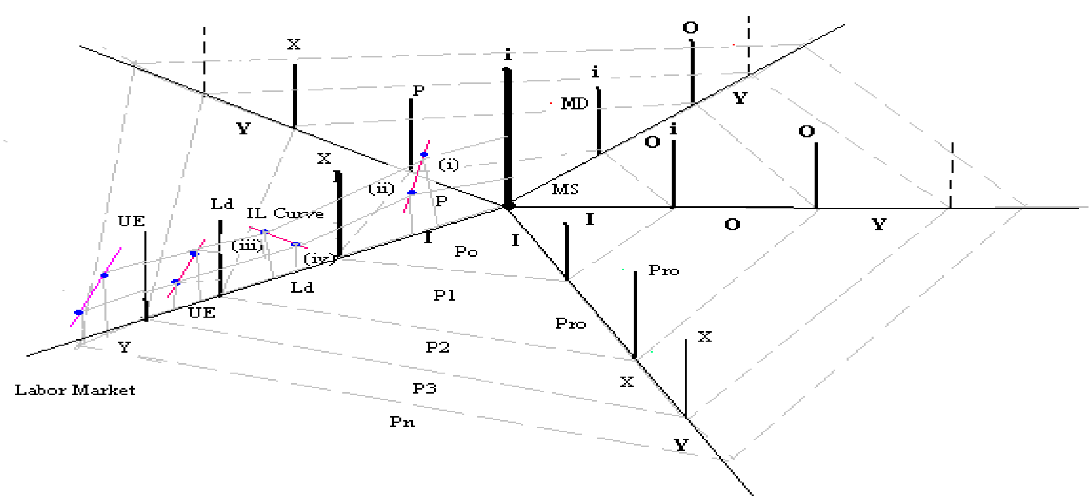
The labor sub-market is represented graphically by the investment/labor demand (IL) curve. All windows refractions on the general axis A_3 apply the *Omnia Mobilis* assumption (everything is moving). This part of the chapter demonstrates how the interest growth rate (i) can affect the investment growth rate (I), the labor demand growth rate (Ld) and the unemployment growth rate (UE) from a multi-dimensional and dynamic perspective. Basically, the first window refraction space is a depiction of the relationship between the interest growth rate (i) and the investment growth rate (I). The two scenarios are: (i) first, if the interest growth rate (i) increases then the investment growth rate (I) falls; (ii) second, if the interest growth rate (i) decreases then the investment growth rate (I) rises in the first window refraction.

The second window refraction is focused on the relationship between the investment growth rate (I) and the labor demand growth rate (Ld) becomes obvious. (iii) If the investment growth rate (I) increases then it can generate a high labor demand growth rate (Ld), but (iv) if the investment growth rate (I) decreases then it can only generate a low labor demand growth rate (Ld) in the labor market (see Figure 4).

The third window refraction on A_3 shows a downward slope in the relationship between the labor demand growth rate (Ld) and unemployment growth rate (UE). Finally, the last window refraction on the general axis 3 (A_3) shows the relationship between the income growth rate (Y) under different levels of unemployment growth rate (UE) (see Expression 4). The IL curve can also find its "*momentum of balance synchronization stage*" at any time together with the IS, LM, PE and IT curves simultaneously. The *momentum of balance synchronization stage* among the five markets is unexpected and faster according to the behavior of the economic, political, technological, social and natural & environment forces. The labor sub-market under the general axis 3 (A_3) is fixed into four windows refractions:

(4.) $A_3 = /I = f\ (i)/\ ®\ /Ld = f\ (I)/\ ®\ /\ UE = f\ (Ld)/\ ®\ /\ Y = f\ (UE)/$

Figure 4: The Labor Sub-Market Analysis under the General Axis 3 (A_3): IL Curve



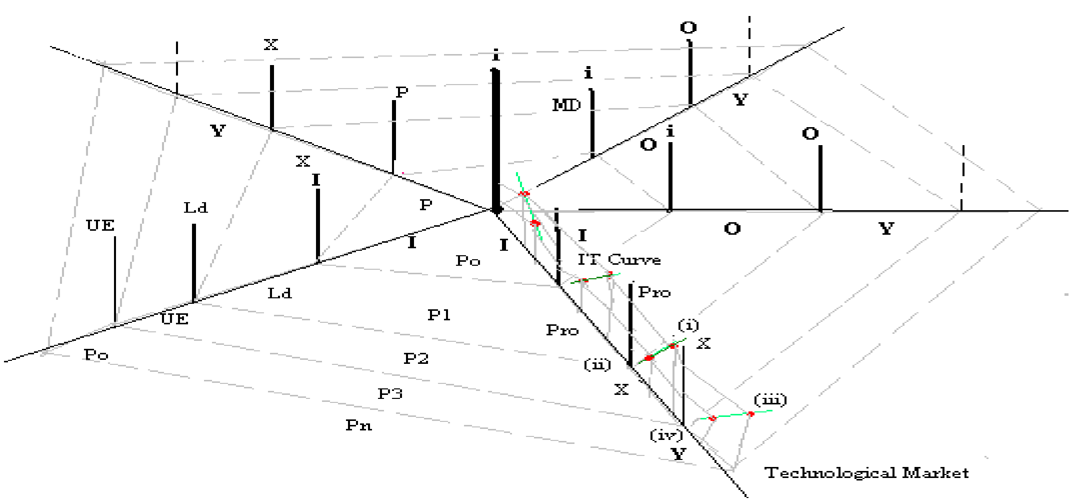
e. The Technological Sub-Market Analysis under the General Axis 4 (A_4) Level: IT Curve

Lastly, the study of the technological sub-market under the general axis (A_4) is divided by four windows refractions (see Expression 5). The first window refraction on the general axis 4 (A_4) shows the relationship between the interest growth rate (i) and the investment growth rate in technology (I). The second window refraction in the same general quadrant (A_4) shows the relationship between the productivity growth rate (Pro) and different levels of investment growth rate in technology (I). Successively, the third window refraction shows how the productivity growth rate (Pro) can directly affect the exports growth rate (X). This can be observed in two possible scenarios: (i) first, if the productivity growth rate (Pro) increases then the exports growth rate (X) rises; (ii) second, if the productivity growth rate (Pro) decreases then the exports growth rate (X) falls (see Figure 5).

The last window refraction on A_4 exhibits the relationship between the income growth rate (Y) based on different levels of the exports growth rate (X). Moreover, the third window refraction shows two scenarios: (iii) first, if the exports growth rate (X) increases then the income growth rate (Y) rises; (iv) second, if the exports growth rate (X) decreases then the income growth rate (I) falls (see Figure 5). The IP curve assumes that it is in a permanent movement within its windows refraction respectively under the application of the *Omnia Mobilis* assumption. The IS curve can find its "*momentum of balance synchronization stage"* together with the other four sub-markets (i.e. goods sub-market -IS-, money sub-market -LM-, exports sub-market -PE- and labor sub-market -IL-) at any time. The technological sub-market under the general axis 4 (A_4) is fixed into four windows refractions respectively:

$$(5.)\ A_4 = /I=f(i)/ \circledR /Pro=f(I)/ \circledR /X=f(Pro)/ \circledR /Y=f(X)$$

Figure 5: The Technological Sub-Market Analysis under the General Axis 4 (A_4): IT Curve

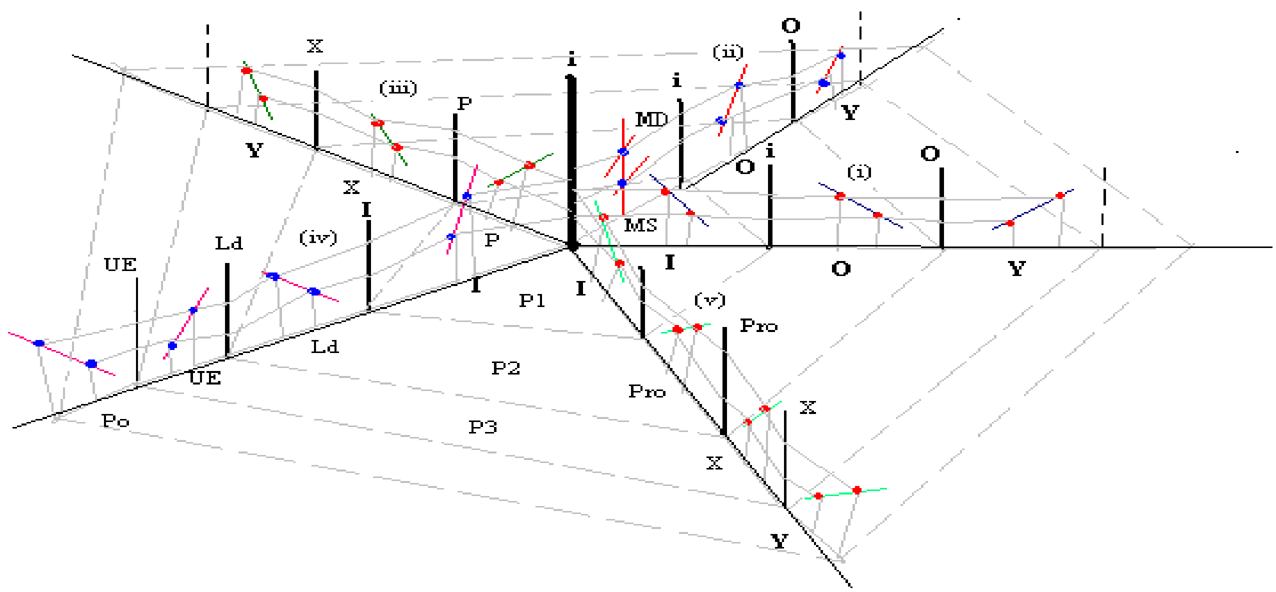


f. The State of Dynamic Imbalance (DIS)

In broad terms, the inter-linkage coordinate space provides a platform to analyze five different sub-markets that are incorporated in the same coordinate space: (i) goods sub-market (IS curve), (ii) money sub-market (LM curve), (iii) exports sub-market (PE curve), (iv) the labor sub-market (IL curve) and (v) the technological sub-market (IT curve) (see Figure 6). It is assumed that all sub-markets operate simultaneously in the same space and time, thereby presenting a State of Dynamic Imbalance (DIS) that will support all possible sub-market environments under study. The DIS is based on the application of the *Omnia Mobilis* assumption (everything is moving). The state of dynamic imbalance is not chaos; it is an unconditional and unexpected complex sensitive reaction of all sub-markets that is generated by different economic, political, social, technological, natural & environmental forces simultaneously under uncertain expectations. Therefore, the goods sub-market (IS curve), money sub-market (LM curve), exports sub-market (PE curve), labor sub-market (IL curve) and technological sub-market (IT curve) do not necessarily need to be in equilibrium simultaneously, because all markets are in a state of dynamic imbalance. Moreover, this chapter assumes that *the momentum of balance synchronization stage* is a short fleeting transitional state that in any unpredictable moment can appear spontaneously among the five sub-markets at any time.

Therefore, the state of equilibrium will be replaced by "*the momentum of balance synchronization stage"*. When "*the momentum of balance synchronization stage"* actually appears depends on the relaxation of the five sub-markets at any time. This chapter argues that market equilibrium is not a static and isolated phenomenon; rather, it is a transitional and evolutionary stage that cannot be arbitrarily controlled or determined. We need to remember that the study of market equilibrium is not a natural phenomenon that can be measured or demonstrated exactly by sciences. Market equilibrium is in a state of dynamic imbalance all the time, where the market is defined as the interaction among humans to satisfy necessities at different levels, and it depends on two basic conditions. First, it depends on the behavior of the economic, social, political, technological and natural & environmental forces. Second, it depends on the historical period of time and the efficient allocation of resources to maximize human necessities (profit or consumption). Therefore, market behavior cannot be forecasted easily because all the forces mentioned before are unpredictable and uncertain within time and space.

Figure 6: The State of Dynamic Imbalance (DIS)



14.3. Concluding Remarks

This chapter concludes that the market is always in a state of dynamic imbalance (DIS) from a graphical point of view. The DIS is applied on the sub-five markets (goods, money, exports, labor and technological) to simulate a state of permanent movement. We assume that all sub-market behavior does not need to be in equilibrium, because all sub-markets keep within a state of dynamic imbalance all the time. Finally, if the five sub-markets can find at any time their *momentum of balance synchronization stage* then the market does not necessarily need to be in equilibrium simultaneously, because the five sub-markets are in a state of dynamic imbalance. The *momentum of balance synchronization stage* depends upon the relaxation of the five sub-markets originated by the behavior of the economic, political, social, technological and natural & environmental forces. Therefore, it is a fleeting and unpredictable momentum that can appear spontaneously among the five sub-markets (goods, money, exports, labor and technological) at any time.

CHAPTER 15

ECONOMIC WAVES: THE EFFECT OF THE U.S. ECONOMY ON WORLD ECONOMY

15.1. Introduction to the Idea of Economic Waves

This chapter will give a short introduction about economic waves, which are based on the construction of a large surface plotted in the same graphical space. The large surface is formed by different parts that represent different markets (countries/regions); at the same time, all these markets are connected directly to a single epicenter. This epicenter is fixed by the GDP growth rate of the U.S.

In fact, the GDP growth rate of the U.S. economy can experience a dramatic, uncontrolled and non-logical change at any time such as expansion, contraction or stagnation. An abrupt negative fall of the GDP growth rate in the U.S. economy can generate strong damage at different levels in different markets simultaneously. This is due to the large international trade exchange and investment mobility between the U.S. economy and different countries/regions.

Firstly, we assume that each market (country/region) has a large number of windows refraction (or quadrants), and each window refraction (or quadrant) is formed by its X-axis which represents time (days, weeks, months, years and decades) and its Y-axis which represents the main variable(s) in analysis. The main variables of each window refraction by different market(s) are the GDP_{US}, exports (X), foreign direct investment (FDI), stock market (SM) and unemployment (U) growth rates respectively. Hence, each market (country/region) shows five windows refraction within the same coordinate space (see Table 1 and Figure 1).

The second assumption is that the economic waves in each market (country/ region) demonstrate different sizes and speeds of time. The size and speed of time in the economic waves depend on uncontrolled forces of the market according to economic speculation(s), economic bubbles and imaginary markets.

The main objective of building these economic waves is to evaluate the negative impact coming from a deep economic recession centering around the largest economy of the world such as the U.S. economy. To observe the negative effect of a possible deep economic recession and the generation of economic waves, we suggest the application of multi-dimensional graphical modeling that can simulate the movement of economic waves in real time by the application of graphical computer animation. This is based on the construction of a large number of slides that are joined together into the assembly and production of a video. This multi-dimensional graphical animation technique can help to observe the effects of a possible deep economic recession in the U.S. economy and the generation of economic waves in different markets (countries/regions), and at the same time, gauge the level of dependency and vulnerability of different countries.

TABLE 1:
Windows Refraction

Country 1 or Region 1: **Windows Refraction:** Windows Refraction 1╬ Windows Refraction 2 ╬ Windows Refraction 3 ╬ . . . Windows Refraction ∞…	**Country 2 or Region 2:** **Windows Refraction:** Windows Refraction 1╬ Windows Refraction 2 ╬ Windows Refraction 3 ╬ ... Windows Refraction ∞…	**Country 3 or Region 3:** **Windows Refraction:** Windows Refraction 1╬ Windows Refraction 2 ╬ Windows Refraction 3 ╬ … Windows Refraction ∞…
Country 4 or Region 4: **Windows Refraction:** Windows Refraction 1╬ Windows Refraction 2 ╬ Windows Refraction 3 ╬ ... Windows Refraction ∞…	**Country 5 or Region 5:** **Windows Refraction:** Windows Refraction 1╬ Windows Refraction 2 ╬ Windows Refraction 3 ╬ ... Windows Refraction ∞…	**Country ∞ or Region ∞:** **Windows Refraction:** Windows Refraction 1 ╬ Windows Refraction 2 ╬ Windows Refraction 3 ╬ ... Windows Refraction ∞…

Finally, this chapter outlines the economic recession in the U.S. economy between year 2007 and year 2008, and its effects on two large countries (Japan and China) and three large regions (European Union -EU-, ASEAN and Latin America -LA-). We assume that the epicenter is the GDP growth rate of the U.S. that is connected to all markets (country/region); at the same time each market has a large number of windows refraction. The construction of economic waves is started by plotting a single value (growth rate) in each window refraction and joining each single value located in each window refraction by straight lines from the epicenter to the last window refraction in each market (see Figure 1); therefore, we suggest the application of the "windows refraction links (╬)" concept (see Appendix 3).

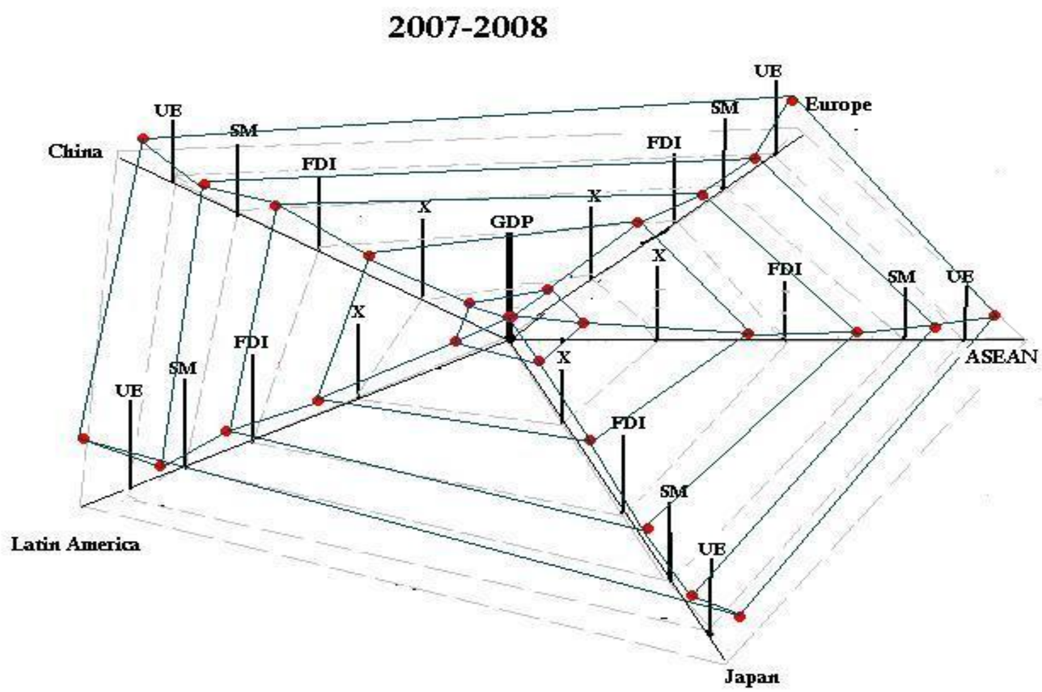
The windows refraction links (╬)facilitate the connection of all windows refraction in the same market and other markets simultaneously, from the epicenter until the last window refraction in the same market. Therefore, the epicenter is going to affect different countries simultaneously in the same graphical space, but in different magnitudes and speeds of time. We assume that these countries maintain a high international trade exchange and investment mobility relationship with the U.S. According to this chapter, the economic waves originate from the GDP growth rate of the U.S. economy and spread to the rest of the world economy. In fact, it is possible to observe how different countries are affected in different levels from a deep recession in the U.S. economy. On the other hand, this new graphical modeling offers to economists, policy makers, students and academics a multi-dimensional graphical modeling method to analyze economic recession or economic crisis concerning the world economy. This method is based on the use of the inter-linkage coordinate space.

Between 2007 and 2008, there was a constant generation of economic waves that struck different markets around the world because of the poor performance of the GDP growth rate of the U.S. economy. The generating of economic waves originates from the strong relationship that exists between the rest of the world and the U.S. economy through international trade exchange, FDI mobility and stock markets integration. The economic waves effect shows clearly how integrated the world economy has become under the umbrella of globalization. Moreover, the final impact of a deep slowdown of the U.S. economy can be observed in the last phase of the economic waves, in this case, shown in the unemployment and poverty levels in different markets such as Japan, China, ASEAN, EU and Latin America (see Figure 1).

TABLE 2:
Economic Waves: the U.S., Japan, China, ASEAN, Latin America and the European Union (2006-2007 and 2007-2008)

Country 1: Japan **Windows Refraction:** ╬ Windows Refraction 1: GDP/ U.S. ╬ Windows Refraction 2: Exports to US ╬ Windows Refraction 3: FDI from US ╬ Windows Refraction 4: Stock Market ╬ Window Refraction 5: Unemployment	**Country 2: China** **Windows Refraction:** ╬ Windows Refraction 1: GDP/ U.S. ╬ Windows Refraction 2: Exports to US ╬ Windows Refraction 3: FDI from US ╬ Windows Refraction 4: Stock Market ╬ Window Refraction 5: Unemployment	**Region 3: ASEAN** **Windows Refraction:** ╬ Windows Refraction 1: GDP/U.S. ╬ Windows Refraction 2: Exports to US ╬ Windows Refraction 3: FDI from US ╬ Windows Refraction 4: Stock Markets ╬ Window Refraction 5: Unemployment
Region 4: Latin America **Windows Refraction:** ╬ Windows Refraction 1: GDP/U.S. ╬ Windows Refraction 2: Exports to US ╬ Windows Refraction 3: FDI from US ╬ Windows Refraction 4: Stock Markets ╬ Window Refraction 5: Unemployment	**Sub-Market 5: European Union** **Windows Refraction:** ╬ Windows Refraction 1: GDP/U.S. ╬ Windows Refraction 2: Exports to US ╬ Windows Refraction 3: FDI from US ╬ Windows Refraction 4: Stock Markets ╬ Window Refraction 5: Unemployment	

FIGURE 1
Economic Waves in the period between 2007-2008



GDP: Gross Domestic Product
FDI: Foreign Direct Investment
SM: Stock market
X: Exports
UE: Unemployment

Statistical Sources: NBER, World Bank and IMF

15.2. Concluding Remarks

This chapter concludes that from day to day, the world economy has become more vulnerable when it comes to suffering a global recession or global inflation. This is because of: (i) the strong and rapid integration of markets that are closed to the U.S. economy through international trade exchange; (ii) the high dependency on foreign direct investment (FDI) by American transnational companies; (iii) the interconnection of stock markets through sophisticated information communication technologies (ICT). In fact, the high possibility of being affected by strong economic waves on a number of markets is real and latent at any time. This can be observed when the economic waves arrive at its final phase or last window refraction in the same market (country or region). The last window refraction shows the unemployment growth rates of all markets.

CHAPTER 16

THE VISUALIZATION OF COMPLEX ECONOMIC PHENOMENA FROM A MULTI-DIMENSIONAL GRAPHICAL PERSPECTIVE: A CASE STUDY OF THE U.S. ECONOMY (1929-2009)

16.1. The Visualization of Complex Economic Phenomena from a Multi-dimensional Graphical Perspective

In the study of complex economic phenomena, it is common to observe the application of different statistical methods to analyze historical data (database) or to generate forecasts under the application of different econometrics models. This is based on the use of sophisticated and powerful computer software to run a large number of variables (multi-variable), functions and equations simultaneously. But the graphical modeling applied in statistics methods and econometric models until today continue to be displayed on 2-dimensional graphs. This research argues that 2-dimensional graphs cannot visualize a large number of variables (multi-variables), functions and equations simultaneously in the same graphical space.

In contrast, we suggest the application of inter-linkage coordinate space and graphical animation that facilitates the visualization of complex economic phenomena in the same graphical space in real time. Hence, the use of inter-linkage coordinate space with different statistical methods and econometrics models can facilitate the visualization of large number of databases, or different results, on the same graphical space. To apply inter-linkage coordinate space and multi-dimensional graphical animation, we need to assume that the market is formed by a group of sub-markets and that all these sub-markets are moving in real time. These sub-markets are the goods sub-market, money sub-market, social sub-market, financial sub-market, international trade sub-market, labor sub-market, government sub-market, transport & energy sub-market and technological sub-market (see Table 2 and Figure 1). Each sub-market has a large number of windows refraction (or quadrants), and each window refraction (or quadrant) is formed by its X-axis which represents time (days, weeks, months, years and decades) and its Y-axis which represents the main variable in analysis, based on the use of growth rates respectively. Each sub-market shows four, five or an infinite number of windows refraction, according to our research priorities (see Table 1); at the same time, these windows refraction show different relationship(s) and different partial times.

The idea of time and space in this chapter is totally different from the traditional view of time. We assume that the market is formed by a large number of sub-markets that are moving all the time at different speeds of time under the application of the *Omnia Mobilis* assumption (everything is moving). Each sub-market is formed by a large number of windows refraction (or quadrants) that are also moving at different speeds of time. This chapter proposes to divide time into four types: general time (universal time), evolutionary time (future time), partial time (present time) and constant time (past time). The first assumption to support that different types of time exist is that any economic phenomenon is multi-dimensional and therefore each of its dimension(s) develops different speeds of time.

TABLE 1:
Sub-Markets and Windows Refraction

Sub-Market 1: **Windows Refraction:** Windows Refraction 1: Windows Refraction 2: Windows Refraction 3: . . . Windows Refraction ∞:	**Sub-Market 2:** **Windows Refraction:** Windows Refraction 1: Windows Refraction 2: Windows Refraction 3: . . . Windows Refraction ∞:	**Sub-Market 3:** **Windows Refraction:** Windows Refraction 1: Windows Refraction 2: Windows Refraction 3: Windows Refraction 4: . . . Windows Refraction ∞:
Sub-Market 4: **Windows Refraction:** Windows Refraction 1: Windows Refraction 2: Windows Refraction 3: . . . Windows Refraction ∞:	**Sub-Market 5:** **Windows Refraction:** Windows Refraction 1: Windows Refraction 2: Windows Refraction 3: . . . Windows Refraction ∞:	**Sub-Market 6:** **Windows Refraction:** Windows Refraction 1: Windows Refraction 2: Windows Refraction 3: . . . Windows Refraction ∞:
Sub-Market 7: **Windows Refraction:** Windows Refraction 1: Windows Refraction 2: Windows Refraction 3: . . . Windows Refraction ∞:	**Sub-Market 8:** **Windows Refraction:** Windows Refraction 1: Windows Refraction 2: Windows Refraction 3: . . . Windows Refraction ∞:	**Sub-Market ∞:** **Windows Refraction:** Windows Refraction 1: Windows Refraction 2: Windows Refraction 3: . . . Windows Refraction ∞:

For the purposes of this research, we would like to define the different type(s) of times. First, partial time shows different events through time and space of any economic phenomenon according to unexpected natural and uncontrolled events. Second, partial time always becomes constant time: this means that every second, minute, hour, day, week, month and year that passes becomes a constant time (past time). Third, evolutionary time (future time) is always moving under constant chaos and imbalance all the time. Fourth, general time is the synchronization of an infinite number of partial times running into an infinite windows refraction or an infinite number of sub-markets.

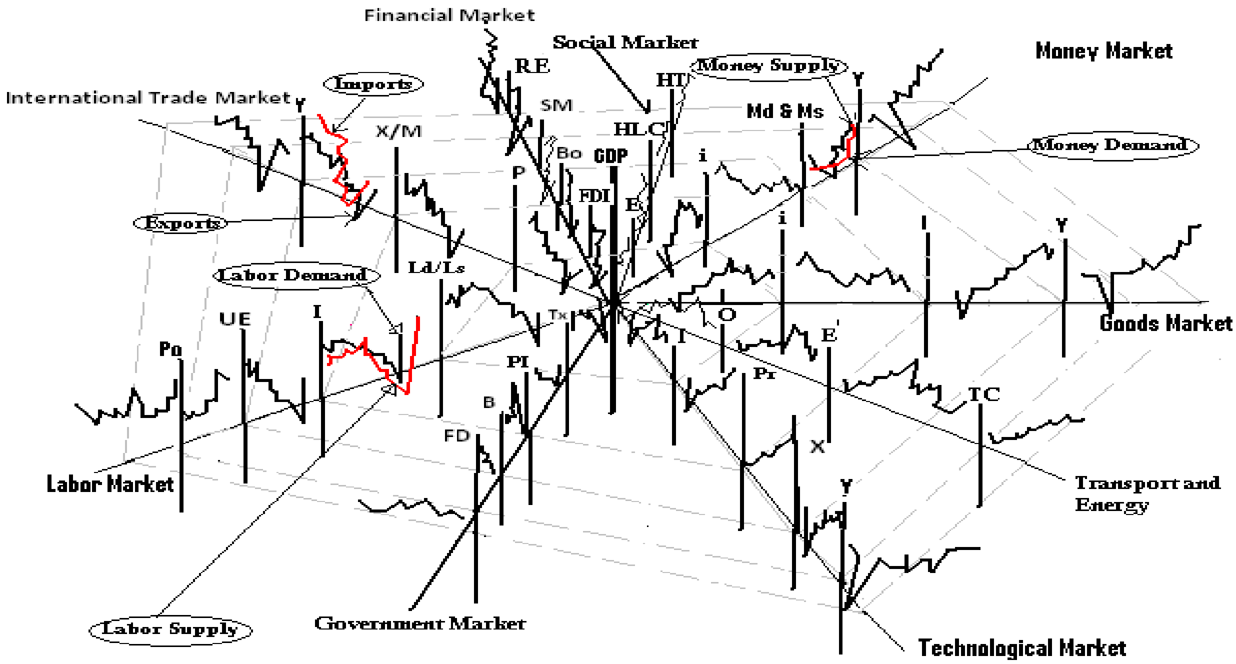
We argue that the application of inter-linkage coordinate space and multi-dimensional graphical animation facilitates the understanding of the behavior and trends of complex economic phenomena within the same graphical space. The inter-linkage coordinate space and multi-dimensional graphical animation can generate a global visual effect to observe the behavior of any economy as a whole; at the same time, this alternative multi-dimensional graphical modeling can generate a "real time effect" under the application of graphical computer animation based on the construction of a large number of slides that are joined together into the assembly and production of a video. It is possible to observe different variables simultaneously in constant movement. This multi-dimensional graphical technique can make it possible to observe the failures of different sub-markets in the same graphical space, and at the same time, the generation of suitable policies to solve these failures in different sub-markets in moments of economic recession or economic crisis.

Finally, this chapter presents the development of the U.S. economy from 1929 to 2009 in a single graph; the same graph makes it possible to visualize nine sub-markets and forty windows refraction interacting in the same graphical space. This graph has 3,200 values plotted into forty windows refraction located within nine sub-markets. These sub-markets are comprised of the goods sub-market, money sub-market, social sub-market, financial sub-market, international trade sub-market, labor sub-market, government sub-market, transport & energy sub-market and technological sub-market (see Table 2 and Figure 1). For the purposes of this research, we will not go too deeply in the analysis of the U.S. economy; we will explore it only to display the U.S. economy within a multi-dimensional coordinate space under the use of different databases in different sub-markets (windows refraction). The application of the multi-dimensional coordinate space method offers an alternative multi-dimensional graphical modeling technique for economists, policy makers, students and academics.

TABLE 2:
Sub-Markets and Windows Refraction:
The U.S. Economy (1929-2009)

Sub-Market 1: Goods Market **Windows Refraction:** Windows Refraction 1: GDP Windows Refraction 2: Interest Rate Windows Refraction 3: Investment Windows Refraction 4: Income	**Sub-Market 2:** Money Market **Windows Refraction:** Windows Refraction 1: GDP Windows Refraction 2: Interest Rate Windows Refraction 3: Money: Supply and Demand Windows Refraction 4: Income	**Sub-Market 3:** Social Market **Windows Refraction:** Windows Refraction 1: GDP Windows Refraction 2: Education Windows Refraction 3: Low Cost Housing Windows Refraction 4: Health Care
Sub-Market 4: Financial Market **Windows Refraction:** Windows Refraction 1: GDP Windows Refraction 2: FDI Windows Refraction 3: Bonds Windows Refraction 4: Stock Market Window Refraction 5: Real Estate	**Sub-Market 5:** International Trade Market **Windows Refraction:** Windows Refraction 1: GDP Windows Refraction 2: Production Windows Refraction 3: Exports and Imports Windows Refraction 4: Income	**Sub-Market 6:** Labor Market **Windows Refraction:** Windows Refraction 1: GDP Windows Refraction 2: Investment Windows Refraction 3: Labor: Supply and Demand Windows Refraction 4: Unemployment Window Refraction 5: Poverty
Sub-Market 7: Government Market **Windows Refraction:** Windows Refraction 1: GDP Windows Refraction 2: Taxes Windows Refraction 3: Public Investment Windows Refraction 4: Fiscal Deficit	**Sub-Market 8:** Technological Market **Windows Refraction:** Windows Refraction 1: GDP Windows Refraction 2: Investment Windows Refraction 3: Productivity Windows Refraction 4: Exports Window Refraction 5: Income	**Sub-Market 9:** Transport and Energy Market **Windows Refraction:** Windows Refraction 1: GDP Windows Refraction 2: Oil Prices Windows Refraction 3: Energy Prices Windows Refraction 4: Transport Costs

FIGURE 1
The U.S. Economy from 1929-2009



GDP: Gross Domestic Product	**i:** Interest Rates
I: Investment	**Y:** Income
Md: Money Demand	**Ms:** Money Supply
FDI: Foreign Direct Investment	**Bo:** Bonds
SM: Stock market	**RE:** Real Estate
P: Production	**X:** Exports
M: Imports	**Ld:** Labor Demand
Ls: Labor Supply	**UE:** Unemployment
Po: Poverty	**Tx:** Tax
PI: Public Investment	**B:** Budget
FD: Fiscal Deficit	**Pr:** Productivity
O: Oil Price	**E':** Energy Prices
TC: Transport Costs	**E:** Education
HLC: Low Cost Housing	**HT:** Health Care

Statistics Resources: NBER, World Bank and IMF

16.2. Concluding Remarks

This chapter concludes that the application of the inter-linkage coordinate space can offer statistics and econometrics models an alternative multi-dimensional graphical modeling approach to visualize a large number of databases, econometrics and forecasting modeling results within the same graphical space.

CHAPTER 17

THE GLOBAL ECONOMIC CRISIS SMASH EFFECT SIMULATOR (GECSE-SIMULATOR)

17.1. Introduction to the Global Economic Crisis Smash Effect Simulator (GECSE-Simulator)

The construction of the global economic crisis smash effect simulator (GECSE-Simulator) is based on the application of economic waves modeling. To build each economic wave in our simulation, we suggest the simultaneous application of the inter-linkage coordinate space and economic modeling in real time. Initially, the GECSE-simulator uses n-number of economies "E" in its analysis. Each economy has its general axis; at the same time, each general axis can show a large number of sub-axes. All these sub-axes are interconnected by straight lines until they reach the last sub-axis. A reminder: each sub-axis runs with different multi-dimensional partial differentiation(s) ($\partial Y/\partial X$) (see Annex 1) in real time (☼) (see Annex 2). The idea of applying a large number of partial differentiation(s) successively is to generate an effect of movement of different economic waves in the same graphical space.

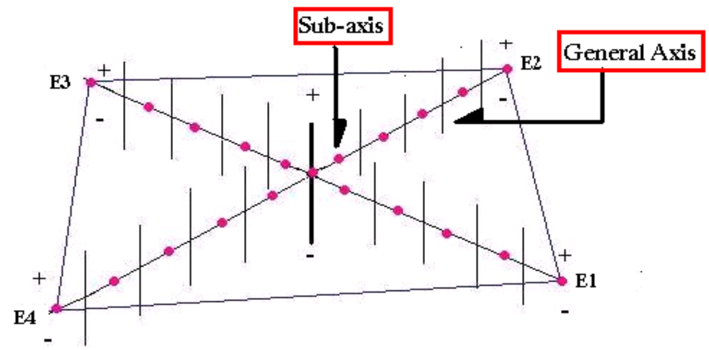
According to the GECSE-simulator, each sub-axis is interconnected into the same general axis by the application of the inter-linking sub-axis system "╬". The function of this is to join each sub-axis into the same general axis. Finally, all general axes and sub-axes are joined at all levels of analysis under the application of the fixed exponential "λ" in different periods of time (t+1). However, the assumption is that all sub-axes and the general axis are moving under the application of economic modeling in real time "☼" (see Expression 1). We also suggest the application of the *Omnia Mobilis* assumption to help in the relaxation of each sub-axis. This is to reduce the use of the *Ceteris Paribus* assumption in our simulator. Finally, we observe a large number of surfaces (economic waves) in permanent movement using the GECSE-simulator. The movement of these surfaces starts from the epicenter of the inter-linkage coordinate space until its end in the last sub-axis into the same general axis. The real impact of this simulator is located on the last sub-axis (see Figure 1). The final analysis in the GECSE-simulator is based on the analysis of different surfaces displayed in different parts of the inter-linkage coordinate space.

1.

$$\text{☼}\boldsymbol{S} = {}^{\text{☼}\lambda_{t+1}}\left(\begin{array}{l} \boldsymbol{E_1} = \text{☼}[\partial \boldsymbol{Y}^{i}_{1\text{-}0}/\partial \boldsymbol{X}^{i}_{1\text{-}0}]*L_j \text{ ╬ } \text{☼}[\partial \boldsymbol{Y}^{i}_{1\text{-}1}/\partial \boldsymbol{X}^{i}_{1\text{-}1}]*L_j \text{ ╬ } \text{☼}[\partial \boldsymbol{Y}^{i}_{1\text{-}2}/\partial \boldsymbol{X}^{i}_{1\text{-}2}]*L_j \text{ ╬}\ldots\text{╬ } \text{☼}[\partial \boldsymbol{Y}^{i}_{1\text{-}\infty}/\partial \boldsymbol{X}^{i}_{1\text{-}\infty}]*L_j \\ \boldsymbol{E_2} = \text{☼}[\partial \boldsymbol{Y}^{i}_{2\text{-}0}/\partial \boldsymbol{X}^{i}_{2\text{-}0}]*L_j \text{ ╬ } \text{☼}[\partial \boldsymbol{Y}^{i}_{2\text{-}1}/\partial \boldsymbol{X}^{i}_{2\text{-}1}]*L_j \text{ ╬ } \text{☼}[\partial \boldsymbol{Y}^{i}_{2\text{-}2}/\partial \boldsymbol{X}^{i}_{2\text{-}2}]*L_j \text{ ╬}\ldots\text{╬ } \text{☼}[\partial \boldsymbol{Y}^{i}_{2\text{-}\infty}/\partial \boldsymbol{X}^{i}_{2\text{-}\infty}]*L_j \\ \qquad\qquad\qquad\qquad \bullet \\ \boldsymbol{E_\infty} = \text{☼}[\partial \boldsymbol{Y}^{i}_{\infty\text{-}0}/\partial \boldsymbol{X}^{i}_{\infty\text{-}0}{}^{i}]*L_j \text{ ╬ } \text{☼}[\partial \boldsymbol{Y}^{i}_{\infty\text{-}1}/\partial \boldsymbol{X}^{i}_{\infty\text{-}1}]*L_j \text{ ╬ } \text{☼}[\partial \boldsymbol{Y}^{i}_{\infty\text{-}2}/\partial \boldsymbol{X}^{i}_{\infty\text{-}2}]*L_j \text{ ╬}\ldots\text{╬ } \text{☼}[\partial \boldsymbol{Y}^{i}_{\infty\text{-}\infty}/\partial \boldsymbol{X}^{i}_{\infty\text{-}\infty}]*L_j \end{array} \right)$$

Partial differentiation: i= {o,1,2,3…∞} and Level: j= {o,1,2,3…∞}

Figure 1: The GECSE-Simulator Coordinate System



17.2. The Application of the GECSE-simulator

The GECSE-simulator will be applied to five different economies simultaneously. These five economies are preceded by the first one, the United States economy, which is fixed as the epicenter in the GECSE-simulator. Additionally, we include the other four economies distributed into four general axes respectively; these four economies are the ASEAN economy (E_1), Chinese economy (E_2), European economy (E_3) and Japanese economy (E_4) (see Expression 2). Basically, the GECSE-Simulator uses six variables: the GDP growth rate(s) of the United States economy (GDP_{US}), the imports growth rate(s) of the United States from these four economies (M), the foreign direct investment growth rate(s) (FDI) from the United States to these four economies and vice versa, the stock market exchange growth rate(s) between the United States and these four economies (SM), the unemployment growth rate(s) from these four economies (UE) and finally the poverty growth rate(s) of these four economies (P). Each sub-axis is multiplied by a coefficient that is called the level of devastation of the global financial crisis (L).

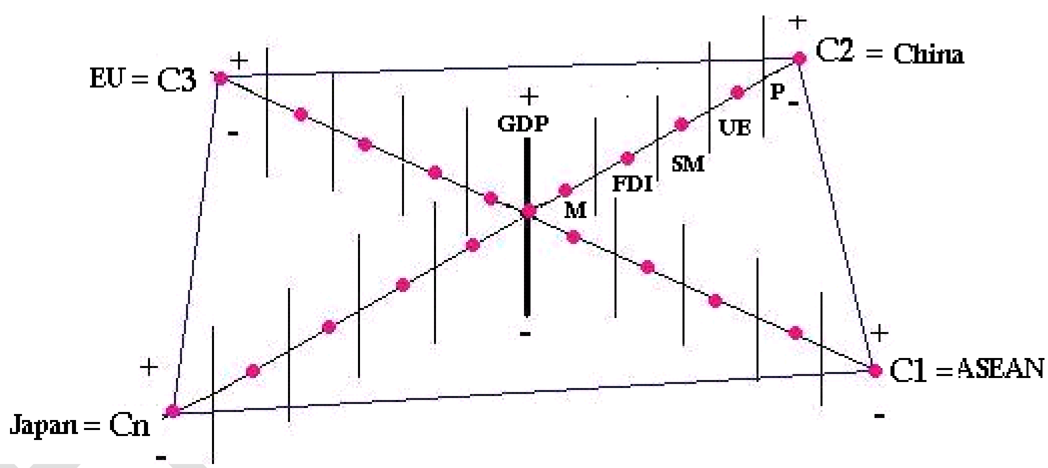
The devastation of the global financial crisis (L) is a coefficient is a discount rate that aids in observing the final impact of the global financial crisis in different economies and the global economy. We apply partial differentiation(s) in real time between the GDP growth rate(s) of the U.S. and imports growth rate(s) (M) on the first sub-axis, GDP growth rate(s) of the U.S. and foreign direct investment growth rate(s) (FDI) on the second sub-axis, GDP growth rate(s) of the U.S. and the stock market exchange growth rate(s) (SM) on the third sub-axis, GDP growth rate(s) of the U.S. and unemployment growth rate(s) (UE) on the fourth sub-axis, GDP growth rate(s) of the U.S. and poverty growth rate(s) (P) on the fifth sub-axis in the same general axis. Each partial differentiation(s) is multiplied by the level of devastation of the global financial crisis (L). This is to generate different scenarios under different levels of impact of the global financial crisis on each economy in the analysis simultaneously. At the same time, we suggest applying an exponential of real time ($☼\lambda_{t+1}$) to join all partial differentiation(s) in each sub-axis and general axis until we can build a single surface. If we observe this on a large screen, it is possible to observe a large number of surfaces (economic waves) moving like waves in the same space and at the same time from the epicenter to the last sub-axis in the same general axis.

The final objective for using the GECSE-simulator is to show different scenarios and the impact of the global financial crisis according to the level of devastation of the global financial crisis (L). Now it is possible to visualize the negative effects of a global financial crisis from a global perspective. Hence, this simulator permits the representation of different scenarios and effects of the global financial crisis on the world economy within the same graphical space and time (see Figure 3).

2.

$$\text{☼}\lambda_{t+}\quad \text{☼}S = \left\{ \begin{array}{l} E_1 = \text{☼}[\partial GDP_{US}^{i}/\partial M_1^{\,i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial FDI_1^{i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial SM_1^{i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial UE_1^{i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial P_1^{i}]*L_j \\ E_2 = \text{☼}[\partial GDP_{US}^{i}/\partial M_2^{\,i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial FDI_2^{i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial SM_2^{i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial UE_2^{i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial P_2^{i}]*L_j \\ E_3 = \text{☼}[\partial GDP_{US}^{i}/\partial M_3^{\,i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial FDI_3^{i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial SM_3^{i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial UE_3^{i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial P_3^{i}]*L_j \\ E_4 = \text{☼}[\partial GDP_{US}^{i}/\partial M_4^{\,i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial FDI_4^{i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial SM_4^{i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial UE_4^{i}]*L_j \text{╬} \text{☼}[\partial GDP_{US}^{i}/\partial P_4^{i}]*L_j \end{array} \right.$$

Figure 2: The GECSE-Simulator: Graphical Modeling

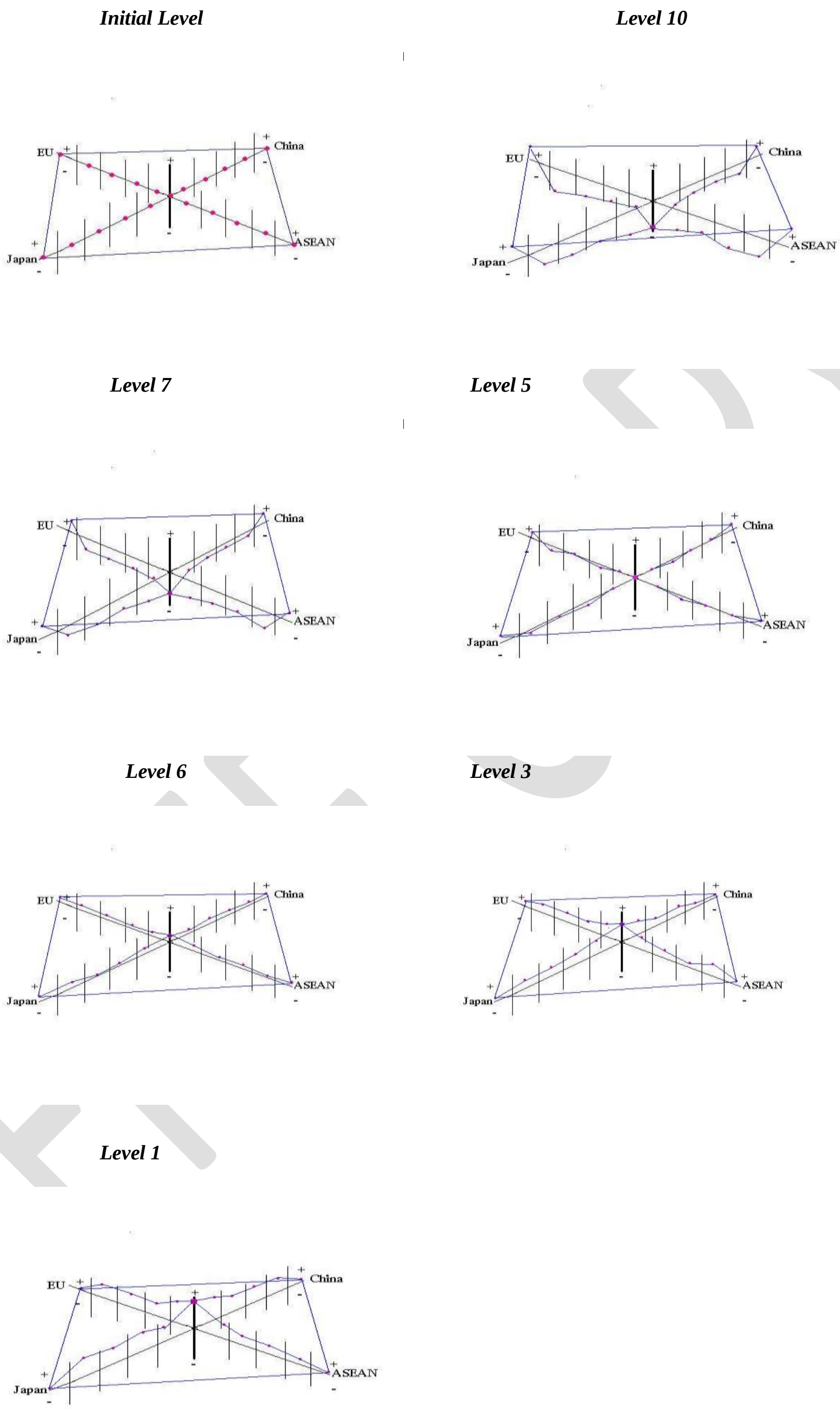


The level of devastation of the global financial crisis (L) is classified into ten levels, from Level 1 (low impact) to Level 10 (high impact). We observe in Figure 3 that a Level 10 impact is the highest level of devastation brought about by the global financial crisis on the world economy. We can also observe that the levels of unemployment growth rates among the four economies in analysis such as the ASEAN economy (E_1), Chinese economy (E_2), European economy (E_3) and Japanese economy (E_4) are located between 15% to 20% and the poverty growth rates are located between 20% and 25%; both indicators show the higher levels of unemployment and poverty rates in case of a deep global financial crisis. The economies which are more affected by the global financial crisis at Level 10 are the European economy and the Japanese economy. This is due to the strong trade and investment relationship that exists between them and the American economy according to the GECSE-Simulator. The Chinese economy and ASEAN economy show large amounts of unemployment and poverty but this is proportionately less than the European economy and the Japanese economy. In the case of the Chinese economy and ASEAN economy, the unemployment growth rates are located between 9% and 11% respectively, but the poverty growth rates for both economies is equal to 15% and 16% (see Figure 3) If we continue analyzing up to Level 7, it is possible to observe a better performance of the GDP growth rate of U.S. economy than at Level 8. At the same time, the American economy experiences a better performance in its unemployment growth rate with 12% and a poverty growth rate of 15%. The Chinese economy and the ASEAN economy cannot show any improvement of unemployment growth rates and poverty growth rates at Level 7 (see Figure 3).

At Level 5, it is possible to observe that the GDP growth rate of the U.S. economy is equal to 0. But the unemployment growth rate of the U.S. is equal to 8% and the poverty growth rate of the U.S. economy is 13%. Level 5 also shows a minimum impact on the European economy and Japanese economy with insignificant reductions in the unemployment and poverty growth rates located between 15% and 17%. But in the case of the ASEAN economy and Chinese economy the impact is less because the unemployment and poverty growth rates only show 10% and 15%. We can say that the European economy and Japanese economy have a high dependence upon the good performance of the GDP growth rate of the U.S. economy than upon the Chinese and ASEAN economies (see Figure 3). According to the simulation, Level 6 shows a positive but weak GDP growth rate of the U.S. economy: the levels of unemployment and poverty growth rates in the American economy show a better performance, but are only a little higher, with 7% for unemployment growth rates and 11% for poverty growth rates. The Chinese economy and ASEAN economy show a better performance than before but the unemployment growth rates only decrease from 10% to 8% respectively (see Figure 3).

Finally, the simulation at Level 3 and Level 0 show the lowest devastation rates of the global financial crisis on the world economy. These levels are exceptional but hard to be aspired to by the American economy because we are referring to a huge expansion of the GDP growth rates, i.e. between 11% and 15%, annually. And the final impact of a huge expansion of the GDP growth rate of the U.S. economy on the European economy and Japanese economy can reduce its unemployment growth rates to between 0.5% and 1.5% and the poverty growth rate to levels of 5%. We can observe that among the four economies mentioned, those who receive the most benefit from a higher performance of the GDP growth rate of the U.S. economy are, in order, the European economy, Japanese economy, Chinese economy and the ASEAN economy respectively. Under Level 3 and Level 0, both the Chinese economy and the ASEAN economy can decrease their unemployment growth rates to between 3% and 5%, but the level of poverty growth rates in the Chinese economy and ASEAN economy can only decrease from 12% to 7% (see Figure 3) according to this simulation.

Figure 3: The Global Economic Crisis Smash Effect Simulator at Different Levels



17.3. Concluding Remarks

This chapter offers policy makers, central banks, academics and students of economics an alternative multi-dimensional graphical modeling approach to analyze the final impact of a global financial crisis from a multi-dimensional perspective. The GECSE-simulator can generate a large number of scenarios originating from a global financial crisis, according to the level of devastation of the global financial crisis (L) coefficient. The main objective of this is to create different simulations and measure the catastrophic(s) effect(s) of any global financial crisis upon the world economy within the same graphical space.

CHAPTER 18
THE INPUT-OUTPUT MULTI-DIMENSIONAL ANALYSIS

18.1. Introduction

The input-output analysis model was introduced by Wassily Leontief, who deals with a particular question: "What level of output should each of the n industries in an economy produce, in order that it will just be sufficient to satisfy the total demand for that product…?" (Leontief, 1951). The model Leontief proposes is a static and partial equilibrium version; the input-output analysis does not show general equilibrium or dynamic modeling. Therefore, the construction of the input-output analysis is based on the use of three production sectors (agriculture, industry and services). In the original paper written by Leontief, the services sector appears as householders (Leontief, 1985). The basic structure of the input-output table shows a large number of production sectors, but almost all the examples are based on the use of three sectors. This model uses a series of assumptions.

The first assumption is that each production sector produces a single homogeneous commodity. The second assumption is that the model is working under a fixed input ratio. The third assumption is that all production sectors work under the constant returns to scale. Despite the simplistic appearance of this model, the contribution of Leontief is a very useful one, because this economic model shows an alternative view of how the economy works based on the interaction of different industries from different production sectors ("S"), such as agriculture, industry and services. The final step is to calculate the minimum output to produce a specific commodity to satisfy the basic demands of any country.

Hence, this chapter proposes the use of an alternative mathematical and graphical modeling approach to study input-output analysis from a multi-dimensional perspective. Our model is called "the input-output multi-dimensional analysis", which incorporates a large number of commodities "j", production sub-sectors "i" and four production sectors "S" in our analysis, based on the application of Econographicology (Ruiz Estrada, 2007), matrix algebra, multi-dimensional partial differentiation and economic modeling in real time.

18.2. The Input-Output Multi-Dimensional Analysis

Initially, we have a large number of "j" commodities generated by "i" number of production sub-sectors by four production sectors "S" (see Expression 1). In this case, we have four production sectors: agriculture, light industry (manufacturing), heavy industry (the production of capital goods) and services (see Expression 3, 5, 7 and 9). The final output from these four production sectors depends on the output from all production sub-sectors respectively (see Expression 2, 4, 6 and 8). In fact, the agriculture sector (production sector one "S_1") includes the production of "j" number of commodities by "i" sub-sectors. For example, we can argue that the production of coffee can be classified as a sub-sector "i" within the agriculture sector represented by "S_1" under "m" number of coffee producers.

Moreover, we assume that the production of any commodity "j" by any sub-production sector "i" is related to the fast technological challenges and the domestic and international demands of the market. On the other hand, we also need to assume in our model that the innovation, research and development of new commodities under low cost production can generate high demand within different markets simultaneously. We can also observe that each production sub-sector "i" can show unexpected high or low intensive exchange of commodities "j" among all sub-sectors "i" in the same production sector "S" (see Expression 1), based on the idea that the market always keeps in a state of dynamic imbalance; to support this argument, we apply the *Omnia Mobilis* assumption to generate the relaxation of the exchange of commodities "j" among all production sectors "S" and sub-sectors "i" in the same production sector.

(1) $\delta S_{sij} : \delta S_{sij}$ where $i = \{0,1,2,\ldots,\infty\ldots\}$
$j = \{0,1,2,\ldots,\infty\ldots\}$
$S = \{1,2,3,4\}$

S = Production sector i = sub-sector j = commodities.

The equation (1) exists under two premises:

a. If $\delta S_{sij} = \delta S_{sij}$ then the final output into the exchange of this sub-production sector becomes 0.
b. If $\delta S_{sij} \neq \delta S_{sij}$ then the final output into the exchange of this sub-production sector becomes a real or negative number.

Sector one (S_1) represents the agriculture sector; this production sector basically shows a large number of sub-sectors, where there is an exchange of an infinite number of commodities "j" among all sub-sectors "i" in the same production sector "S". The final output into the box of each matrix below shows the final output after we calculate the exchange of commodities among all sub-sectors simultaneously. The same situation can be observed within $sector_2$ (light industry), $sector_3$ (heavy industry) and $sector_4$ (services).

(2) **<u>Sector S_1</u>**

Sector S_1	G_{100}	G_{101}	G_{102}	. . .	G_{10j}	S_1TO
G_{100}	0	$[\delta G_{100}:\delta G_{101}]$	.	. .	$[\delta G_{100}:\delta G_{10j}]$	ΣS_{100}
G_{101}	$[\delta G_{101}:\delta G_{100}]$	0	.	. .	$[\delta G_{101}:\delta G_{10j}]$	ΣS_{110}
G_{102}	.	.		. . .	.	.
.	.	.		. . .	.	.
G_{10j}	$[\delta G_{10j}:\delta G1_{00}]$	$[\delta G_{10j}:\delta G_{101}]$		. . .	0	ΣS_{10j}
S_1TI	ΣS_{100}	ΣS_{101}		. . .	ΣG_{10j}	ΣS_1

Note: "G" represents commodities

(3) $\Sigma S_1 = f$ (0 ╤ [$\delta G_{100}:\delta G_{101}$] ╤…╤ [$\delta G_{100}:\delta G_{10j}$] ╤…╤ [$\delta G_{10j}:\delta G_{101}$] ╤ 0)

(4) **Sector S_2**

Sector S_2	G_{210}	G_{211}	G_{212}	. . .	G_{21j}	S_2TO
G_{210}	0	[$\delta G_{210}:\delta G_{211}$]	•	• •	[$\delta G_{210}:\delta G_{21j}$]	ΣS_{210}
G_{211}	[$\Delta g_{211}:\delta G_{210}$]	0	.	. .	[$\delta G_{211}:\delta G_{21j}$]	ΣS_{211}
G_{212}	.	.		. . .	.	.
.	.	.		. . .	.	.
G_{21j}	[$\delta S_{21j}:\delta S_{210}$]	[$\delta S_{21j}:\delta S_{211}$]		. . .	0	ΣS_{21j}
S_2TI	$\Sigma S2_{10}$	$\Sigma S2_{11}$		. . .	ΣS_{21j}	$\Sigma S2$

(5) $\Sigma S_2 = f$ (0 ╤ [$\Delta g_{210}:\delta G_{211}$] ╤…╤ [$\delta G_{210}:\delta G_{21j}$] ╤…╤ [$\delta G_{21j}:\delta G_{211}$] ╤ 0)

(6) **Sector S_3**

Sector S_3	G_{320}	GS_{321}	G_{322}	. . .	G_{32j}	S_3TO
G_{320}	0	[$\Delta G_{320}:\delta G_{321}$]	•	• •	[$\delta G_{320}:\delta G_{32j}$]	ΣS_{320}
G_{321}	[$\delta G_{321}:\delta G_{320}$]	0	.	. .	[$\delta G3_{21}:\delta G3_{2j}$]	ΣS_{321}
G_{322}	.	.		. . .	.	.
.	.	.		. . .	.	.
G_{32j}	[$\Delta g_{32j}:\delta G_{320}$]	[$\delta G_{32j}:\delta G_{321}$]		. . .	0	ΣS_{32j}
G_3TI	ΣS_{320}	ΣS_{321}		. . .	ΣS_{32j}	ΣS_3

(7) $\Sigma S_3 = f$ (0 ╤ [$\delta G_{320}:\delta G_{321}$] ╤…╤ [$\delta G_{320}:\delta G_{32j}$] ╤…╤ [$\delta G_{32j}:\delta G_{321}$] ╤ 0)

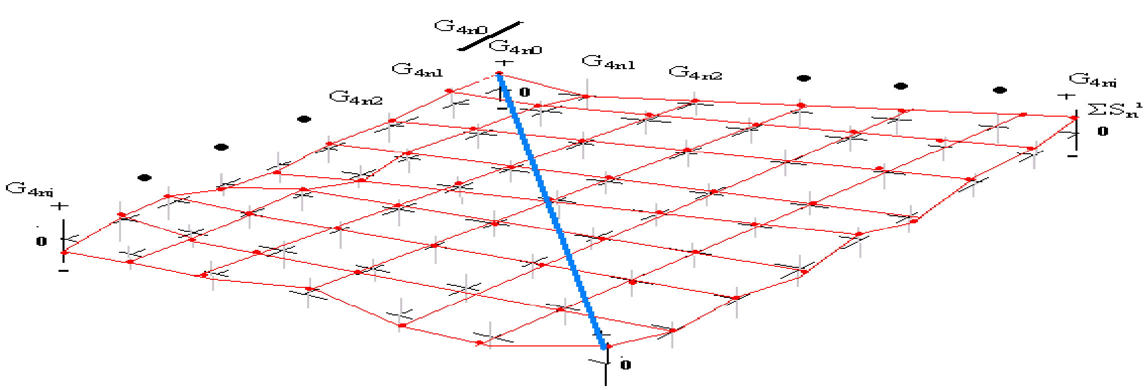
(8) **Sector S_4**

Sector S_4	G_{4n0}	G_{4n1}	G_{4n2}	. . .	G_{4nj}	S_4TO
G_{4n0}	0	$[\Delta g_{4n0}:\delta G_{4n1}]$	.	. .	$[\delta G_{4n0}:\delta G_{4nj}]$	ΣS_{4n0}
G_{4n1}	$[\delta G_{4n1}:\delta G_{4n0}]$	0	.	. .	$[\delta G_{4n1}:\delta G_{4nj}]$	ΣS_{4n0}
G_{4n2}	.	.		. . .	.	.
.	.	.		. . .	.	.
G_{4nj}	$[\delta G_{nj}:\delta G_{n0}]$	$[\delta G_{nj}:\delta G_{n1}]$		. . .	0	ΣS_{4nj}
S_4TI	ΣS_{4n0}	ΣS_{4n1}		. . .	ΣS_{40j}	ΣS_4

(9) $\Sigma S_4 = f\,(0 \text{╥} [\delta G_{4n0}:\delta G_{4n1}] \text{╥} \ldots \text{╥} [\delta G_{4n0}:\delta G_{4nj}] \text{╥} \ldots \text{╥} [\delta G_{4nj}:\delta G_{4n1}] \text{╥} 0)$

Additionally, this model suggests the plotting of each production sector into four different mega-space coordinate spaces to build four different surfaces; the construction of each surface takes into consideration all the output results from all production sub-sectors within the same production sector. Then, each production sub-sector output result from the same production sector is plotted on its mega-space coordinate space respectively. Finally, we join all production sub-sector results located in different parts of the mega-space coordinate space by straight lines until a single surface is visualized. The main idea of building four different multi-dimensional surfaces is to visualize the behavior of the exchange among all production sub-sectors "i" by the exchange of a large number of commodities "j" within the same production sector "S" (see Figure 1).

Figure 1: The Mega-Space Coordinate Space by Production Sector



Moreover, the final input-output multi-dimensional analysis requires the application of multi-dimensional partial differentiation (see Appendix 1) to observe the changes of two periods of time between the final time (t+1) and the initial time (t). Also in this part of the model, we suggest the application of economic modeling in real time "☼"(see Appendix 2) that consists of calculating successive partial derivatives to observe the changes among the four production sectors simultaneously (see Expression 10). We also suggest joining all production sub-sectors results under the application of the inter-linkage coordinate axis condition, represented by "╦" (see Appendix 3).

(10) $\text{☼}\Sigma S_1^{i} \equiv \Sigma S_1^{'} = \delta f^{'} (S_1)_t / \delta (S_1)_{t+1} d^{'} S_1 \text{╦} \Sigma S_1^{''} = \delta f^{''} (S_1)_t / \delta (S_1)_{t+1} d^2 S_1 \text{╦} \Sigma S_1^{\infty} = \delta f^{\infty} (S_1) / \delta (S_1)_{t+1} d^{\infty} S_1$

$\text{☼}\Sigma S_2^{i} \equiv \Sigma S_2^{'} = \delta f^{'} (S_2)_t / \delta (S_2)_{t+1} d^{'} S_2 \text{╦} \Sigma S_2^{''} = \delta f^{''} (S_2)_t / \delta (S_2)_{t+1} d^2 S_2 \text{╦} \Sigma S_2^{\infty} = \delta f^{\infty} (S_2) / \delta (S_2)_{t+1} d^{\infty} S_2$

$\text{☼}\Sigma S_3^{i} \equiv \Sigma S_3^{'} = \delta f^{'} (S_3)_t / \delta (S_3)_{t+1} d^{'} S_3 \text{╦} \Sigma S_3^{''} = \delta f^{''} (S_3)_t / \delta (S_3)_{t+1} d^2 S_3 \text{╦} \Sigma S_3^{\infty} = \delta f^{\infty} (S_3) / \delta (S_3)_{t+1} d^{\infty} S_3$

$\text{☼}\Sigma S_4^{i} \equiv \Sigma S_4^{'} = \delta f^{'} (S_4)_t / \delta (S_4)_{t+1} d^{'} S_4 \text{╦} \Sigma S_4^{''} = \delta f^{''} (S_4)_t / \delta (S_4)_{t+1} d^2 S_4 \text{╦} \Sigma S_4^{\infty} = \delta f^{\infty} (S_4) / \delta (S_4)_{t+1} d^{\infty} S_4$

The final graph from the input-output multi-dimensional analysis is based on the use of the 5-dimensional coordinate space (vertical position). At this point, we are only considering plotting the four multi-dimensional partial derivatives results from each production sector: agriculture, light industry, heavy industry and services (see Expression 11) on the 5-dimensional coordinate space (vertical position). After each partial derivative result is plotted on its axis, the result from each neighbor axis is joined by a straight line. At the same time the results of the four partial derivatives plotted on its axis need to be joined to the GDP growth rate that is located on the fifth axis. To join the five axes, it is necessary to apply the general inter-linkage coordinate condition, represented by "╬" (see Appendix 3).

(11) $\text{GDP-Surface} \equiv \text{☼}S^* \equiv \text{☼}\Sigma S_1^{i} \text{╬} \text{☼}\Sigma S_2^{i} \text{╬} \text{☼}\Sigma S_3^{i} \text{╬} \text{☼}\Sigma S_4^{i}$

The final output of the result of the input-output multi-dimensional analysis is called the "GDP mega-surface". It depends on the final position that the GDP mega-surface experiences on the 5-dimensional coordinate space (vertical position). There are four possible scenarios (see Expression 12, 13, 14 and 15) when it comes to analyzing the behavior of the GDP mega-surface according to the speed of exchange of goods and services by production sector.

(12) $\text{☼}S^* \equiv \text{☼} +\Sigma S_1^{i} \text{╬} \text{☼} +\Sigma S_2^{i} \text{╬} \text{☼} +\Sigma S_3^{i} \text{╬} \text{☼} +\Sigma S_4^{i}$

{if $+\text{☼}S^* \cap R_+$ then the surface ≡ economic growth synchronized}

(13) $\text{☼}S^* = 0 \equiv \text{☼}\ \Sigma S_1^{i} = 0 \text{╬} \text{☼}\ \Sigma S_2^{i} = 0 \text{╬} \text{☼}\ \Sigma S_3^{i} = 0 \text{╬} \text{☼}\ \Sigma S_4^{i} = 0$

{if ☼S* ∩ 0 then the surface ≡ general economic stagnation}

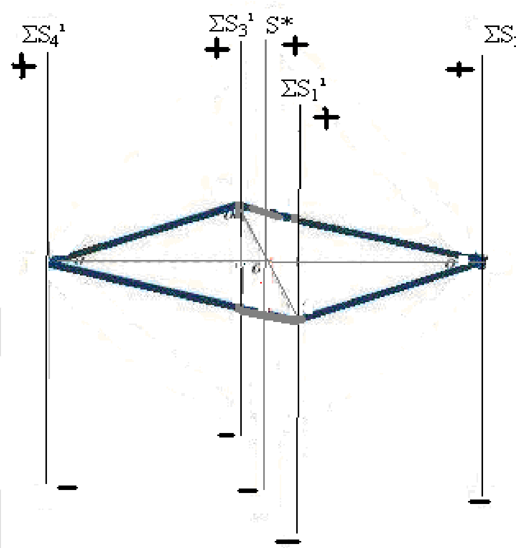
(14) ☼ ±S* ≡ ☼ ±ΣS_1^i ╬ ☼ ±ΣS_2^i ╬ ☼ ±ΣS_3^i ╬ ☼ ±ΣS_4^i

{if ☼S* ∩ $R_{+/-}$ then the surface ≡ irregular economic growth}

(15) ☼-S* ≡ ☼ -ΣS_1^i ╬ ☼ -ΣS_2^i ╬ ☼ -ΣS_3^i ╬ ☼ -ΣS_4^i

{if ☼S* ∩ R_- then the surface ≡ economic recession}

Figure 2: **I-O Multi-Dimensional Graphical Analysis**



18.3. Concluding Remarks

We conclude that the input-output multi-dimensional analysis can keep up with the simultaneous interaction of a large number of commodities exchange among different production sub-sectors in the same production sector. We can also observe the exchange among the four production sectors (agriculture, light industry, heavy industry and services sector) in the same model by the application of successive multi-dimensional partial derivatives from different equations that interact together in the same mathematical and graphical model. While the contribution of Leontief was a ground-breaking one, it is not sufficient to explain the dynamic behavior of the world economy today.

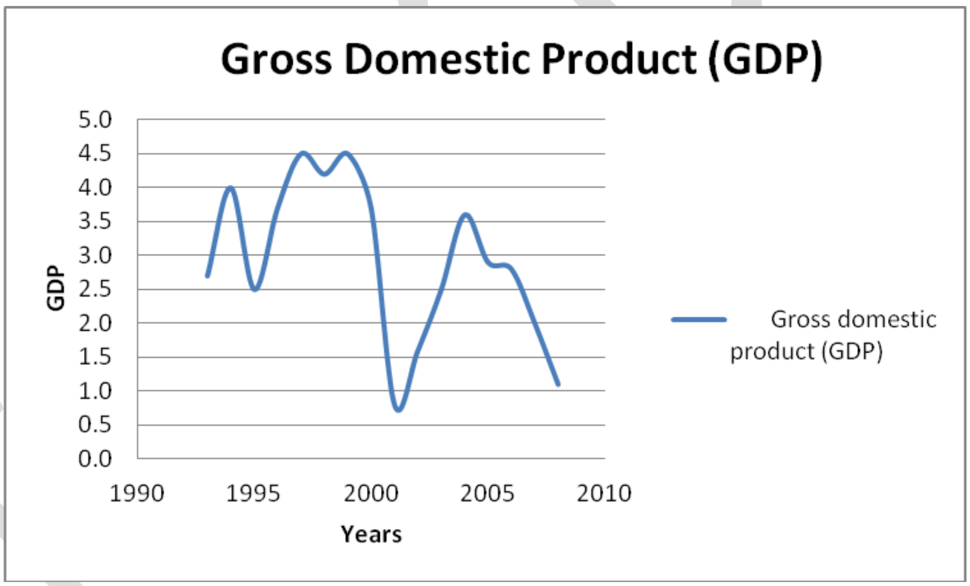
CHAPTER 19

THE GRAPHICAL VISUALIZATION OF GDP FROM A MULTI-DIMENSIONAL PERSPECTIVE

19.1. Introduction

The idea of proposing a multi-dimensional graphical modeling approach is to make it possible to visualize the complex and dynamic behavior of different variables that are involved in the construction of the GDP. Therefore, we assume that all these variables are always in a state of permanent change in the same graphical space. Usually, economists and academics continue visualizing the GDP under the application of the traditional 2-dimensional graphical modeling, using the classic linear graphical trends technique. The linear graphical trends technique can compare the graphical behavior of the GDP by plotting the variable time (daily, weekly, monthly, yearly) on the "X" axis and the GDP growth rate on the "Y" axis to visualize the behavior of the GDP across different periods of time (see Figure 1).

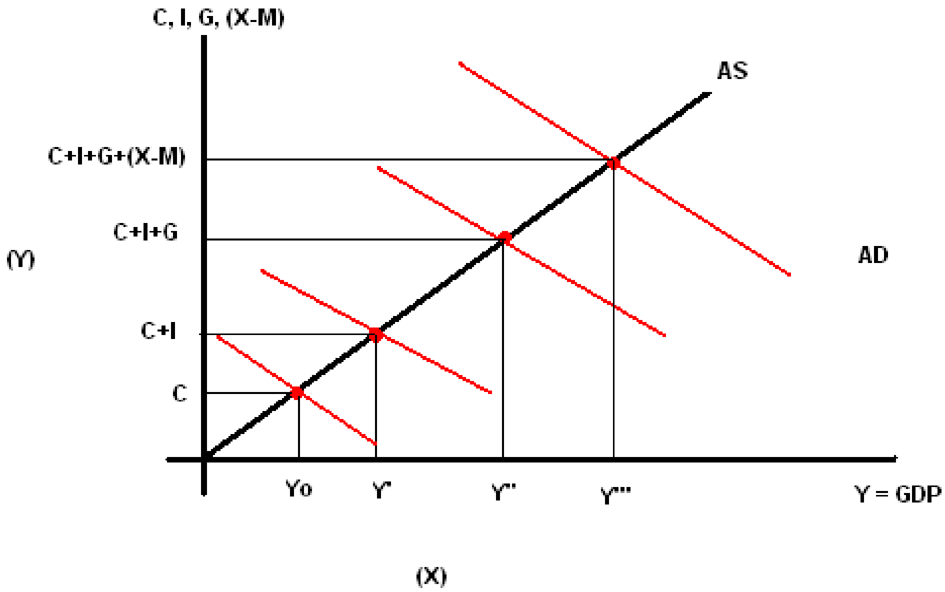
FIGURE 1: Gross Domestic Product by Year



Source: NBER

On the other hand, the graphical construction of the GDP by the expenditure method using the 2-dimensional graphical modeling approach makes it possible to visualize the aggregate demand curve (AD) that is built by consumption (C), gross investment (I), government spending (G) and net exports (X-M). Hence, these four macro-variables are fixed on the "Y" axis and the output (real national income) is fixed on the "X" axis (see Figure 2).

FIGURE 2: The Construction of the GDP Using the Expenditure Method



We can observe that in the last two examples of how to draw the GDP, both examples only show the use of two axes (X,Y) to explain the relationship between two variables that interact together in the same graphical space. Consequently, we cannot visualize the interaction of a large number of variables simultaneously within the same graphical space. In fact, the 2-dimensional graphical modeling method does not offer an extra set of axes to plot a large number of variables that are involved in the construction of the GDP according to this research. Therefore, the use of multi-dimensional graphical modeling opens new frontiers to visualize complex and dynamic changes involving a large number of variables simultaneously in the same graphical space. Additionally, the multi-dimensional graphical modeling requires the application of graphical modeling in real time (see Appendix 2) to observe, in a much better way, the behavior of all variables in permanent movement distributed in different axes. The classic idea about endogenous and exogenous variables is totally different in multi-dimensional graphical modeling, because we are referring to a large number of exogenous variables that interact together, while the endogenous variable becomes a large, single surface located within the same graphical space. We assume that each exogenous variable runs under different speeds of time, depending on the rapid input of information in multi-dimensional graphical modeling.

The main objective of multi-dimensional graphical modeling is to monitor a large amount of data that is running in real time. The idea is to visualize unknown and unexpected relationships among different variables involved in the construction of the GDP in the same graphical space. The evaluation of results from multi-dimensional graphical modeling is totally different from the traditional 2-dimensional graphical modeling, because we do not only visualize the effect of a single exogenous variable on the endogenous variable. Instead, the behavior of a large number of variables running in real time is visualized using different axes (exogenous variables). At the same time, the behavior of the endogenous variable is represented by the general surface.

The final target of multi-dimensional graphical modeling is to visualize the rapid changes in real time of all variables, to give an alert just in time about unusual behavior involving some or all variables from the GDP. This is to prepare any country for a financial crisis. The main idea of this is to take suitable action to reduce the damage of a possible financial crisis that can occur at any time. Our basic premise is that any economic crisis cannot be stopped; its damage can only be reduced to certain levels in the short or medium term, but not in the long term, according to this research. The multi-dimensional graphical modeling analysis depends on the construction of the general surface located in the mega-space coordinate space. The general surface can experience three possible phases. The good performance phase occurs when the general surface is located on the positive integers of the mega-space coordinate space. The stagnation performance phase is based on the location of the general surface at Level Zero of the mega-space coordinate space or when all values plotted on the mega-space coordinate space have not experienced any change from the last period of analysis. Finally, the poor performance phase is when the general surface is located under the negative integers of the mega-space coordinate space. Additionally, the general surface is formed by an infinite number of nano-surfaces joined together within the mega-space coordinate space.

Initially, each nano-surface is constructed by plotting four annual growth rate values into four neighboring vertical axes. The idea is to join the four neighboring vertical axes by straight lines until a single nano-surface is built. After the nano-surface is built, different colors are used to distinguish them. In this case, each nano-surface can show three possible colors: pink, orange and red. The color depends on the position of the four annual growth rates values located in the four neighboring vertical axes respectively. Also the nano-surface can experience three possible scenarios: (a.) if the values of the four neighboring vertical axes from the same nano-surface have positive integer numbers, this is called "good performance"; (b.) if the values of the four neighboring vertical axes from the same nano-surface are equal to zero, this is called "stagnant performance"; (c.) if the values of the four neighboring vertical axes from the same nano-surface have negative integer numbers, this is called "poor performance". What we look forward to is observing the behavior of each variable involved in the construction of the GDP from a multi-dimensional perspective. Therefore, the construction of the general surface is based on joining all nano-surfaces together in the same graphical space. This multi-dimensional graphical modeling is interested in visualizing the behavior and performance of all variables in different vertical axes simultaneously.

The performance of this multi-dimensional graphical modeling depends on the color of each nano-surface. In fact, we use different colors to facilitate the analysis of the final results in each nano-surface and the general surface. This is to aid in observing the behavior of different variables simultaneously. This multi-dimensional graphical modeling always requires the interconnection of four neighboring vertical axes to build a single nano-surface. At the same time, the interconnection of all nano-surfaces can help to build the general surface. In the same graphical modeling, we also suggest the application of graphical modeling in real time (see Appendix 2) to observe rapid changes in movement, as and when these happen, on each nano-surface and the general space simultaneously. In fact, we propose that multi-dimensional graphical modeling can facilitate the live visualization of any economy by central banks, policy makers and academics.

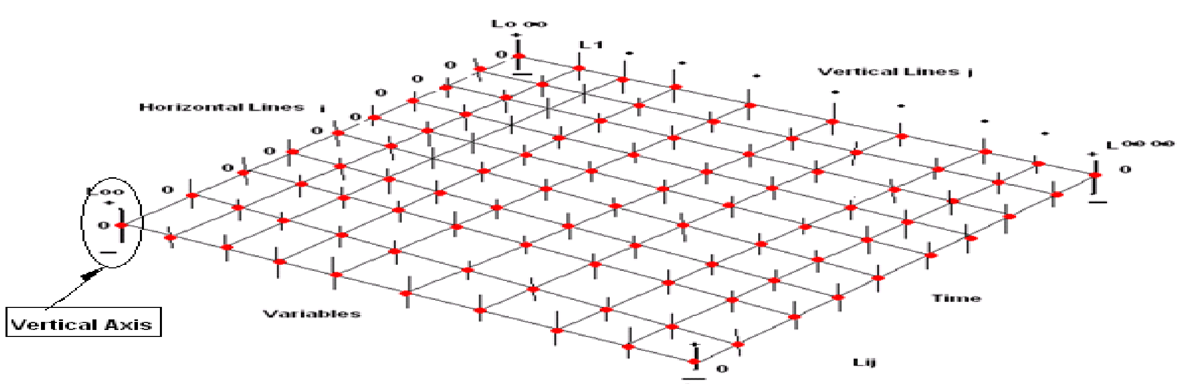
19.2. Introduction to the Mega-Space Coordinate Space

The mega-space coordinate space application is formed by infinite vertical axes. Each vertical axis is divided by positive and negative integers. The annual growth rate is plotted on each vertical axis, and it can only move up and down all the time. Each vertical axis plays an important role in building a nano-surface and the general surface. The construction of each nano-surface is based on joining the values of four annual growth rates plotted in four neighboring vertical axes. These values of these four neighboring vertical axes are joined by straight lines until the nano-surface is built. To observe the changes of each nano-surface, it is necessary to apply different colors such as pink, orange and red. If the values of the four neighboring vertical axes show positive integer numbers, then the nano-space becomes pink. If the values of the four neighboring vertical axes are equal to zero, the nano-space becomes orange. Finally, if the values of the four neighboring vertical axes show negative integer numbers, then the nano-space becomes red. If we join all the nano-surfaces, we can observe that the general surface is made up of different colors. The application of colors is to facilitate the visualization of a large number of nano-surfaces and the general surface within the same graphical space (see Figure 3). It is important to mention at this point that no connection or dependency exists among the values of the four neighboring vertical axes. We only use straight lines to build each nano-space. At the same time, this construction requires the application of the concept of multi-dimensional coordinate space interconnectivity (╬) (see Appendix 3).

However, the mega-space coordinate space also requires the application of graphical modeling in real time (see Appendix 2) to generate an effect of live movement on each nano-surface and on the general surface. This depends on the speed of data input into each annual growth rate plotted into its vertical axis. The coordinate system for the mega-space coordinate space is equal to:

$$(1.)\quad S = f\,(╬\Delta X_{<i;j>} \,.\,.\,.\, ╬\Delta X_{<i+1;j+1>})$$

FIGURE 3: The Mega-Space Coordinate Space



19.3. The application of the Mega-Space Coordinate System in the Analysis of the GDP

The application of the mega-space coordinate space in GDP analysis is based on the visualization of the GDP of the U.S. economy from 1993 to 2008 (see Table 1). The classification of variables is made up of four general variables and seventeen sub-variables. The first general variable (X_1) is the personal consumption expenditure that is sub-divided by three sub-variables: durable goods (X_{11}), non-durable goods (X_{12}) and services (X_{13}). The second general variable (X_2) is the gross private domestic investment that is divided into fixed investments (X_{21}), non-residential (X_{211}), structural (X_{2112}) and residential (X_{212}). The third general variable (X_3) is the net exports of goods and services, which is divided into exports (X_{31}), goods (X_{311}) and services (X_{321}), in the same item the imports (X_{32}) is divided by goods (X_{321}) and services (x_{322}). Finally, the fourth general variable (X_4), government consumption expenditure, is divided into three sub-variables: federal (X_{41}), national defense (X_{411}), non-defense (X_{412}) and state and local (X_{42}) (see Table 1). Hence, each general variable and sub-variable mentioned above applies its own annual growth rates, and each annual growth rate for each general variable and sub-variable is plotted into its respective vertical axis.

After, each annual growth rate has been plotted into each vertical axis, we proceed to build each nano-surface. The construction of each nano-surface takes into consideration the values of four annual growth rates simultaneously. These values will be plotted into the four neighboring vertical axes. Finally, the values of the four neighboring vertical axes are joined by straight lines until a single nano-surface is constructed. A reminder: each annual growth rate can be a positive or negative integer number. This can help in the assignment of colors to analyze the behavior of each nano-surface and its general surface. For example, according to our classification system, if the values of the four annual growth rates in the four neighboring vertical axes are positive integer numbers, then the nano-surface becomes pink. If the values of the four annual growth rates in its four neighboring vertical axes are equal to zero, then the nano-surface becomes orange. If the values of the four annual growth rates in the four neighboring vertical axes are negative integer numbers, then the nano-surface becomes red (see Figure 4).

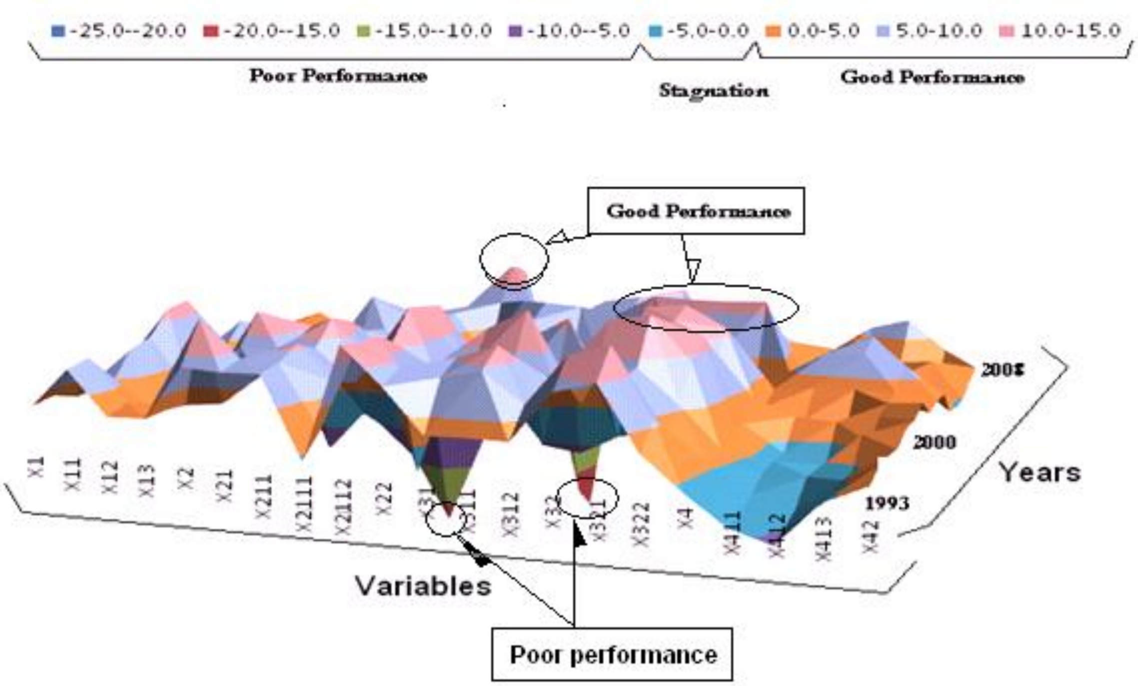
Figure 3 shows the performance of each general variable and sub-variable from the GDP of the U.S. between 1993 and 2006. The performance of each general variable and sub-variable depends on the color that we suggested previously. Therefore, this makes it possible to sound the alert about the risk of a potential financial crisis. This can be observed by the fact that the gross private domestic investment of the U.S. between the periods 2005/2006 and 2007/2008 have become red, especially in the sub-prime sector and residential sector (X_{212}).

Table 1.--Real Gross Domestic Product: Percent Change from Preceding Year																
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008\r\
Gross domestic product (GDP)....	2.7	4.0	2.5	3.7	4.5	4.2	4.5	3.7	0.8	1.6	2.5	3.6	2.9	2.8	2.0	1.1
Personal consumption expenditures (X1)	3.3	3.7	2.7	3.4	3.8	5.0	5.1	4.7	2.5	2.7	2.8	3.6	3.0	3.0	2.8	0.2
Durable goods (X11)	7.8	8.4	4.4	7.8	8.6	11.3	11.7	7.3	4.3	7.1	5.8	6.3	4.6	4.5	4.8	-4.3
Nondurable goods (X12)	2.7	3.5	2.2	2.6	2.7	4.0	4.6	3.8	2.0	2.5	3.2	3.5	3.4	3.7	2.5	-0.6
Services (X12)	2.8	2.9	2.6	2.9	3.3	4.2	4.0	4.5	2.4	1.9	1.9	3.2	2.6	2.5	2.6	1.5
Gross private domestic investment (X2)	8.9	13.6	3.1	8.9	12.4	9.8	7.8	5.7	-7.9	-2.6	3.6	9.7	5.8	2.1	-6.4	-6.7
Fixed investment (X21)	8.6	9.3	6.5	9.0	9.2	10.2	8.3	6.5	-3.0	-5.2	3.4	7.3	6.8	1.9	-3.1	-6.0
Nonresidential (X211)	8.7	9.2	10.5	9.3	12.1	11.1	9.2	8.7	-4.2	-9.2	1.0	5.8	7.2	7.5	4.9	1.6
Structures (X2112)	-0.7	1.8	6.4	5.6	7.3	5.1	-0.4	6.8	-2.3	[illegible]	-4.1	1.3	1.3	8.2	12.7	11.2
Equipment and software (X2112)	12.5	11.9	12.0	10.6	13.8	13.3	12.7	9.4	-4.9	-6.2	2.8	7.4	9.3	7.2	1.7	-3.0
Residential (X212)	8.2	9.6	-3.2	8.0	1.9	7.6	6.0	0.8	0.4	4.8	8.4	10.0	6.3	-7.1	-17.9	-20.8
Net exports of goods and services (X3)																
Exports (X31)	3.2	8.7	10.1	8.4	11.9	2.4	4.3	8.7	-5.4	-2.3	1.3	9.7	7.0	9.1	8.4	6.2
Goods (X311)	3.3	9.7	11.7	8.8	14.3	2.2	3.8	11.2	-6.1	-4.0	1.8	9.0	7.7	9.9	7.5	6.0
Services (X312)	3.2	6.3	6.3	7.2	5.9	2.9	5.6	2.9	-3.2	1.9	0.0	11.5	5.6	7.2	10.5	6.6
Imports (X32)	8.8	11.9	8.0	8.7	13.6	11.6	11.5	13.1	-2.7	3.4	4.1	11.3	5.9	6.0	2.2	-3.5
Goods (X321)	10.1	13.3	9.0	9.3	14.4	11.7	12.4	13.5	-3.2	3.7	4.9	11.3	6.8	6.0	1.7	-4.2
Services (X322)	2.9	5.7	3.3	5.5	9.4	11.4	6.9	11.1	-0.4	2.1	0.0	11.5	1.4	6.0	4.4	0.2
Government consumption expenditures																
and gross investment (X4)	-0.9	0.0	0.5	1.0	1.9	1.9	3.9	2.1	3.4	4.4	2.5	1.4	0.4	1.7	2.1	2.9
Federal (X41)	-4.2	-3.7	-2.7	-1.5	-1.0	-1.1	2.2	0.9	3.9	7.0	6.8	4.2	1.2	2.3	1.6	6.0
National defense (X411)	-5.6	-4.9	-3.8	-1.4	-2.8	-2.1	1.9	-0.5	3.9	7.4	8.7	5.8	1.5	1.6	2.5	7.2
Nondefense (X412)	-0.7	-1.2	-0.4	-0.7	2.6	0.7	2.8	3.5	3.9	6.3	3.4	1.1	0.6	3.6	-0.2	3.6
State and local (X42)	1.4	2.6	2.6	2.3	3.6	3.6	4.7	2.7	3.2	3.1	0.2	-0.2	-0.1	1.3	2.3	1.1

r Revised. Revisions include changes to series affected by the incorporation of revised wage and salary estimates for the fourth quarter of 2008.

Source: NBER

Figure 4: U.S. GDP-Surface Monitoring: 1993 -2008



19.4. Concluding Remarks

This chapter concludes that the mega-space coordinate space can be considered an effective graphical tool to sound the alert against a possible financial crisis from the very beginning. It is to prepare any economy against the eventuality of crisis. It can also reduce the danger of damage from a possible financial crisis. This is because, according to our research, any financial crisis cannot be stopped; nevertheless we can effectively reduce the damage caused by such a crisis by reducing the magnitude of its proportions by establishing a better system of regulation and control in the financial markets as well as more effective fiscal and monetary policies.

CHAPTER 20
WHY HAS THE MARKET BECOME MORE VULNERABLE IN THE 21ST CENTURY?

20.1. Introduction

This chapter explains the complex and dynamic behavior of the market from a multi-dimensional perspective. Initially, we assume that five global forces simultaneously exist and interact together to affect market behavior. These five global forces are economic global forces, social global forces, political global forces, technological global forces and natural global forces. All these global forces always keep in a constant quantitative and qualitative transformation(s) across time and space. Additionally, we also assume that the market has become much more vulnerable, and that it can suffer a crisis at any time, according to the advanced stages in the evolution of the market. Usually, the traditional explanation of market behavior is based on the use of supply and demand forces. We argue that these forces can only give us a basic explanation about the dynamic and complex behavior of the market.

Moreover, the theoretical contribution by Adam Smith, David Ricardo, Augustin Cournot and Alfred Marshall (Barber, 2009 and Gordon, 1965) about market behavior was very useful to explain how the market works and the failures of the market. If we analyze the points of view put forward about market behavior by these four economists, we notice different conceptions and views, perhaps caused by the different historical times that each of these economists lived in. This research concurs that all these economists were right, at their particular points of time, in the way that they interpreted and explained the dynamic and complex behavior of the market within its historical momentum. However, using the same logic, the theories of these economists are now insufficient and inadequate to explain the behavior of the market today.

In the study of the market, a common strategy is to use the *Ceteris Paribus* assumption. In our case, the application of the *Ceteris Paribus* assumption is wholly unnecessary because we argue that in studying the market, certain variables that are considered less important cannot be isolated from the analysis; they must be included in the study of market behavior. For this reason, we suggest the use of new assumptions and graphical modeling to explain more clearly the dynamicity and chaotic behavior that the market can experience across time and space. Firstly, this research assumes that the market always experiences a state of dynamic imbalance. This is only made possible by the application of the *Omnia Mobilis* assumption (everything is moving). Using the *Omnia Mobilis* assumption helps to include more variables without any isolation in the study of the market. Additionally, we suggest the application of multi-dimensional graphical modeling to facilitate the visualization of market behavior from a global perspective. Additionally, the market can be considered a complex and multi-dimensional system under the interaction of the private and public sector. In the end, both sectors become complementary and are effectively inseparable when it comes to keeping the economy of any country alive. In our opinion, the market is not a simple place to exchange goods and services. On the contrary, the market is a dynamic multi-dimensional system that is affected by different global forces, all of which keep in constant quantitative and qualitative transformation(s) at all times. According to this research, the study of market behavior basically depends on the volatility of five global forces and the historical momentum of human experience in different phases.

Therefore, in the study of the market over the last past fifty years, we can observe the application of sophisticated and complex econometrics and mathematical models and techniques that try to represent the market in the most up-to-date way, as a whole, to show the dynamic and complex behavior of the market. But we can also observe that all these models and techniques cannot encompass a large number of variables or reduce the isolation of some variables that are considered not important enough to be taken into account when it comes to building the model.

Finally, we would like to propose an alternative multi-dimensional model to analyze and visualize the rapid changes of market behavior based on the output of five global forces: global economic forces output, global social forces output, global political forces output, global technological forces output and global natural forces output. Each global force output runs in real time and directly affects market behavior simultaneously, without isolating some variable(s).

20.2. The Model

This model attempts to use a multi-dimensional mathematical and multi-dimensional graphical approach. We propose the use of the 6-dimensional coordinate space (vertical position). This specific coordinate space offers six axes to plot five exogenous variables and one endogenous variable; this makes it possible to observe the changes of each exogenous variable and the endogenous variable within its axis separately and simultaneously in the same graphical space. We also suggest the application of the *Omnia Mobilis* assumption to generate the relaxation of the five global forces of the market. The main objective of this is to observe in real time the behavior of the market without any isolated variables. In this case, each market force is fixed into its axis. These global forces are: economic global forces (X_1) (See Expression 1), social global forces (X_2) (see Expression 2), political global forces (X_3) (see Expression 3), technological global forces (X_4) (see Expression 4) and natural global forces (X_5) (see Expression 5). Each global force has its specific function with a large number of factors (i) that always keep changing in real time (☼). All these factors (i) in our model can be considered independent sub-variables. At the same time, we also suggest that each global force applies an infinite number of partial derivatives (∂), everything is running in real time (☼) and everything directly affects the final market vulnerability trend index (/☼Y*/).

$$(1.)\ X_1 = f(☼f_{11}, ☼f_{12},\ldots,☼f_{1n}) \text{ and } n = \infty$$
$$(2.)\ X_2 = f(☼f_{21}, ☼f_{22},\ldots,☼f_{2n}) \text{ and } n = \infty$$
$$(3.)\ X_3 = f(☼f_{31}, ☼f_{32},\ldots,☼f_{3n}) \text{ and } n = \infty$$
$$(4.)\ X_4 = f(☼f_{41}, ☼f_{42},\ldots,☼f_{4n}) \text{ and } n = \infty$$
$$(5.)\ X_5 = f(☼f_{51}, ☼f_{52},\ldots,☼f_{5n}) \text{ and } n = \infty$$

The measurement of each global force is based on Equation 6, where several partial derivatives (∂) are running in real time (☼) between different periods of time: past time <t-1> and future time <t+1>.

$$(6.)\ ☼X_i = ☼ [\partial X_{i<t+1>} / \partial X_{i<t-1>}] => i = \{1,2,3,4,5\}$$

Each global force in our model can be measured by Expression 7, 8, 9, 10 and 11. Later, each of the five global forces will be plotted directly onto its respective axis in the 6-dimensional coordinate space:

$$(7.)\ \text{☼}X_1 = \text{☼}\,[\partial X_{1<t>} / \partial X_{1<t-1>}]$$
$$(8.)\ \text{☼}X_2 = \text{☼}\,[\partial X_{2<t>} / \partial X_{2<t-1>}]$$
$$(9.)\ \text{☼}X_3 = \text{☼}\,[\partial X_{3<t>} / \partial X_{3<t-1>}]$$
$$(10.)\ \text{☼}X_4 = \text{☼}\,[\partial X_{4<t>} / \partial X_{4<t-1>}]$$
$$(11.)\ \text{☼}X_5 = \text{☼}\,[\partial X_{5<t>} / \partial X_{5<t-1>}]$$

The market vulnerability trend index (/☼Y*/) can be calculated using Equation 12. The final result of the market vulnerability trend index (/☼Y*/) is always represented by an absolute value.

$$(12.)\ /\text{☼}Y^*/ = \underset{i=1}{\overset{5}{\text{╬}}}\ \text{☼}\,[\partial X_{i<t>} / \partial X_{i<t-1>}] \Rightarrow i = \{1,2,3,4,5\}$$

However, the final measurement of the market vulnerability trend index (/☼Y*/) (see Expression 13) continues to apply an infinite number of partial derivatives (∂) running in real time (☼) (see Appendix 1). All these global forces mentioned before are interconnected by a common variable called "the market vulnerability trend index (/☼Y*/)". At the same time, this index requires the application of the interconnectivity principle (╬).

$$(13.)\ /\text{☼}Y^*/ = \text{☼}\,[\partial X_{1<t+1>} / \partial X_{1<t-1>}]\ \text{╬}\ \text{☼}\,[\partial X_{2<t+1>} / \partial X_{2<t-1>}]\ \text{╬}\ \text{☼}\,[\partial X_{3<t+1>} / \partial X_{3<t-1>}]\ \text{╬}\ \text{☼}\,[\partial X_{4<t+1>} / \partial X_{4<t-1>}]\ \text{╬}\ \text{☼}\,[\partial X_{5<t+1>} / \partial X_{5<t-1>}]$$

The final analysis of this model depends on the final output from global economic forces, global social forces, global political forces, global technological forces and global natural forces, as well as the market vulnerability trend index (/☼Y*/). Once we find the final output for all global forces and the market vulnerability trend index, then we can plot each final output into its respective axis in the 6-dimensional coordinate space (see Figure 1). Finally, we proceed by joining all final outputs within each axis by applying straight lines until a single surface is built. This surface will be called "the market surface". The market surface can show three possible results (see Figure 2):

(1.) If the market surface is located on a high level within the 6-dimensional coordinate space, we refer to it as a "high-vulnerability intensity"
(2.) If the market surface is located between a high and low level within the 6-dimensional coordinate space, we refer to it as an "unstable-vulnerability intensity"
(3.) If the market surface is located at a low level in the 6-dimensional coordinate space, then we refer to it as a "low-vulnerability intensity"

Figure 1
The 6-Dimensional Coordinate Space

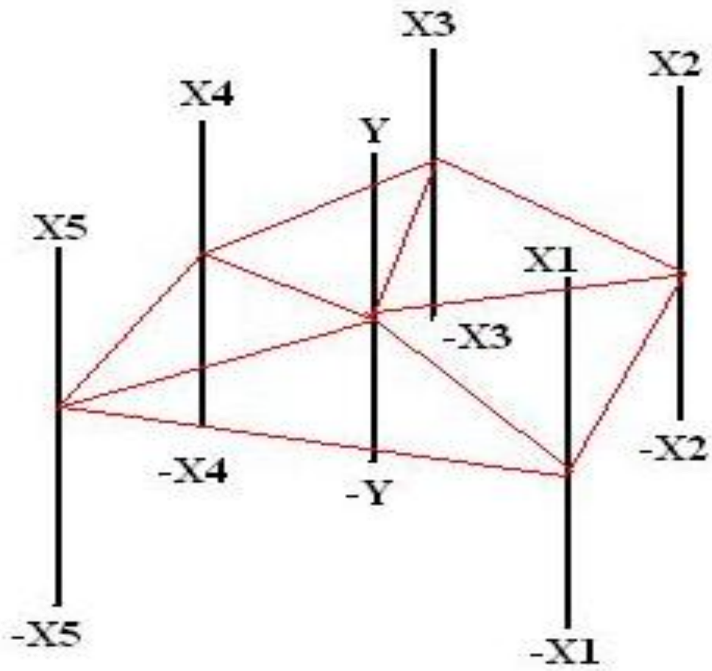
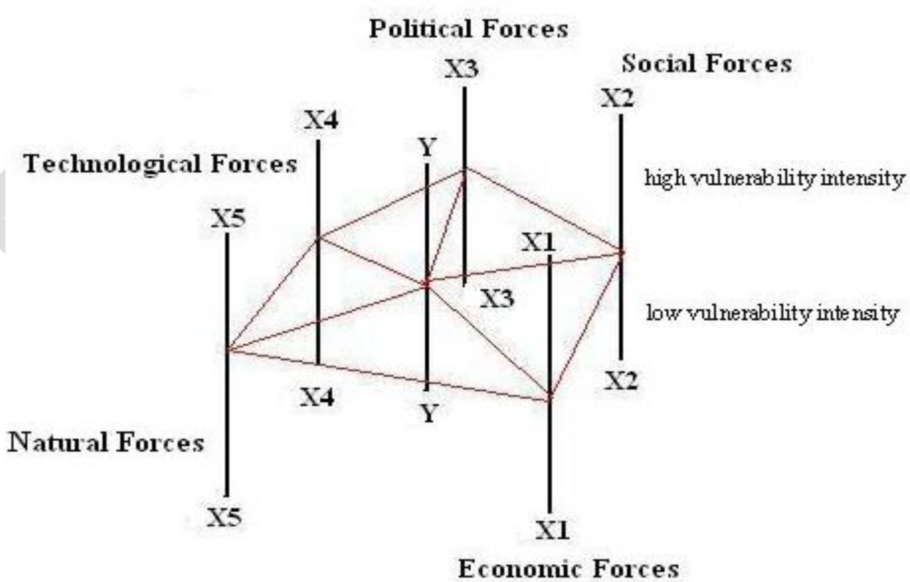


Figure 2
The Graphical Modeling of the Market Surface



20.3. Analysis of the Final Results

The case study for this chapter is the vulnerability of the U.S. market between the 20th and 21st century. We use 1500 variables (exogenous sub-variables) distributed into the five general exogenous variables (five global forces) which are fixed as economic global forces (500 variables), social global forces (300 variables), political global forces (400 variables), technological global forces (200 variables) and natural global forces (100 variables) respectively. Our final target is to measure the market vulnerability trend index (/☼Y*/) (general endogenous variable). This is to compare the vulnerability of the U.S. market between these two centuries. This model applies partial derivatives in real time under the use of average values per decade from the same century (see Table 1).

TABLE 1

Levels of Vulnerability in the Global Economic, Global Social, Global Political, Global Technological and Global Natural Forces and The Market Vulnerability Trend Index (/☼Y*/)

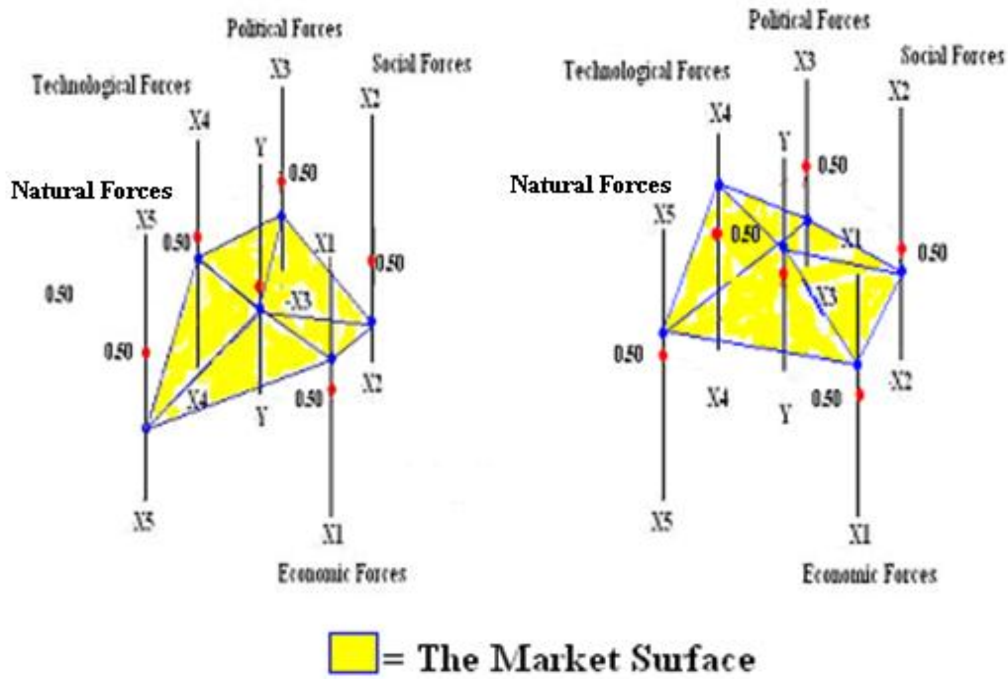
Variable Century	Global Economic Forces (**X1**)	Global Social Forces (**X2**)	Global Political Forces (**X3**)	Global Technological Forces (**X4**)	Global Natural Forces (**X5**)	**☼Y***
20th Century	0.6852114	0.425143	0.454813	0.468715	0.558741	0.61852468
21st Century	0.8521247	0.512544	0.885484	0.852414	0.858713	0.81025594

The final results from this model show that, between the 20th century and 21st century, the U.S. market became more vulnerable according to the market vulnerability trend index (/☼Y*/) which moved from 0.61852468 to 0.81025594 (see Table 1). When it comes to economic global forces, the U.S. market shows a level of vulnerability of 0.8521247 in the 21st century compared to 0.6852114 in the 20th century.

Both the global social forces component and the global political forces component of the U.S market experienced a small growth expansion in its rates of vulnerability compared to the economic global forces component. The global social forces component of the U.S. market showed a vulnerability rate from 0.425143 to 0.512544 according to Table 1. Subsequently, the political global forces vulnerability rate of the U.S. market experienced a move from 0.454813 to 0.885484 (see Table 1).

The technological global forces component of the U.S market shows the largest rate of vulnerability in these two centuries; this changed from 0.468715 to 0.852414. Something similar happened to the natural global forces rate for the U.S. market, which can be observed by a considerable expansion of its vulnerability rate from 0.558741 to 0.858713 (see Figure 3). Hence, we can conclude that the market behavior of the U.S has become more vulnerable due to the rapidly advancing stages that the U.S. market can experience. Figure 3 demonstrates clearly that the market surface of the U.S. during the 20th century is lower than the market surface of the U.S. in the 21st century.

FIGURE 3
The Market Surface of the United States in the 20th and 21th Century



20.4. Concluding Remarks

The last chapter of this book concludes that the vulnerability of market behavior basically depends on five global forces: economic global forces, social global forces, political global forces, technological global forces and natural global forces. All these five global forces interact and keep constantly changing across time and space. [Note: We encourage the inclusion of all possible general variables and sub-variables that can affect the market behavior, without any isolation or restriction.] At the same time, the application of multi-dimensional graphical modeling in real time is required in order to observe the complex and dynamic behavior of the market as a whole. Finally, we conclude that the analysis of the U.S. market has become more vulnerable according to the advanced stages of humanity's evolution and the rapid changes within each global force. This can be observed in the final results of our model.

CHAPTER 21
KOREAN UNIFICATION: A MULTIDIMENSIONAL ANALYSIS
BY MARIO ARTURO RUIZ ESTRADA AND DONGHYUN PARK

21.1. Introduction

The Korean peninsula has been divided between the capitalist South Korea and the communist North Korea since the end of the Second World War. The two countries share a common people, history and culture, and the political division of the peninsula is an artificial relic of the Cold War. Nevertheless, the division is very real, and the border between the two countries remains among the most tightly sealed and heavily militarized in the world. Continuous rapid growth has transformed South Korea from a typical poor developing country into an economic powerhouse which is one of the world's 12 biggest economies.[1] In contrast, decades of autarky and central planning have reduced North Korea to one of the poorest countries in the world.[2] The dire and worsening economic crisis in North Korea has fuelled concerns in South Korea about a chaotic collapse of the North Korean government and hence chaotic reunification. Politically, South Korea is a thriving democracy whereas North Korea is communist dictatorship. There are thus many parallels between the German unification which took place in 1990 and a potential unification between the two Koreas. The existing literature on the prospects for Korean unification focuses primarily on the economic consequences of unification.[3] This is perfectly understandable in light of the gaping difference in income levels between the two Koreas and the large economic costs of unification for South Korea. Furthermore, the poor performance of the German economy since unification has highlighted the potentially adverse effects of unification for the Korean economy.[4] The central objective of our paper is to contribute to the literature on Korean unification by examining Korean unification from a more global perspective that encompasses not only the economic dimension but other relevant dimensions as well. To do so, we use the Global Dimension of Regional Integration Model (henceforth GDRI Model) recently developed by Ruiz (2004). The defining characteristic of the model, which we discuss in the next section, is that it looks at regional integration simultaneously from political, social, economic and technological perspectives. We apply the model to a comparative analysis of the development levels of the two Koreas in the 1970s, 1980s and 1990s. Convergence has positive implications about the prospects for unification whereas divergence has negative implications.

21.2. The Global Dimension of Regional Integration Model (GDRI Model) and Its Application to a Comparative Analysis of the Two Koreas

The main objective of the GDRI Model is to provide policymakers and researchers a new analytical tool to study the evolution of any regional integration process from a global perspective encompassing the political, social, economic and technological dimensions.[5] The simple and flexible model is based on a group of indexes and graphs, and it can be applied to any case of regional integration. The GDRI Model involves four basic phases. The first phase is the design of the multi-input database table. The second phase is the measurement of individual Regional Global Development Indexes (Xi), which include the Regional Global Political

Development Index (X1), Regional Global Social Development Index (X2), Regional Global Economic Development Index (X3) and Regional Global Technological Development Index (X4). The third phase is the measurement of the Regional Global Development (RGD) index. The last phase is the measurement of Regional Integration Stage (RIS) index. Let us now discuss each of the four basic phases, beginning with the design of the multi-input database table. Table 1 below is an example of the multi-input database table and shows global regional political development. Global refers to the multidimensional nature of political development and is represented by a wide range of political variables. Regional refers to the specific region of interest to the research. Therefore, in our case, global regional political development refers to the political development of the two Koreas as measured by the 15 political variables in Table 1. There is no reason why the number of variables in a multi-input database table should be constant and it can vary according to the objectives of the research and data availability. We can similarly construct multi-input database tables for global regional economic, social and technological development.

Table 1

Multi-Input Database Table: Global Political Development

CODE	POLITICAL FACTORS
P.1.	**External factors**
P.1.1.	Colonization (country)
P.1.2.	Group negotiation power
P.1.3.	Foreign policy influences
P.1.4.1.	Regional
P.1.4.2.	Global
P.1.5.	Negotiation style
P.2.	**Internal factors**
P.2.1.	International organizations support
P.2.3.	Political regime
P.2.4.	Legislative background
P.2.5.	Internal security
P.2.6.	Human rights
P.2.7.	Border problems
P.2.8.	Political stability
P.2.9.	Political structure and public administration
P.2.10.	Army size
P.2.11.	Bureaucracy level

The second phase of the GDRI model is to measure the Global Development Indexes (Xi) using the variables in the four multi-input database tables described above. The four Global Development Indexes are the Global Political Development Index (X1), Global Social Development Index (X2), Global Economic Development Index (X3) and Global Technological Development Index (X4). The data we input for each country in the region – in our case, North Korea and South Korea are the countries and Korea is the region – are based on statistical and historical data. Furthermore, all our data are binary – i.e. either 1 or 0 – and determined by either quantitative or qualitative criteria. A big reason for using binary data is that we attach the same level of importance to all the variables in our multi-input database tables. Another reason for using binary data is that it allows us to analyze countries with limited data, such as North Korea.

Table 2 below is an example of a multi-input database table with binary data inputted, and it shows the global political development of South Korea, North Korea and the Koreas in the 1970s. For example, the value for the variable "political regime" is 1 if the country is democratic and 0 if the country is non-democratic.[6] Therefore, as the last three columns show, the value is 1 for South Korea and 0 for North Korea. Similarly, the value of the variable "human rights" is 1 if a country's protection of human rights is strong and 0 if it is weak. This is why we input 1 for South Korea and 0 for North Korea. The total for South Korea is 7 or 47 % since there are 15 variables and the total for North Korea is 1 or 7%. The global political development of South Korea and North Korea in the 1970s is thus 47% and 7%, respectively.

Table 2

Global Political Development of South Korea and North Korea in the 1970s

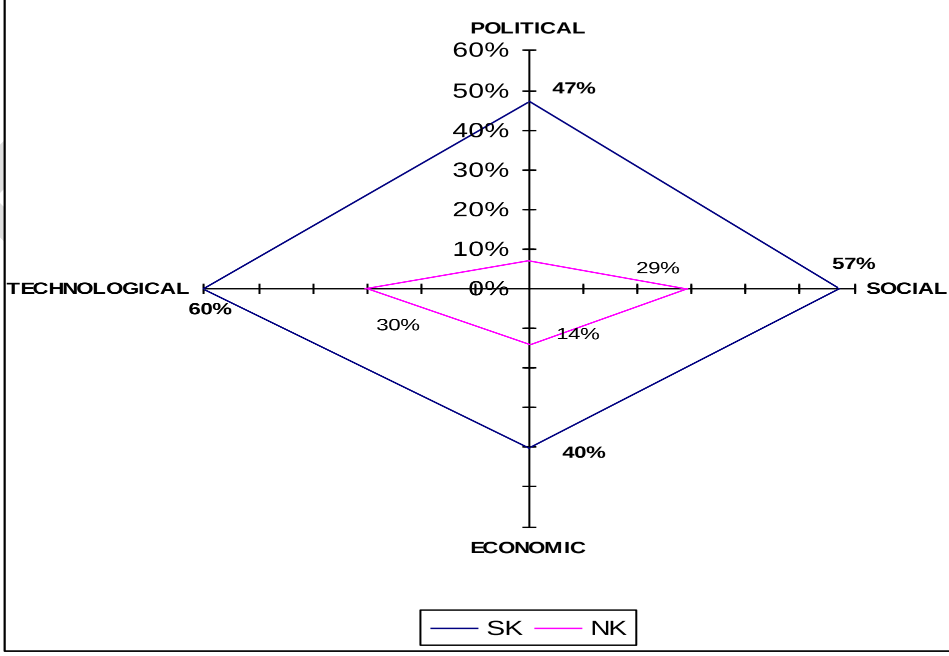
CODE	POLITICAL FACTORS	SK	NK
P.1.	**External factors**		
P.1.1.	Colonization (country)	0	0
P.1.2.	Group negotiation power	1	0
P.1.3.	Foreign policy influences		
P.1.4.1.	Regional	1	0
P.1.4.2.	Global	0	0
P.1.5.	Negotiation style	1	0
P.2.	**Internal factors**		
P.2.1.	International organizations support	1	0
P.2.3.	Political regime	1	0
P.2.4.	Legislative background	0	0
P.2.5.	Internal security	1	1
P.2.6.	Human rights	1	0
P.2.7.	Border problems	0	0
P.2.8.	Political stability	0	0
P.2.9.	Political structure and public administration	0	0
P.2.10.	Army size	0	0
P.2.11.	Bureaucracy level	0	0
TOTAL		**7**	**1**
TOTAL (%)		**47**	**7**

We can similarly input binary data for all the variables in the multi-input database tables for social, economic and technological development of the two Koreas in the 1970s.[7] We find the global social development of South Korea and North Korea in the 1970s to be 57% and 29%, the global economic development of South Korea and North Korea in the 1970s to be 40% and 14%, and the global technological development of South Korea and North Korea in the 1970s to be 60% and 30%.[8]

The third phase of the GDRI model is to use the four Global Development Indices (Xi) we found in the model's second phase – i.e. political, social, economic and technological – to estimate the Global Overall Development Index (X), which sums up the information contained in the four indices. Intuitively, the Global Overall Development Index (X) measures a country's overall level of development from a multidimensional or global perspective encompassing political, social, economic and technological development. Furthermore, as we saw earlier, we measured political, social, economic and technological development themselves from a multidimensional or global perspective, using a wide range of variables relevant to the development of each sphere.

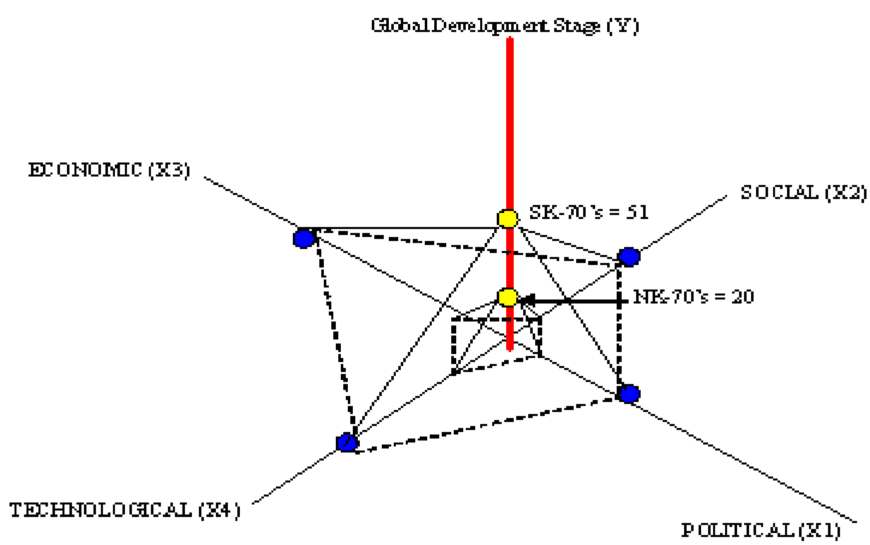
The first step in estimating the Global Overall Development Index (X) is to plot the values of the four Global Development Indices (Xi), as shown in Figure 1 below. This graph will help to illustrate how we compute X. Graph 1 consists of four different triangular areas – each bounded by the values of two of the four global development indices – for South Korea, North Korea and the Koreas. Let us define the triangular area between the political and social axes as A1, social and economic axes as A2, economic and technological axes as A3, and technological and political axes as A4. Each area has a maximum value of 0.25 and the total value of the four areas is 1.

Figure 1
Global Overall Development of South Korea and North Korea
in the 1970s



We compute the overall global development index (X) as the sum of the four areas – A1, A2, A3 and A4. In computing A1, it is useful to think of the value of the Global Political Development Index (X1) as the base and the value of the Global Social Development Index (X2) as the height. We compute A1 by first multiplying X1 and X2, and then dividing their product by four. Similarly, we can compute A2, A3 and A4 by doing the same with the pairs (X2, X3), (X3, X4) and (X4, X1), respectively. For example, for South Korea, A1 is 6.7% since X1 is 47% and X2 is 57%. Likewise, we compute A2, A3 and A4 for South Korea to be 5.7%, 6% and 7.05%. Therefore, South Korea's overall global development index (X) is 25%. We can similarly compute X for North Korea as 3%. Therefore, in the 1970s, South Korea's overall development level was about eight times higher than that of North Korea. The fourth and final phase of the GDRI model is to use the four Global Development Indices (Xi) and coefficients to measure the Global Development Stage (Y) of South Korea and North Korea. The coefficient indicates the relative importance of the political, social, economic and technological dimensions, and sum up to one. For example, if we attach equal importance to the four dimensions, the coefficient for each dimension is 0.25. To obtain the Global Development Stage (Y), we first multiply the Global Development Index (Xi) with the corresponding coefficient – for example, the Global Political Development Index (X1) and the political coefficient – and then sum up the four products. Assuming that each of the four coefficients is 0.25, so that the four dimensions are equally important, we can compute the Global Development Stage (Y) for South Korea and North Korea as 51% and 20%, respectively, in the 1970s. The large gap in Y between South Korea and North Korea indicates a large gap between the two countries in terms of overall development. Figure 2 below provides a graphical representation of Global Development Stage (Y). The height corresponds to Y and the quadrangular area inside the dotted lines corresponds to the Overall Global Development Index (X).

Figure 2
Global Development Stage of South Korea and North Korea in the 1970s



The Global Development Stage (Y) is broadly similar to the Global Overall Development Index (X) since both reflect the overall development level of a country or a region. We define a value of Y between 0% and 33% as the underdeveloped stage, 34% and 66% as the developing stage, and 67% and 100% as the developed stage. Therefore, in the 1970s, South Korea was in the developing stage whereas North Korea was in the underdeveloped stage. We should note that Y is more flexible than X in the sense that it allows us to attach any combination of relative weights to the political, social, economic and technological dimensions. For example, if we attach more importance to the political dimension than the other dimensions, the political coefficient may be 0.40 while the social, economic and technological coefficients may each be 0.20. More generally, we can flexibly vary the relative sizes of the four coefficients to suit our needs.

We now report the main results of our GDRI Model analysis of the two Korea during the 1980s and the 1990s.[9] South Korea's Global Political Development Index (X1) increased from 47% in the 1970s to 67% in the 1980s and 79% in the 1990s, which indicates that South Korea has become progressively more politically developed over time. This reflects South Korea's transformation from authoritarian military-based governments to a thriving pluralistic democracy. In contrast, the same index has remained constant at only 7% for North Korea in the three decades, which is hardly surprising given that the country has remained a communist dictatorship with almost no freedom of expression. The large and growing gap between the two Koreas in political development does not bode well for the prospects of Korean unification since common political values facilitate regional integration, as most clearly evident in the EU.

The social development of South Korea has moved significantly forward in the 1980s and 1990s, in contrast to North Korea, which has failed to make any progress in this area. South Korea's Global Social Development Index (X2) rose from 57% in the 1970s to 86% in the 1980s and 100% in the 1990s. To a large extent, this reflects South Korea's rapid economic development since basic social services such as healthcare and education tend to improve with a country's living standards. In stark contrast, the same index declined from 29% in the 1970s and 1980s to 14% in the 1990s for North Korea, and this decline parallels the country's steep economic decline. The large gap in social development between the two Koreas and the consequent costliness of integrating the social systems of the two countries has negative implications for Korean unification.

The South Korean economy has achieved rapid growth and development, in sharp contrast to the North Korean economy, which has deteriorated sharply over time. South Korea's Global Economic Development Index (X3) has more than doubled, from 40% in the 1970s to 75% in the 1908s and 84% in the 1990s. This is consistent with the country's radical transformation from a poor developing country to a highly successful newly industrialized economy (NIE) that has become a model of economic development for the Third World. On the other hand, for North Korea, the same index has plummeted from 14% in the 1970s to 2% in the 1980s and 1990s. The North Korean economy has collapsed to such an extent that malnutrition is a fairly widespread problem. The wide and growing economic divide between the two Koreas remains by far the most serious obstacle to unification. It implies that the financial and economic costs of unification may be unsustainably high for South Korea.

South Korea has made substantial technological progress and has reached a high level of technological development, as evident in the evolution of its Global Technological Development Index (X4), which rose from 60% in the 1970s to 70 % in the 1980s and 100% in the 1990s. This is hardly surprising in light of the fact that technological upgrading has been an essential ingredient of South Korea's successful economy. On the other hand, North Korea's X4 fell from 30% in the 1970s to 10% in the 1980s and 1990s, reflecting a sharp decline in the country's technological base. This decline is both an effect and cause of the collapse of the country's poor economic performance. The large and increasing technological gap between the two countries raises the technological costs of unification and thereby has negative implications for the prospects of unification.

Table 3 below summarizes the global development of South Korea and North Korea in the political, social, economic and technological spheres during the 1970s, 1980s and 1990s. Table 3 clearly shows an unmistakable difference between the two Koreas. In contrast to South Korea, which has achieved substantial progress in all four spheres, North Korea has failed to do so in any of the four spheres. The wide and growing inter-Korean gap is not limited to economic development but extends to development in other areas as well. The fact that the Koreas are becoming less similar in all aspects rather than more similar does not bode well for their unification.

Table 3

Global Political, Social, Economic and Technological Development of

South Korea and North Korea in the 1970s, 1980s and 1990s

	1970s		1980s		1990s	
	SK	NK	SK	NK	SK	NK
POLITICAL	47%	7%	67%	7%	79%	7%
SOCIAL	57%	29%	86%	29%	100%	14%
ECONOMIC	40%	14%	75%	4%	84%	2%
TECHNOLOGICAL	60%	30%	70%	10%	100%	10%

We now use the four Global Development Indices (Xi) to estimate the Global Overall Development Index (X) for the two Koreas in the 1980s and 1990s.[10] To repeat, the Global Overall Development Index (X) measures a country's overall level of development from a multidimensional perspective encompassing the political, social, economic and technological aspects. We find X to be 55% for South Korea and 1% for North Korea in the 1980s, and 82% for South Korea and 1% for North Korea in the 1990s. The evolution of X over time confirms the picture of a wide and growing gap between the Koreas. South Korea has managed to reach a high overall development level through rapid progress in all four areas whereas North Korea's overall development level continues to stagnate at a very low level.

We use the four Global Development Indices (Xi) and coefficients reflecting the relative importance of each Xi to measure the Global Development Stage (Y) of South Korea and North Korea in the 1980s and 1990s.[11] To repeat, the Global Development Stage (Y) is similar to the Global Overall Development Index (X) in the sense that both reflect a country's overall development level. Assuming that each coefficient is 0.25, so that the political, social, economic and technological dimensions are equally important, we compute the Global Development Stage (Y) for South Korea and North Korea to be 75% and 13%, respectively, in the 1980s. Our computed value of Y rises to 91% for South Korea but falls even further to 8% for North Korea in the 1990s. According to our earlier definitions, South Korea is well into the developed stage while North Korea remains at a very low stage of development. The large and growing difference in Y between the two Koreas mirrors the large and growing difference in their overall development level.

21.3. Concluding Remarks

Unification between two countries is inherently a complex and multidimensional phenomenon entailing the unification of their economies, political systems, social systems, and a wide range of other societal hardware and software. The German unification of 1990 clearly illustrated the multidimensional nature of inter-country unification. Like pre-unification Germany, Korea is divided into a democratic market economy – South Korea – and a communist centrally planned economy – North Korea. In this paper, we look at the prospects for Korean unification by comparing their development from a multidimensional perspective rather than focusing solely on any single dimension. To carry out such a broader analysis, we use the Global Dimension of Regional Integration Model (GDRI Model) recently developed by Ruiz (2004), which evaluates the prospects for regional integration from a global or multidimensional perspective. More specifically, we use the GDRI model to examine and compare the political, social, economic and technological development of the two Koreas in the 1970s, 1980s and 1990s. Our main finding is a large and growing gap between the two Koreas in terms of political, social, economic and technological development and consequently, overall development. Our analysis thus clearly reveals a divergence between the two Koreas rather than a convergence, which suggests that unification is likely to be a painful and disruptive process entailing large adjustment costs.

In terms of policy implications, our analysis suggests that while the large and growing economic gap between the two Koreas is indeed a serious obstacle to inter-Korean integration and unification, South Korean policymakers would do well to appreciate the inherently multidimensional nature of unification. That is, unifying the two Koreas is not simply a matter of unifying two economies but also unifying political, social and technological systems as well. This is a valuable lesson that is also highly relevant for policymakers in other countries pursuing closer integration. Our analysis provides support for the South Korean government's "sunshine policy" of diplomatically engaging North Korea and providing economic assistance in the sense that such a policy will slow down the momentum of inter-Korean divergence in the short run and promote convergence in the long run.[12] The international community also has a stake in facilitating eventual inter-Korean unification through dialogue and assistance since convergence and stronger links between the two Koreas offer the best hopes for transforming North Korea into a responsible full-fledged member of the international community.

At the same time, while "sunshine policy" is appropriate in a broader sense, South Korean policymakers should pay closer attention to the non-economic aspects of inter-Korean convergence. For example, they have so far chosen to largely ignore the lack of progress in the political development of North Korea, whose government remains one of the world's most repressive dictatorships with almost complete lack of basic human rights. Our analysis implies that a narrow policy approach based on economic assistance alone is likely to be misguided and unproductive since lack of political convergence may hinder unification even if there is significant progress in terms of economic convergence. Of course, economic convergence could indirectly promote convergence in the political, social and technological spheres as well. After all, materially better off societies tend to have more open political systems, provide better education and use more advanced technology. Be that as it may, in light of our findings, South Korean policymakers would do well to extend more multidimensional assistance which has a direct positive impact on the multidimensional development of North Korea and hence multidimensional inter-Korean convergence. Finally, our study also lends support to the European Union's policy of requiring potential new members to pursue reforms in non-economic areas well as economic areas.

CHAPTER 22
BEYOND THE CETERIS PARIBUS ASSUMPTION: MODELING DEMAND AND SUPPLY ASSUMING OMNIA MOBILIS

BY MARIO ARTURO RUIZ ESTRADA, SU FEI YAP AND SHYAMALA NAGARAJ

22.1. Introduction

The *ceteris paribus* assumption can be considered a vital tool in the process of building economic models to explain complex economic phenomenon. This assumption translated from Latin means "all other things [being] the same". It facilitates the description of how a variable of interest changes in response to changes in other variables by examining the effect of one variable at a time. An extremely important contribution of Alfred Marshall, it supports the understanding of the application of *ceteris paribus* assumption in economic models. According to Marshall (1890, v.v.10):

> **"**The element of time is a chief cause of those difficulties in economic investigations which make it necessary for man with his limited powers to go step by step; breaking up a complex question, studying one bit at a time, and at last combining his partial solutions into a more or less complete solution of the whole riddle. In breaking it up, he segregates those disturbing causes, whose wanderings happen to be inconvenient, for the time in a pound called *Ceteris Paribus.* The study of some group of tendencies is isolated by the assumption *other things being equal:* the existence of other tendencies is not denied, but their disturbing effect is neglected for a time. The more the issue is thus narrowed, the more exactly can it be handled: but also the less closely does it correspond to real life. Each exact and firm handling of a narrow issue, however, helps towards treating broader issues, in which that narrow issue is contained, more exactly than would otherwise have been possible."

Marshall's approach thus allows the analyses of complex economic phenomena by parts where each part of the economic model can be joined to generate an approximation of the real world. This approach can be termed the Isolation Approach and according to Marshall (Schlicht, 1985, p.18) originates from two possible Isolation clauses. First the *ceteris paribus* assumption allows some variables to be considered unimportant. This clause is called Substantive Isolation. Substantive Isolation considers that some unimportant variables cannot significantly affect the final result of the economic model. Second, the *ceteris paribus* assumption allows the influence of some important factors to be disregarded. The application of the *ceteris paribus* assumption in this case is purely hypothetical; therefore the second clause is called Hypothetical Isolation. It allows parts of the model to be managed more easily.

In other words, to explain a complex economic phenomenon, the *ceteris paribus* approach considers the effect partially of each variable in a set of m variables (termed usually independent variables, X_j , j = 1, 2, . . ., m) upon a variable of interest (usually termed the dependent variable, Y). From a mathematical point of view, the *ceteris paribus* assumption in an economic model is equivalent to the partial derivative, which explains how one independent variable, say X_k, in a set of independent variables can affect the dependent variable Y while the other independent variables are being held constant. From a graphical point of view, the *ceteris paribus* assumption supports the elaboration of scenarios that can be visualized on 2-Dimensional (X,Y) space. More precisely if Y is a function of, say, X_1 and X_2, the (partial) relationship between Y and X_1 can be visualized in the 2-D space describing Y and X_1, assuming X_2 is held constant. In order to approximate real world, Marshall (1890, v.v.10) goes on to propose that "With each step more things can be let out of the pound; exact discussions can be made less abstract, realistic discussions can be made less inexact than was possible at an earlier stage." The real-world scenario is thus approximated by the cumulative effect of the partial effects of the X variables on Y.

With the availability of multi-dimensional graphs based on the application of Cartesian Spaces (Ruiz, 2007, p.5), it is possible to visualize what we call the Omnia Mobilis (everything is moving) assumption. The Cartesian space is used to generate is used to generate multi-dimensional-graphs with different dimensions that can be shown to move with time. But more than that, the multi-dimensional graph provides an alternative to the Marshall view of step-by-step cumulative partial approach to modeling a complex economic phenomenon.

In this paper we are concerned with the application of multi-dimensional graphs in visualizing and modeling total change in an independent in response to changes in any or all of the (many) independent variables affecting it within the same framework of space and time. The multidimensional-graph can also be used to describe dynamic and multi-functional analyses that represent changes within the total function of an economic variable. The next section discusses the application of multi-dimensional graphs to model demand and supply. The third section concludes the paper.

22.2. Visualizing and Modeling Demand and Supply Surfaces

Concerning the graphical methods for modeling demand and supply, it is necessary to mention the significant contributions of Antoine Augustin Cournot. Cournot (1897, p.427) derived the first formula for the rule of supply and demand as a function of price. He was also the first economist to draw supply and demand curves on a graph (2-Dimensional view). Cournot believed that economists should utilize graphs only to establish probable limits and express less stable facts in more absolute terms. He further held that the practical use of mathematics in economics involves not only strict numerical precision, but also graphical visualization. Besides Cournot, other innovative economists who contributed to the analytical graph system in economic models over time were William Stanley Jevons, Marie-Esprit-Léon Walras, Vilfredo Pareto, Alfred Marshall and Francis Ysidro Edgeworth (McClelland, 1976, p. 97).

In this section, we describe the application of multi-dimensional graphs to the analysis of demand and supply. The supply and demand model determines the quantity sold in the market. The usual model predicts that in a competitive market, price will function to equalize the quantity demanded by consumers and the quantity supplied by producers, resulting in an economic equilibrium of quantity. The application of multi-dimensional graphs allows the visualization and modeling of the effect of other variables on quantity demanded and supplied. With this application, the quantity sold in the market will equal quantity demanded and quantity supplied only under certain circumstances. In other cases, the quantity sold in the market will be a balance between the demand and supply quantities.

The application of the Infinity Cartesian Space (I-Cartesian Space) (Ruiz, 2006, p.3) is used to obtain demand and supply surfaces that replace the usual 2-Dimensional (and 3-Dimensional) demand and supply lines. The general function to build demand and supply cylinders is given below by:

$$Y_{C:L} = f_C([X_{C:L:j}, P_{C:L:j}, R_{C:L:j}], j = 1, \ldots, m_C)$$

Where:

$C = \{1, 2\}$ is the Cylinder, C = 1 for the demand cylinder and C = 2 for the supply cylinder

$L = \{1, 2, 3, \ldots, n\}$, $n \rightarrow \infty$, is the Level

m_C , $m_C \rightarrow \infty$, is the number of independent variables in cylinder C

$X_{C:L:j}$ is the independent variable j in cylinder C at level L lying in position $P_{C:L:j}$ with value $R_{C:L:j}$;

$P_{C:L:j}$, $0^{\circ} \leq P_{C:L:j} < 360^{\circ}$, is the position of $X_{C:L:j}$ in cyclinder C at level L;

$R_{C:L:j}$ is the radius corresponding to the $X_{C:L:j}$ in cylinder C at level L

$Y_{C:L}$ is the dependent variable, quantity demanded (C=1) and quantity supplied (C=2) at level L

Assumptions

1. Application of *Omnia Mobilis* assumption.
2. The set of independent variables affecting demand are not necessarily the same as that for supply; however price is common to both sets.
3. The set of independent variables for demand and for supply are available for the same number of levels, that is, "n". Usually the level represents time.
4. The unit of measurements of all variables is the same. For example, all variables can be measured in terms of growth.
5. Price is the independent variable $X_{C:L:1}$, located at position $P_{C:L:1} = 1^{\circ}$ in both cylinders and for all levels. Since price in the demand cylinder must equal price in the supply cylinder, the radius $R_{1:L:1} = R_{2:L:1}$

Definitions

1. The Balance Line, BL_L, is the line that joins $Y_{1:L}$ and $Y_{2:L}$ at level L.
2. The Balance Point is a point on BL_L that indicates the quantity sold at level L.
3. The Balance Quantity Line (BQL) is the vertical line that connects all the Balance Points, L = 1, …, n. It forms the hinge between the demand and supply cylinders and at each level L and in each cylinder it is located at $P_{C:L:0} = 0^{\circ}$.

The Demand Cylinder

As seen from Figure 1, the demand cylinder is a series of n sub-cylinders, one for each level. For a given sub-cylinder, say for L=1, the values of the m_1 independent variables $X_{1:L:j}$ affecting demand $Y_{1:L}$ are plotted on the base of the sub-cylinder as the radii. The value of a specific independent variable at time point 1, say $X_{1:1:1}$ is plotted as $R_{1:1:1}$ the radius pictured lying on a flat surface at angle $P_{1:1:1}$ measured from 1° line used for price as its reference line. The points from the end of the radii are joined to meet in a single point on the top of each sub-cylinder at height $Y_{1:1}$, the quantity demanded at time L. The diameter of the sub-cylinder is twice the maximum radius. The demand function is expressed as:

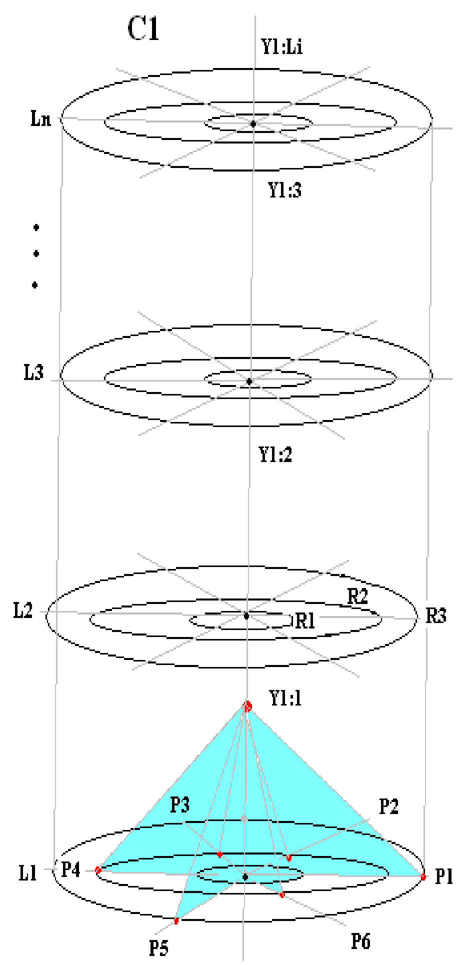
$$Y_{1:L} = f_1([X_{1:L:j}, P_{1:L:j}, R_{1:L:j}], j = 1, \ldots, m_1)$$

The Supply Cylinder

Similarly, the supply cylinder is a series of n sub-cylinders, one for each level. For a given sub-cylinder, say for L=1, the values of the m_2 independent variables $X_{2:L:j}$ affecting demand $Y_{2:L}$ are plotted on the base of the sub-cylinder as the radii. The value of a specific independent variable at time point 1, say $X_{2:1:1}$ is plotted as $R_{2:1:1}$ the radius pictured lying on a flat surface at angle $P_{2:1:1}$ measured from 1° line used for price as its reference line. The points from the end of the radii are joined to meet in a single point on the top of each sub-cylinder at height$Y_{2:1}$, quantity supplied at time L. The diameter of the sub-cylinder is twice the maximum radius. The supply function is expressed as

$$Y_{2:L} = f_2 ([X_{2:L:j}, P_{2:L:j}, R_{2:L:j}], j = 1, \ldots, m_2)$$

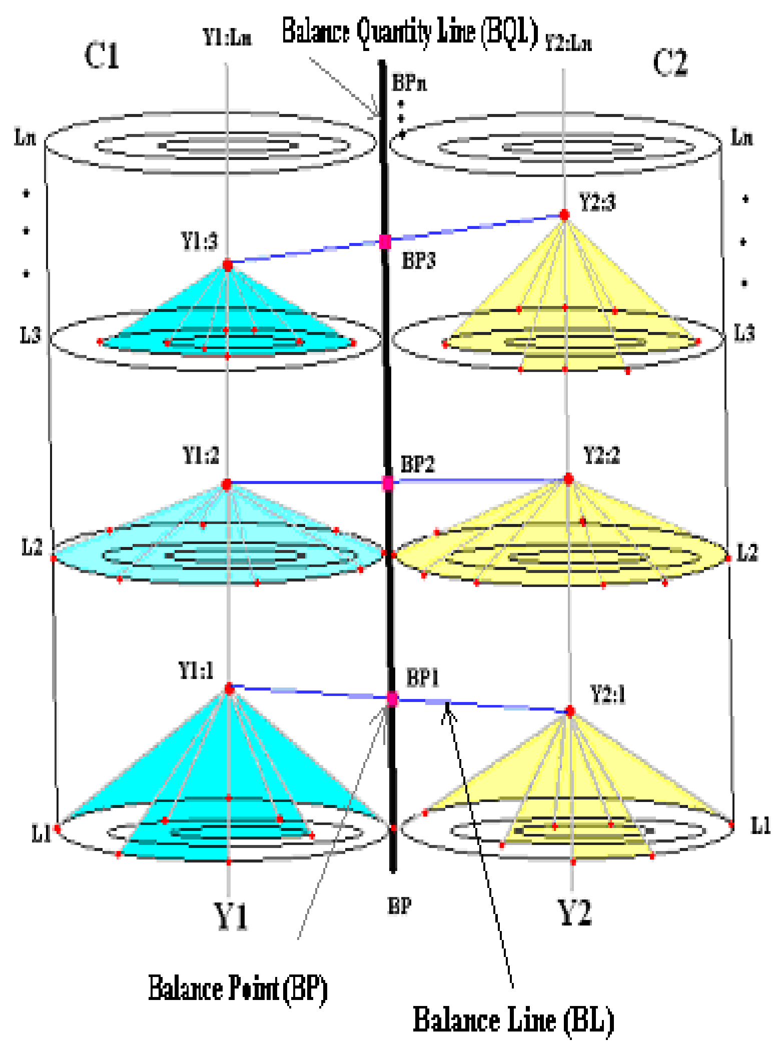
Figure 1:
Demand Cylinder



The Demand and Supply Surfaces

The demand and supply surfaces are placed side by side as shown in Figure 2, the sub-cylinder for level L for demand being adjacent to the sub-cylinder for level L for supply. The maximum height of the sub-cylinders at level L will be the maximum of $Y_{1:L}$ and $Y_{2:L}$. The demand and supply surfaces are then two oblique cylinders consisting of sub-cylinders of varying diameters. The two cylinders are hinged on a common line located at position $P_{C:L:0} = 0^{\circ}$. This common line is called the Balance Quantity Line (BQL) and connects all the Balance Points which show the quantities sold in the market at all the different levels.

Figure 2:
Demand and Supply Cylinders



The Balance Line, Balance Point and Changes in Demand and Supply

The balance line, BL_l, is the line that connects $Y_{1:L}$ and $Y_{2:L}$ in sub-cylinder L. This line may be linear as shown in Figure 3 or non-linear. The quantity sold in the market lies somewhere on this line given by the Balance Point, BP_L. The quantity sold is thus viewed as a "balance" between demand and supply quantities. Thus,

$$BP_L = g(Y_{1:L}, Y_{2:L})$$

In other words, the quantity sold in the market is a function not only of the common price but also of all the factors that affect supply and demand. This suggests that demand and supply quantities can remain in disequilibrium at time L.

Example

If we assume that BL_L is a straight line, then its slope is given by

$$S_L \quad = \quad \left| Y_{1:L} - Y_{2:L} \right| \quad / \quad \left| \max_j \{R_{1:L:j}\} + \max_j \{R_{1:L:j}\} \right|$$

As demand or supply changes from one level to the next, the slope of the line will change. The Balance Point, however, may or may not change as that depends on the joint effect of all variables that affect quantity. In order to understand the Balance Line, it is useful to consider three scenarios:

Scenario 1: Only one independent variable, price; demand equals supply
Scenario 2: More than one independent variable; demand equals supply
Scenario 3: More than one independent variable; demand does not equal supply

Figure 3 shows the demand and supply surfaces for each of these scenarios for levels L=1, 2 and 3 with assumed data.

Scenario 1

In this case, the two cylinders will be of same diameter and will be straight cylinders, that is, the mid-points of the cross-sectional circles will be on the same line. Quantity demanded equals quantity supplied, and the quantity sold in the market is the equilibrium quantity under the *ceteris paribus* assumption. With $Y_{1:1} = Y_{2:1}$, $S_L = 0$. The Balance Line is thus a horizontal line (See figure 3).

The demand and supply functions are

$Y_{1:1} = f_1\,([X_{1:1:1}, P_{1:1:1}, R_{1:1:1}])$ $\qquad$ $Y_{2:1} = f_2\,([X_{2:1:1}, P_{2:1:1}, R_{2:1:1}])$

The graph for level L=1 is:

Demand Cylinder	Supply Cylinder
$Y_{1:1} = 4$	$Y_{2:1} = 4$
$R_{1:1:1} = 3$ (price)	$R_{2:1:1} = 3$ (price)

The slope of the Balance Line is

$S_L = (4-4)/(3+3) = 0/9 = 0$

The Balance Point showing the quantity sold in the market at level 1 is

$BP_1 = Y_{1:1} = Y_{2:1} = 4$

Scenario 2

Since $Y_{1:2} = Y_{2:2}$, the slope of the Balance Line will be zero and quantity demanded equals quantity supplied and the quantity sold in the market equals the equilibrium quantity under the *ceteris paribus* assumption. In this situation, the quantity sold under the *omnia mobilis*

assumption does not differ from that under the *ceteris paribus* assumption. That is, the other variables besides price have the same effect as price on the quantity supplied or demanded (see figure 3).
The demand and supply functions are
$Y_{1:2} = f_1$ ($[X_{1:2:j}, P_{1:2:j}, R_{1:2:j}]$, j = 1, . . ., 9) $Y_{2:2} = f_2$ ($X_{2:2:j}, P_{2:2:j}, R_{2:2:j}]$, j = 1, . . ., 9)

The graph for level L=2 is:

Demand Cylinder	Supply Cylinder
$Y_{1:2} = 5$	$Y_{2:2} = 5$
$R_{1:2:1} = 5$ (price)	$R_{2:2:1} = 5$ (price)
$R_{1:2:2} = 5$	$R_{2:2:2} = 5$
$R_{1:2:3} = 5$	$R_{2:2:3} = 5$
$R_{1:2:4} = 5$	$R_{2:2:4} = 5$
$R_{1:2:5} = 5$	$R_{2:2:5} = 5$
$R_{1:2:6} = 5$	$R_{2:2:6} = 5$
$R_{1:2:7} = 5$	$R_{2:2:7} = 5$
$R_{1:2:8} = 5$	$R_{2:2:8} = 5$
$R_{1:2:9} = 5$	$R_{2:2:9} = 5$

The slope of the Balance Line is
$S_L = (5-5)/(5+5) = 0/10 = 0$
The Balance Point showing the quantity sold in the market at level 2 is
$BP_2 = Y_{1:2} = Y_{2:2} = 5$

Scenario 3

Finally consider Scenario 3, where $Y_{1:3} \neq Y_{2:3}$. In this case, the diameters of each sub-cylinder for the two cylinders would be different; the cylinders become oblique. Then the Balance Line will slope down towards the sub-cylinder with the lower quantity. The quantity sold will be shown by the Balance Point, a point on this line determined by all the independent variables in both the demand and supply cylinders. In this situation, the quantity sold under the *omnia mobilis* assumption differs from that under the *ceteris paribus* assumption (see figure 3).
The demand and supply functions are
$Y_{1:L} = f_1$ ($[X_{1:3:j}, P_{1:3:j}, R_{1:3:j}]$, j = 1, . . ., 9) $Y_{2:L} = f_2$ ($X_{2:3:j}, P_{2:3:j}, R_{2:3:j}]$, j = 1, . . ., 9)
The graph for level L=3 is:

Demand Cylinder	Supply Cylinder
$Y_{1:3} = 5$	$Y_{2:3} = 4$
$X_{1:3:1} = 5$ (price)	$X_{2:3:1} = 5$ (price)
$X_{1:3:2} = 3$	$X_{2:3:2} = 4$
$X_{1:3:3} = 5$	$X_{2:3:3} = 2$
$X_{1:3:4} = 5$	$X_{2:3:4} = 4$
$X_{1:3:5} = 6$	$X_{2:3:5} = 4$
$X_{1:3:6} = 3$	$X_{2:3:6} = 4$
$X_{1:3:7} = 5$	$X_{2:3:7} = 5$
$X_{1:3:8} = 5$	$X_{2:3:8} = 6$
$X_{1:3:9} = 6$	$X_{2:3:9} = 5$

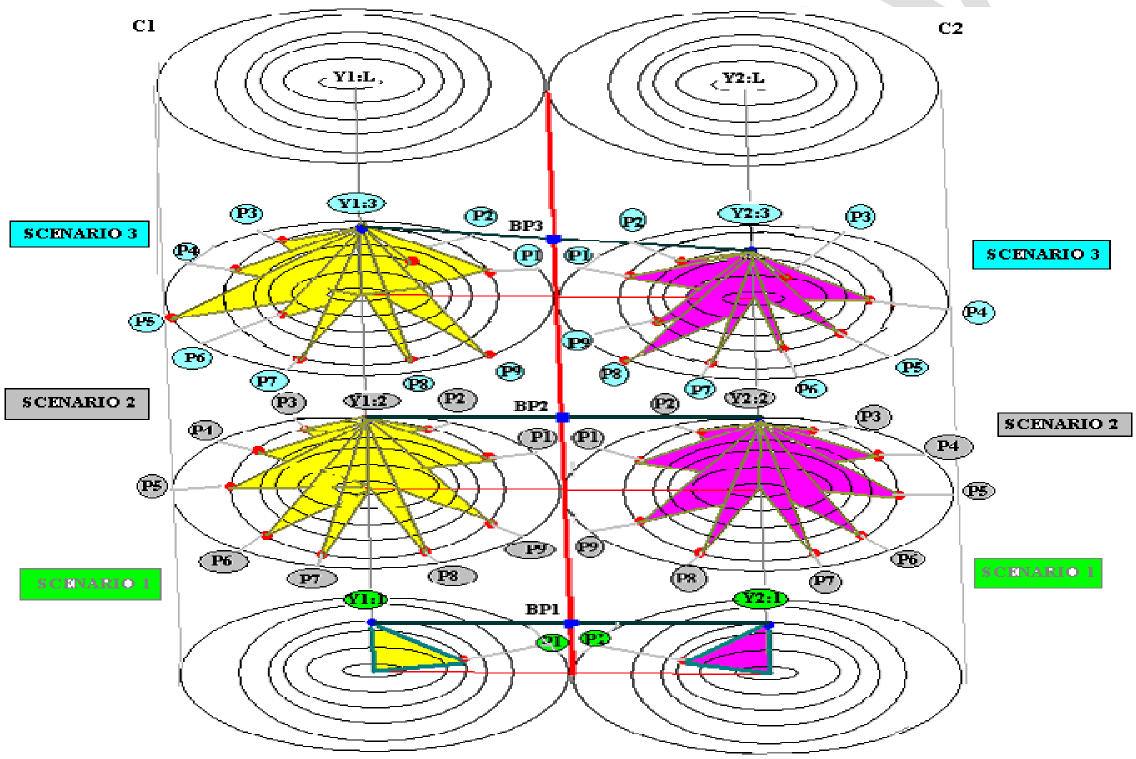
The slope of the Balance Line is

$S_L = (5-4)/(6+6) = 1/12$

The Balance Point showing the quantity sold in the market at level 3 will lie between 4 and 5.

$BP_3 \neq Y_{1:3} = 5$ and $BP_3 \neq Y_{2:3} = 4$

Figure 3:
Demand and Supply Surfaces Application



22.3. Conclusion:

The use of the *ceteris paribus* assumption is linked to the type of graphs used such as 2-Dimensional and conventional 3-Dimensional graphs. The multi-dimensional graph goes beyond the traditional approach to allow the visualization of the *omnia mobilis* (everything is moving) assumption and further provides an alternative to modeling total change in a dependent variable. In order to demonstrate the applicability of multi-dimensional graphs we have used it in the context of demand and supply. The approach shows that quantity sold in the market is not necessarily equal to the quantity demanded or supplied when the effect of independent variables other than just price is taken into account. Quantity demanded and supplied are mostly in disequilibrium and the quantity sold is a joint function of all the independent variables that affect supply and demand.

CHAPTER 23
WHAT IS POLICY MODELING?

23.1. Introduction

This paper makes several observations and recommendations pertaining to policy modeling. First, it introduces a definition of policy modeling together with a way to classify policy modeling. Based on a careful study of the total of 1501 research papers published in the Journal of Policy Modeling (JPM) between 1979 and 2009, it presents the percentages of papers published in individual categories of policy modeling identified. Second, based on an observation of the common approaches used in policy modeling papers in the past 30 years in JPM, this paper recommends multidisciplinary approach to policy modeling. It suggests the incorporation of multidisciplinary, non-economic variables in policy modeling to formulate strong policies. Third, in connection with the multidisciplinary approach, it proposes the application of the 'Omnia Mobilis' assumption (Ruiz Estrada, Yap and Nagaraj, 2008) to policy modeling. Under this assumption ('everything is moving'), a good range of variables should be included and no relevant variables should be neglected in policy modeling.

As its fourth and main contribution, this paper introduces the idea of evaluating policy modeling. It introduces the purpose-built Policy Modeling Consistency Index (PMC-Index) to evaluate the level of consistency of any policy modeling. Through its PMC-Surface, this index can further be used to identify the strengths and weaknesses within any policy modeling. There are four basic steps in the implementation of the PMC-Index. These four steps are: (i) the use of multi-input-output table; (ii) classification of variables and identification of parameters; (iii) measurement of PMC-Index; (iv) construction of the PMC-Surface.

23.2. Definition and Classification of Policy Modeling

"Policy modeling" can be defined as "an academic or empirical research work, that is supported by the use of different theories as well as quantitative or qualitative models and techniques, to analytically evaluate the past (causes) and future (effects) of any policy on society, anywhere and anytime." As an integral part of this definition, "policy" is defined as "a theoretical or technical instrument that is formulated to solve specific problems affecting, directly or indirectly, societies across different periods of times and geographical spaces."

Policy modeling can also be classified. Based on a study of all the one thousand five hundred and one (1501) papers that were published in the Journal of Policy Modeling (JPM) from 1979 to 2009 (30 years) (see Table 1 and Figure 1), policy modeling can be classified into the following twelve (12) categories: (i) domestic and international trade policy modeling; (ii) energy, communications, infrastructure and transportation policy modeling; (iii) environmental and natural resources management policy modeling; (iv) fiscal and government spending policy modeling; (v) institutional, regulation and negotiation policy modeling; (vi) labor, employment and population policy modeling; (vii) monetary, banking and investment policy modeling; (viii) production and consumption policy modeling; (ix) technological and R&D policy modeling; (x) welfare and social policy modeling; (xi) economic growth and development policy modeling; (xii) miscellaneous policy modeling.

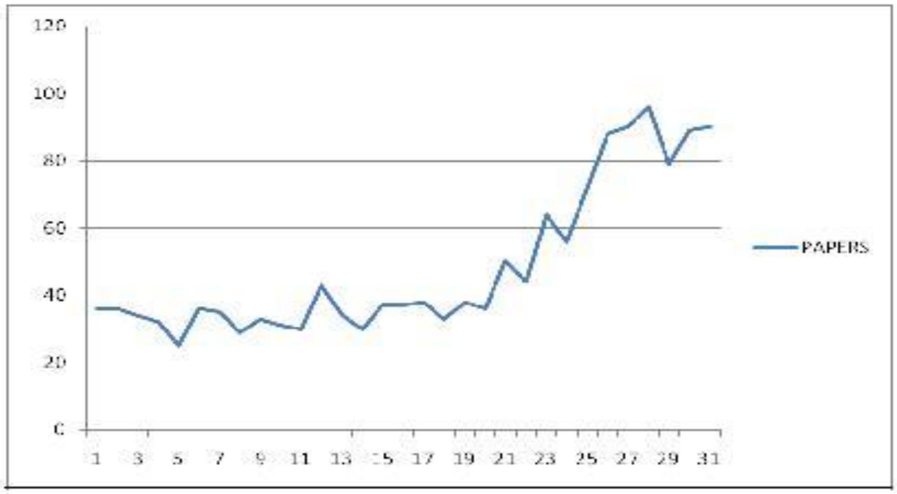
Based on the same study and the same classification above, the percentages of papers in the individual categories of policy modeling were found to be as follows: (i) domestic and international trade policy modeling (220 papers = 15%); (ii) energy, communications, infrastructure and transportation policy modeling (80 papers = 5%); (iii) environmental and natural resources management policy modeling (70 papers = 5%); (iv) fiscal and government spending policy modeling (80 papers = 5%); (v) institutional, regulation and negotiation policy modeling (55 papers = 4%); (vi) labor, employment and population policy modeling (70 papers = 5%); (vii) monetary, banking and investment policy modeling (410 papers = 27%); (viii) production and consumption policy modeling (165 papers = 11%); (ix) technological and R&D policy modeling (35 papers = 2%); (x) welfare and social policy modeling (56 papers = 4%); (xi) economic growth and development policy modeling (150 papers = 10%); (xii) miscellaneous policy modeling (110 papers = 7%) (see Table 2 and Figure 2).

Table 1:
Total of Papers Published by JPM from 1979 to 2009

Year (vol)	I1	I2	I3	I4	I5	I6	I7	I8	I9	TOP
1979 (1)	12	14	10	0	0	0	0	0	0	36
1980 (2)	12	14	10	0	0	0	0	0	0	36
1981 (3)	11	11	12	0	0	0	0	0	0	34
1982 (4)	10	11	11	0	0	0	0	0	0	32
1983 (5)	8	8	9	0	0	0	0	0	0	25
1984 (6)	9	11	6	10	0	0	0	0	0	36
1985 (7)	9	8	7	11	0	0	0	0	0	35
1986 (8)	7	7	7	8	0	0	0	0	0	29
1987 (9)	9	6	6	12	0	0	0	0	0	33
1988 (10)	8	7	8	8	0	0	0	0	0	31
1989 (11)	7	5	8	10	0	0	0	0	0	30
1990 (12)	8	7	20	8	0	0	0	0	0	43
1991 (13)	8	9	9	8	0	0	0	0	0	34
1992 (14)	6	8	7	9	0	0	0	0	0	30
1993 (15)	11	7	5	7	7	0	0	0	0	37
1994 (16)	10	4	4	7	6	6	0	0	0	37
1995 (17)	11	6	4	7	6	4	0	0	0	38
1996 (18)	7	4	5	4	7	6	0	0	0	33
1997 (19)	9	4	6	6	7	6	0	0	0	38
1998 (20)	5	7	5	5	7	7	0	0	0	36
1999 (21)	8	6	7	8	9	6	6	0	0	50
2000 (22)	6	5	5	3	12	6	7	0	0	44
2001 (23)	6	6	9	9	9	10	8	7	0	64
2002 (24)	7	9	6	7	10	5	8	4	0	56
2003 (25)	13	12	10	10	7	8	6	6	0	72
2004 (26)	18	11	8	7	12	9	10	13	0	88
2005 (27)	9	9	10	9	11	11	12	11	8	90
2006 (28)	9	13	11	15	8	11	11	10	8	96
2007 (29)	10	14	13	15	12	15	0	0	0	79
2008 (30)	16	19	11	14	15	14	0	0	0	89
2009 (31)	11	19	16	14	12	18	0	0	0	90
									Total	1501

Source: Journal of Policy Modeling (JPM) – Elsevier Group
I: Issue
TOP: Total of Papers

Figure 1: Papers Published in JPM from 1979 until 2009



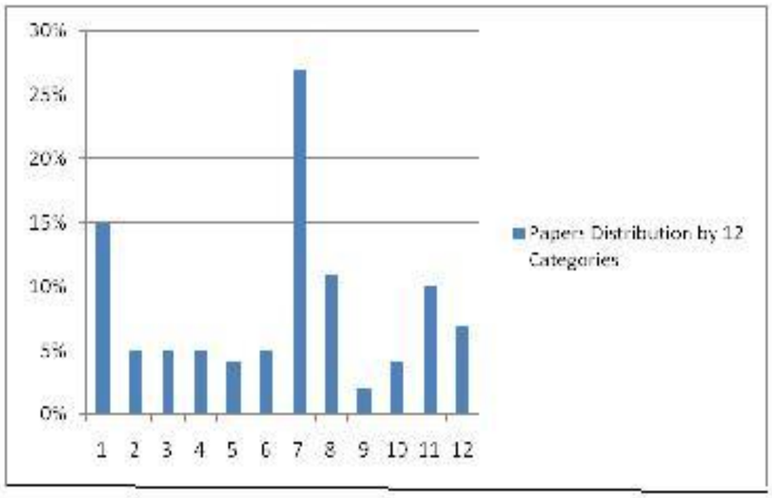
Source: Journal of Policy Modeling (JPM) – Elsevier Group

Table 2:
JPM Papers Distribution by 12 Categories (1979-2009)

	Papers	%
1. Domestic and International Trade Policy Modeling	220	15%
2. Energy, Communications, Infrastructure and Transportation Policy Modeling	80	5%
3. Environmental and Natural Resources Management Policy Modeling	70	5%
4. Fiscal and Government Spending Policy Modeling	80	5%
5. Institutional, Regulation and Negotiation Policy Modeling	55	4%
6. Labor, Employment and Population Policy Modeling	70	5%
7. Monetary, Banking and Investment Policy Modeling	410	27%
8. Production and Consumption Policy Modeling	165	11%
9. Technological and R&D Policy Modeling	35	2%
10. Welfare and Social Policy Modeling	56	4%
11. Economic Growth and Development Policy Modeling	150	10%
12. Miscellaneous Policy Modeling	110	7%
	1501	100%

Source: Journal of Policy Modeling (JPM) – Elsevier Group
Note: Miscellaneous: General and Partial Equilibrium Analysis, Macroeconomics Analysis and New Topics in Economics.

Figure 2: JPM Papers Distributed by12 Categories (1979-2009)



Source: Journal of Policy Modeling (JPM) – Elsevier Group

23.3. Proposed Approach to Policy Modeling

23.3.1. Multidisciplinary Approach

Among the 1501 papers published in JPM in the past 30 years (1979-2009), the following research orientation was common: benefit/cost, probabilistic or forecasting analysis through the application of econometric methods and use of microeconomic and macroeconomic levels secondary data. Also, among these 1501 papers, and for the past 30 years, there has been an increasing dependency of policy modeling on econometrics models, methods and techniques. Ninety seven percent (97%) or 1456 of these papers adopted the economics research approach in policy modeling. Only 3% or 45 of these papers adopted the institutional approach or multidisciplinary approach (entailing several disciplines such as history, economics, sociology, politics, technology and social sciences et cetera) in policy modeling.

This paper is of the view that the absence of non-economic variables can considerably increase the vulnerability of any policy. Therefore, it suggests that any policy modeling should take into consideration a wide range of factors, including unforeseen factors. These factors include, among others, natural disaster trends, climate changes, terrorism, crime and violence, poverty expansion, religion and beliefs, education system, social events and phenomena, social norms and behavior, et cetera. This paper maintains that it is necessary to incorporate these sorts of factors in policy modeling in order to formulate strong policies of minimal vulnerability possible. However, it must be assumed that all these factors maintain a constant quantitative and qualitative transformation(s) in different historical periods of the society concerned.

23.3.2 'Omnia Mobilis' Assumption

The Ceteris Paribus assumption was commonly applied to policy modeling in earlier publications in JPM. This paper suggests that it is not necessary to apply the Ceteris Paribus assumption to policy modeling. The argument is that no relevant variable should be neglected or considered less important to be accounted for in policy modeling. For this reason, this paper proposes a new assumption for policy modeling: the 'Omnia Mobilis' assumption (everything is moving) advanced by Ruiz Estrada, Yap and Nagaraj (2008). The objective of applying the Omnia Mobilis assumption is to include a wide range of variables and not neglect any relevant variable in policy modeling.

23.4. The Policy Modeling Consistency Index (PMC-Index)

With the Omnia Mobilis assumption, this paper proposes the "Policy Modeling Consistency Index (PMC-Index) as a tool to evaluate policy modeling. This purpose-built index performs the following functions: (i) to evaluate the consistency level of any policy modeling; (ii) to identify the strengths and weaknesses of any policy modeling.

The construction of the PMC-Index involves the use of fifty (50) sub-variables distributed in ten (10) main-variables. These 10 main-variables are: (X_1) types of research; (X_2) research orientation; (X_3) data sources; (X_4) econometrics methods applied; (X_5) areas of research; (X_6) research theoretical framework; (X_7) policy modeling by sectors; (X_8) economics frameworks; (X_9) geographical analysis; (X_{10}) paper citation.

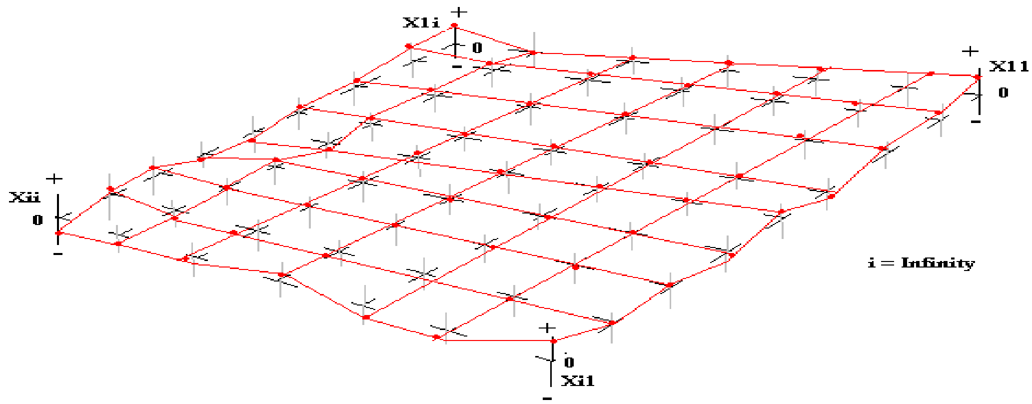
There are four basic steps in the implementation of the PMC-Index. These steps are: (i) the use of multi-input-output table; (ii) classification of variables and identification of parameters; (iii) measurement of the PMC-Index; (iv) construction of the PMC-Surface. The PMC-Surface is used to show the strengths and weaknesses in any policy modeling from a multi-dimensional perspective. The mega-surface coordinate space (see Figure 3) (Ruiz Estrada, 2007) is used in the construction of the PMC-Surface.

23.4.1 Steps to Implement PMC-Index

23.4.1(i) The Use of Multi-Input-Output Table

The multi-input-output table (see Table 3) is an alternative database analysis framework that permits storage of a large amount of data to measure any single variable. This single variable can show the evolution of any policy from a general perspective. In the construction of the PMC-Index, the multi-input-output table functions as the basic analytical framework to measure the "m" number of main-variables. Each main-variable is formed by "n" number of sub-variables. The number of sub-variables in each main-variable is unlimited. As such, the multi-input-output table concept does not include any notion of ranking of variables according to importance. All sub-variables are given the same importance (weight) because we are interested to measure a single value, which is the PMC-Index in this case. In order to give the same weight to all sub-variables, it is necessary to use the binary system. The binary system (0,1) helps to maintain a balance among all variables.

Figure 3: The Mega-Surface Coordinate Space



23.4.1. (ii) Classification of Variables and Identification of Parameters

The construction of the PMC-Index involves 10 main-variables and 50 sub-variables. The 10 main-variables are: (X_1) type of research; (X_2) research orientation; (X_3) data sources; (X_4) econometrics methods applied; (X_5) areas of research; (X_6) research theoretical framework; (X_7) policy modeling by sectors; (X_8) economics frameworks; (X_9) geographical analysis; (X_{10}) paper citation.

I. The first main-variable (X_1) ('types of research') is formed by seven sub-variables: ($X_{1:1}$) predicting; ($X_{1:2}$) monitoring; ($X_{1:3}$) proposal; ($X_{1:4}$) descriptive; ($X_{1:5}$) diagnostic; ($X_{1:6}$) simulation; ($X_{1:7}$) experimental. **II.** The second main-variable (X_2) ('research orientation') is formed by six sub-variables: ($X_{2:1}$) empirical; ($X_{2:2}$) theoretical; ($X_{2:3}$) technical; ($X_{2:4}$) historical; ($X_{2:5}$) quantitative; ($X_{2:6}$) qualitative. **III.** The third main-variable (X_3) ('data sources') consists of six sub-variables: ($X_{3:1}$) primary data; ($X_{3:2}$) secondary data; ($X_{3:3}$) mix data; ($X_{3:4}$) long term; ($X_{3:5}$) medium term; ($X_{3:6}$) short term. **IV.** The fourth main-variable (X_4) ('econometric methods applied on policy modeling') is made up of ($X_{4:1}$) linear regression analysis; ($X_{4:2}$) multiple regression analysis; ($X_{4:3}$) times series data; ($X_{4:4}$) cross-sectional data; ($X_{4:5}$) panel data; multi-dimensional panel data ($X_{4:6}$). **V.** The fifth main-variable (X_5) ('area of research') comprises eight sub-variables: ($X_{5:1}$) economics; ($X_{5:2}$) social; ($X_{5:3}$) technological; ($X_{5:4}$) political; ($X_{5:5}$) environment; ($X_{5:6}$) institutional; ($X_{5:7}$) sciences; ($X_{5:8}$) multi-disciplinary. **VI.** The sixth main-variable (X_6) ('research theoretical framework') comprises three sub-variables: ($X_{6:1}$) original theoretical framework; ($X_{6:2}$) traditional theoretical framework; ($X_{6:3}$) extension theoretical framework. **VII.** The seventh main-variable (X_7) ('policy modeling by sectors') is made up of three sub-variables: ($X_{7:1}$) private sector; ($X_{7:2}$) public sector; ($X_{7:3}$) public/private sector. **VIII**. The eighth main-variable (X_8) ('economics frameworks applied on policy modeling') comprises the following eight sub-variables: ($X_{8:1}$) macroeconomics analysis; ($X_{8:2}$) microeconomics analysis; ($X_{8:3}$) partial equilibrium; ($X_{8:4}$) general equilibrium; ($X_{8:5}$) dynamic modeling; ($X_{8:6}$) static modeling; ($X_{8:7}$) perfect competition; ($X_{8:8}$) imperfect competition. **IX.** The ninth main-variable (X_9) ('geographical analysis') is affected by three sub-variables: ($X_{9:1}$) national level;

($X_{9:2}$) regional level; ($X_{9:3}$) global level. **X.** The tenth main-variable (X_{10}) is 'paper citation'. It is without any sub-variable. (see Table 3).

Besides variables and sub-variables, two (2) parameters are used in the construction of the PMC-Index. These parameters are: (i) if the sub-variable can fit into the policy modeling, then this sub-variable is denoted by "1"; (ii) if the sub-variable cannot fit into the policy modeling, then this sub-variable is denoted by "0". Each parameter uses the binary digit "0" or "1". The binary system is applied to every sub-variable because all sub-variables have the same level of importance and exert the same level of influence in the multi-input-output table.

Table 3: Multi-Input-Output Table

P	X1							X2						X3						X4					
	X1:1	X1:2	X1:3	X1:4	X1:5	X1:6	X1:7	X2:1	X2:2	X2:3	X2:4	X2:5	X2:6	X3:1	X3:2	X3:3	X3:4	X3:5	X3:6	X4:1	X4:2	X4:3	X4:4	X4:5	X4:6

P	X5								X6			X7			X8								X9			X10
	X5:1	X5:2	X5:3	X5:4	X5:5	X5:6	X5:7	X5:8	X6:1	X6:2	X6:3	X7:1	X7:2	X7:3	X8:1	X8:2	X8:3	X8:4	X8:5	X8:6	X8:7	X8:8	X9:1	X9:2	X9:3	X10

Table 4: Application of Binary System in the Multi-Input-Output Table.

P	X1							X2						X3						X4					
V	X1:1	X1:2	X1:3	X1:4	X1:5	X1:6	X1:7	X2:1	X2:2	X2:3	X2:4	X2:5	X2:6	X3:1	X3:2	X3:3	X3:4	X3:5	X3:6	X4:1	X4:2	X4:3	X4:4	X4:5	X4:6
P1	0	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	0	1	1	1	1	1	0	1	1
P2	0	1	1	1	1	1	1	0	1	1	0	1	1	0	1	0	0	1	1	1	1	1	0	0	1
P3	0	1	1	1	1	1	1	0	1	1	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0

P	X5								X6			X7			X8								X9			X10
V	X5:1	X5:2	X5:3	X5:4	X5:5	X5:6	X5:7	X5:8	X6:1	X6:2	X6:3	X7:1	X7:2	X7:3	X8:1	X8:2	X8:3	X8:4	X8:5	X8:6	X8:7	X8:8	X9:1	X9:2	X9:3	X10
P1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0	1	1	1	1	0
P2	1	0	1	0	0	0	0	0	1	1	1	0	0	0	1	0	1	1	1	0	0	1	1	1	1	1
P3	1	0	0	0	0	0	0	0	1	1	1	1	1	0	1	0	1	0	1	0	0	1	0	0	0	0

Variables:

(X1) Type of research
(X1:1) Predicting
(X1:2) Monitoring
(X1:3) Proposal
(X1:4) Descriptive
(X1:5) Diagnostic
(X1:6) Simulation
(X1:7) Experimental
(X2) Research orientation
(X2:1) Empirical
(X2:2) Theoretical
(X2:3) Technical
(X2:4) Historical
(X2:5) Quantitative
(X2:6) Qualitative
(X3) Data source
(X3:1) Primary data
(X3:2) secondary data
(X3:3) Mix data
(X3:4) Long term
(X3:5) Medium term
(X3:6) Short term
(X4) Applied Econometrics methods
(X4:1) Linear regression analysis
(X4:2) Multiple regression analysis
(X4:3) Times series data
(X4:4) Cross-sectional data
(X4:5) Panel data
(X4:6) Multidimensional panel data
(X5) Area of research
(X5:1) Economics
(X5:2) Social
(X5:3) Technological
(X5:4) Political
(X5:5) Environment
(X5:6) Institutional
(X5:7) Sciences
(X5:8) Multi-disciplinary
(X6) Research theoretical framework
(X6:1) original theoretical framework
(X6:2) Traditional theoretical framework
(X6:3) Extension of theoretical framework
(X7) Policy modeling by sectors
(X7:1) Private sector
(X7:2) Public sector
(X7:3) Public/private sector
(X8) Economics framework
(X8:1) Macroeconomics analysis
(X8:2) Microeconomics analysis
(X8:3) Partial equilibrium
(X8:4) General equilibrium
(X8:5) Dynamic modeling
(X8:6) Static modeling
(X8:7) Perfect competition
(X8:8) Imperfect competition
(X9) Geographical analysis
(X9:1) National level
(X9:2) Regional level
(X9:3) Global level
(X10) Paper citation

23.4.1(iii) Measurement of PMC-Index

The measurement of the PMC-Index involves four steps. (i) The first step is to put the 10 main-variables and 50 sub-variables into the multi-input-output table (see Table 3). (ii) The second step is to evaluate sub-variable by sub-variable according to the parameters mentioned above (see Expression 1 and 2). (iii) The third step is to calculate the value of each main-variable. This value is the sum of all sub-variables (of the particular main-variable) divided by the total number of sub-variables (see Expression 3). The last step is the actual measurement of the PMC-Index. The PMC-Index is equal to the sum of all main-variables (see Expression 4).

$$X \sim N\,[0,1] \qquad (1)$$
$$X = \{X\ R: [0\ v\ 1]\} \qquad (2)$$

$$Xt\left(\sum_{j=1}^{n} Xt_{j/T(Xtj)}\right) \quad t = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10,...,\infty \qquad (3)$$

i = main variable; j = sub-variable; t = total variables in analysis

$$PMC=\left(X_1\left(\sum_{i=1}^{7} X_1 i/7\right)+X_2\left(\sum_{J=1}^{6} X_2 j/6\right)+X_3\left(\sum_{k=1}^{6} X_3 k/6\right)+X_4\left(\sum_{l=1}^{6} X_4 l/6\right)+X_5\left(\sum_{m=1}^{8} X_5 m/8\right)+X_6\left(\sum_{n=1}^{3} X_6 n/3\right)+X_7\left(\sum_{o=1}^{3} X_7 o/3\right)+X_8\left(\sum_{p=1}^{8} X_8 p/8\right)+X_9\left(\sum_{r=1}^{3} X_9 r/3\right)+X_{10}\right) \qquad (4)$$

23.4.1(iii)(a)Evaluation of Consistency of Policy Modeling

The PMC-Index can be used to evaluate the level of consistency of any policy modeling. The PMC-Index is classified according to one of these four levels of research consistency: 'perfect consistency'; 'good consistency'; 'acceptable consistency'; 'low consistency'. If the PMC-Index is between 10 and 9 points, then the research is of 'perfect consistency'. If the PMC-Index is between 8.99 and 7 points, then there is 'good consistency' in the research. A PMC-Index that is between 6.99 and 5 points shows 'acceptable consistency' in the research. If the PMC-Index is between 4.99 and 0 points, then we are referring to a 'low consistency' research.

23.*4.1(iv). Construction of Policy Modeling Consistency Surface (PMC-Surface)*

The full implementation of the PMC-Index requires one fourth step, that is, the construction of the PMC-Surface. The purpose of constructing the PMC-Surface is to graphically represent all results in the PMC-Matrix. The PMC-Surface shows the strengths and weaknesses within any policy modeling on a multi-dimensional coordinate space. (see Figure 4).

The construction of the PMC-Surface is based on the PMC-Matrix results (see Expression 5). The PMC-Matrix is a three by three matrix that contains the individual results of all nine main-variables (taken from Table 5). The idea here is to use the results of strictly nine main-variables in the PMC-Matrix to build a symmetric surface. When the PMC-Matrix keeps the number of rows strictly the same as the number of columns, then the PMC-Surface can always show a perfect symmetric view.

$$\text{PMC-Surface} = \begin{pmatrix} X_1 & X_4 & X_7 \\ X_2 & X_5 & X_8 \\ X_3 & X_6 & X_9 \end{pmatrix} \qquad (5)$$

23.4.1(iv)(b). Evaluation of Strengths and Weaknesses of Main-Variables in Policy Modeling

The result of each main-variable in the PMC-Matrix is evaluated according to five levels of performance. If the result of the main-variable is between 1 and 0.90, then this main-variable is of 'excellent performance'. If the result is between 0.89 and 0.70, then the main variable is of 'good performance'. If the main-variable has a result between 0.69 and 0.50, then this main-variable is of 'acceptable performance'. If the main-variable shows a result between 0.49 and 0.30, then this main-variable has 'non-satisfactory performance'. If the main-variable has a result between 0.29 and 0, then its performance is 'poor performance'.

23.5. Application of PMC-Index and PMC-Surface: An Example

For demonstration purposes in this paper, the PMC-Index and PMC-Surface were applied to 3 different cases of policy modeling that were featured in three JPM papers respectively. The first is the paper entitled 'the Korea unification: how painful and costly' (Paper-1) authored by Ruiz Estrada and Park (2008). The second paper is 'the openness growth monitoring model' (Paper-2) authored by Ruiz Estrada and Yap (2006). The third paper is 'the trade liberalization monitoring model' (Paper-3) by Ruiz Estrada (2004).

Paper-1 and Paper-2 each has a PMC-Index of 7 points (good consistency). The PMC-Index of Paper-3 is 4 points (low consistency) (see Table 5). In the case of Paper-3, the 'low consistency' result originates from the following four weak main-variables: main-variable X_3 (0 = poor performance); main-variable X_5 (0.12 = poor performance); main-variable X_7 (0 = poor performance) and main-variable X_9 (0 = poor performance) (see Table 6).

The poor performance of the above four main-variables in Paper-3 can be seen on the PMC-Surface (see Figure 4). Here the PMC-Surface shows the weaknesses within a specific case of policy modeling through a multi-dimensional graphical representation.

Now that we have found the four weaknesses within the policy modeling featured in Paper-3, we can make a series of recommendations. The first recommendation is for Paper-3 to use secondary data in its specific model to improve the main-variable (X_1). As the second recommendation, Paper-3 should include non-economic variables in its model to improve the main-variable (X_5). Thirdly, Paper 3 should identify the sector that is relevant to improve the main-variable (X_7) in the model. Finally, the recommendation is for Paper-3 to improve the main-variable ($X_{9)}$ by applying its model to different regions and countries (see Table 6 and Figure 4).

Table 5: The PMC-Index Measure

	Paper-1	Paper-2	Paper-3
(X1) Type of research	0.86	0.43	0.43
(X2) Research orientation	0.83	0.67	0.67
(X3) Data source	0.50	0.50	0.00
(X4) Econometrics methods applied	0.83	0.67	0.33
(X5) Area of research	0.62	0.25	0.12
(X6) Research theoretical framework	1.00	1.00	1.00
(X7) Policy modeling by sectors	1.00	0.67	0.00
(X8) Economics framework	0.62	0.62	0.50
(X9) Geographical analysis	1.00	1.00	0.00
(X10) Paper citation	0.00	1.00	1.00
TOTAL (PMC-Index)	**7**	**7**	**4**

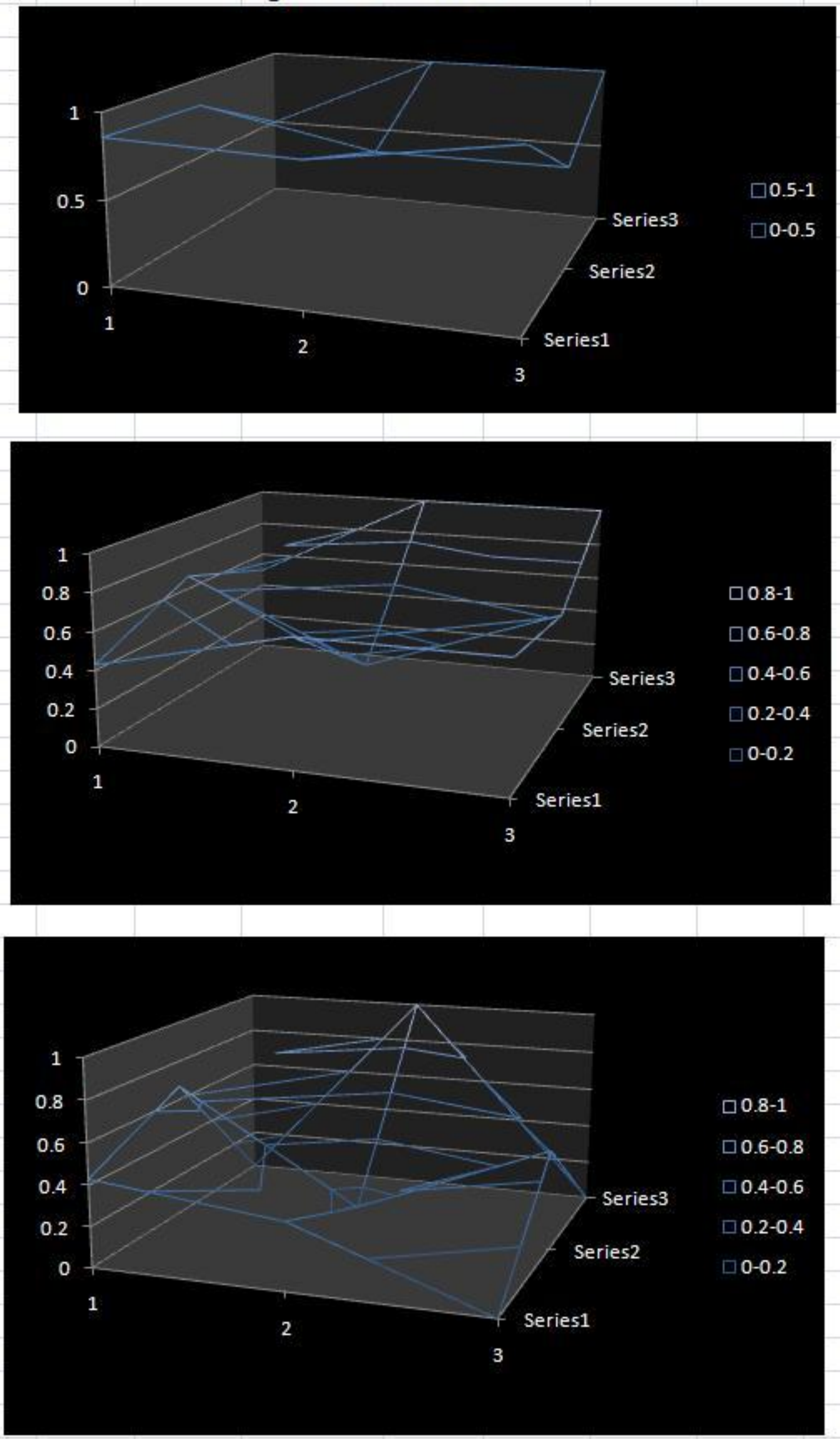
Results:	PMC-inde	Level
Paper-1:	7	Good constency
Paper-2:	7	Good constency
Paper-3:	4	Low consistency

Table 6: PMC-Surface Data

$$\text{Paper-1} = \begin{pmatrix} 0.86 & 0.83 & 1.00 \\ 0.83 & 0.62 & 0.62 \\ 0.50 & 1.00 & 1.00 \end{pmatrix} \quad \text{Paper-2} = \begin{pmatrix} 0.43 & 0.67 & 0.67 \\ 0.67 & 0.25 & 0.62 \\ 0.50 & 1.00 & 1.00 \end{pmatrix}$$

$$\text{Paper-3} = \begin{pmatrix} 0.43 & 0.33 & 0.00 \\ 0.67 & 0.12 & 0.50 \\ 0.00 & 1.00 & 0.00 \end{pmatrix}$$

Figure 4: PMC-Surface



23.6. Concluding Remarks

By introducing a definition of policy modeling, a way of classifying as well as a method of evaluating policy modeling, this paper is a point of departure for the development of a theoretical framework of policy modeling. In effect, the definition, classification and method of evaluation introduced in this paper can be part of a policy modeling theoretical framework. They are useful as terms of reference for policy modeling and generally, for any research pertaining to economic policies. As an instrument to evaluate the strengths and weaknesses within any policy modeling, the PMC-Index can serve to improve the quality of future research in policy modeling. Other recommendations in this paper - specifically 'multidisciplinary approach to policy modeling', 'use of multi-dimensional coordinate space in policy modeling' and 'Omnia Mobilis assumption in policy modeling' – are beneficial to expanding the horizon of research in policy modeling.

CHAPTER 24
THE MINIMUM FOOD SECURITY QUOTA (MFS-QUOTA) IN FOOD SECURITY POLICY MODELING

24.1. Introduction

This paper introduces the Minimum Food Security quota (MFS-Quota) for “food security policy”. The purpose is to find the annual percentage of food storage (from the agricultural sector) that can prepare a country for natural or social disasters. Any country can construct its own MFS-Quota under a “food security policy”. The “food security policy” is defined in this paper as an integral national strategy in monitoring the production, storage and distribution of agricultural goods that are commonly consumed among the population of a country.

It is suggested in this paper that the MFS-Quota can be an alternative index in the analysis of food security policy. A large number of variables need to be included in the process of constructing the MFS-Quota. All the variables have the same level of importance and are integrated into the same model and graphical space. From the mathematical perspective, the MFS-Quota is not a simple relationship between two variables (such as the endogenous variable and the exogenous variable) that are fixed into a specific period of time and space. Hence, the MFS-Quota requires a multi-dimensional variable analytical framework. In this framework no variable is isolated in the mathematical and graphical modeling.

A multi-dimensional mathematical economics modeling in real time is used in the construction of the MFS-Quota. This is in order to avoid isolation of any variables in the construction of the MFS-Quota. The multi-dimensional mathematical economics modeling in real time is an alternative mathematical and geometrical approach to observe the behavior of a large number of variables that move within the same graphical space. This type of modeling requires simultaneous application of a multi-dimensional graphical modeling conceptualized under “Econographicology” (Ruiz Estrada, 2007).

The multi-dimensional mathematical economics modeling in real time enables observation of all changes in different variables in the same graphical space. All these variables are changing constantly with time (years, months, weeks or days) in different parts within the same space. The application of the multi-dimensional mathematical economics modeling in real time opens up the possibility to formulate a food security policy for a country from a multi-dimensional perspective.

The construction of the MFS-Quota varies from one country to another country. It varies according to the diet of the population, population size, geographical location, probabilities of suffering any time from a natural or social disaster and finally, the statistical resources available in the country. In the construction of the MFS-Quota, the presumption is that it is impossible to predict or forecast any natural or social disaster with accuracy.

Usually, the food security policy modeling is studied by using a specific historical-period-of time framework in a frozen 2-Dimensions (X,Y) graph. This framework shows the single relationship between a single exogenous variable and a single endogenous variable. It leaves the rest of the variables isolated under the *"Ceteris Paribus Assumption*". Unexpected scenarios cannot be accounted for in this analysis at the same time.

The *Ceteris Paribus* assumption, translated from Latin, means "all other things [being] the same". In fact, the *Ceteris Paribus* assumption can facilitate the understanding of how a single dependent variable responds to any change from a single independent variable; at the same time, we can keep constant the rest of the independent variables momentarily. Alfred Marshall supports the understanding of the application of *Ceteris Paribus* assumption in economic models by asserting the following (Marshall, 1890: v.v.10):

> **"**The element of time is a chief cause of those difficulties in economic investigations which make it necessary for man with his limited powers to go step by step; breaking up a complex question, studying one bit at a time, and at last combining his partial solutions into a more or less complete solution of the whole riddle. In breaking it up, he segregates those disturbing causes, whose wanderings happen to be inconvenient, for the time in a pound called *Ceteris Paribus.* The study of some group of tendencies is isolated by the assumption *other things being equal:* the existence of other tendencies is not denied, but their disturbing effect is neglected for a time. The more the issue is thus narrowed, the more exactly can it be handled: but also the less closely does it correspond to real life. Each exact and firm handling of a narrow issue, however, helps towards treating broader issues, in which that narrow issue is contained, more exactly than would otherwise have been possible."

Marshall's approach allows the analyses of complex economic phenomena by parts, where each part of the economic model can be joined to generate an approximation of the real world. Such analyses are possible through the application of the isolation approach. The isolation approach features the substantive isolation and hypothetical isolation. First, the substantive isolation allows some variables to be considered unimportant. The substantive isolation considers that some unimportant variables cannot significantly affect the final result of the economic model. Second, the hypothetical isolation allows the influence of some important factors to be disregarded. The application of the *Ceteris Paribus* assumption in this case is purely hypothetical. It allows parts of the model to be managed more easily.

24.2. Introduction to the Mathematical Economic Modeling in Real Time

Multi-dimensional mathematical economics modeling in real time requires the application of the *Omnia Mobilis Assumption* (Ruiz Estrada, Yap and Nagaraj, 2008a) which, translated from Latin, means "everything is moving". The *Omnia Mobilis assumption* enables the location of different variables simultaneously in the same multi-dimensional physical space, showing different dimensions and movements in real time.

The multi-dimensional mathematical economics modeling in real time also assumes that the market is formed by many sub-markets. These sub-markets are: goods sub-market, money sub-market, financial and real-estate sub-market, international trade sub-market, social welfare sub-market, labor sub-market, government sub-market and technological sub-market. All these sub-markets are always in a "*Constant Dynamic Imbalanced State*" (Ruiz Estrada, 2008b). The concept of equilibrium in the multi-dimensional mathematical economics modeling in real time is considered as a leak momentum of balance among all sub-markets. It can appear any time, but when exactly this synchronized balance takes place cannot be predicted.

From a graphical perspective, the multi-dimensional mathematical economics modeling in real time assumes that a single dependent variable and a single independent variable are non-existence. We only can observe the display of a large, single surface (See Figure 1). This single surface that is formed by a large number of independent variables are joined together in the multi-dimensional physical space. This single and large surface alerts us in case of any positive or negative changes among all variables in the same graphical space.

24.3. Method to Construct the Minimum Food Security Quota (MFS-Quota)

The construction of the Minimum Food Security Quota (MFS-Quota) requires multi-dimensional mathematical economics modeling in real time that is conceptualized under "Econographicology" (Ruiz Estrada, 2007). The multi-dimensional mathematical economics modeling in real time is possible with the use of a large general matrix. The following are the steps to construct the MFS-Quota:

- ✓ First Step: input data (v) collected daily on the agriculture production by regions using a standard format.
- ✓ Second Step: transfer the data (v) to different databases (DB) that are connected to a unique information data center.
- ✓ Third Step: plot all data immediately onto different co-ordinates in the multi-dimensional physical space. One database is created for each of the sources. Some examples of the sources are: the central bank, ministry of agriculture, farms, national statistics departments, and public and private research institutes.

The plotting on each co-ordinate is constantly changing. It is based on the use of multi-dimensional graphical modeling in real time (See Expression 3). Basically, the data is changing in real time. The plotting compares the data between two periods of time: the past period of time (t-1) and the present period of time (t).

24.4. Model

The construction of the Minimum Food Security Quota (MFS-Quota) starts with the construction of a matrix i x j represented by Expression (1).

$$(1.)\quad \Delta I_{ij:v} = \begin{pmatrix} X_{11:v} & X_{12:v} \ldots X_{1\infty:v} \\ X_{21:v} & X_{22:v} \ldots X_{2\infty:v} \\ \vdots & \vdots \\ X_{\infty:v} & X_{\infty 2:v} \ldots X_{\infty\infty:v} \end{pmatrix}$$

v = Input data **X** = Variable(s) **j** = Column **i** = Row

It is suggested that 16 variables represented by a matrix 4x4 are used. These variables are the large and medium farms productivity (in tons) growth rate by regions ($X_{11:v1}$), imports of capital goods/agriculture growth rate ($X_{12:v2}$), exports/agriculture goods growth rate ($X_{13:v3}$), probability of civil or world war growth rate ($X_{14:v4}$), probability of natural disasters by water, air and underground growth rate ($X_{21:v5}$), R&D in the agro-industry growth rate ($X_{22:v6}$), FDI/agro-industry growth rate ($X_{23:V7}$), income distribution by rural and urban area growth rate ($X_{24:v9}$), labor demand and supply in the agriculture sector growth rate ($X_{31:V10}$), raining seasons growth rate ($X_{32:v11}$), land demand and supply growth rate ($X_{33:V12}$), agriculture border (Km^2) growth rate ($X_{34:V13}$), inflation growth rate ($X_{41:v14}$), banking interest rate for the agriculture sector growth rate ($X_{42:v15}$) and subsidies to the agriculture sector growth rate ($X_{43:v16}$). Each variable is based on the uses of a growth rate.

The next step is the storing of information in the database (DB) represented by a matrix. (See Expression 2) The matrix consists of information saved in real time (☼) and the application of the interlink database condition (╬)

$$(2.)\quad DB_{ij:v} = \begin{pmatrix} \text{☼}X_{11:v} \;\text{╬}\; \text{☼}X_{12:v} \ldots \;\text{╬}\; \text{☼}X_{1\infty:v} \\ \text{☼}X_{21:v} \;\text{╬}\; \text{☼}X_{22:v} \ldots \;\text{╬}\; \text{☼}X_{2\infty:v} \\ . \qquad . \qquad . \\ \text{☼}X_{\infty:v} \;\text{╬}\; \text{☼}X_{\infty 2:v} \ldots \;\text{╬}\; \text{☼}X_{\infty\infty:v} \end{pmatrix}$$

In the case of the data changes in real time (☼Δ), we are comparing the data we obtained a day before (**t-1** = past period of time) and the information of today (**t** = actual period of time) (See Expression 3).

$$(3.)\quad \text{☼}\Delta X_{ij:v} = \text{☼}X_{ij:v}(t) - \text{☼}X_{ij:v}(t-1)/\ \text{☼}X_{ij:v}(t-1)$$

The calculation of the final determinant is based on the Expression (4) below:

$$(4.)\quad \Delta I_{ij:v} = \begin{pmatrix} \text{☼}\Delta X_{11:v} & \text{☼}\Delta X_{12:v} \ldots & \text{☼}\Delta X_{1\infty:v} \\ \text{☼}\Delta X_{21:v} & \text{☼}\Delta X_{22:v} \ldots & \text{☼}\Delta X_{2\infty:v} \\ . & . & . \\ \Delta X_{\infty:v} & \text{☼}\Delta X_{\infty 2:v} \ldots & \text{☼}\Delta X_{\infty\infty:v} \end{pmatrix}$$

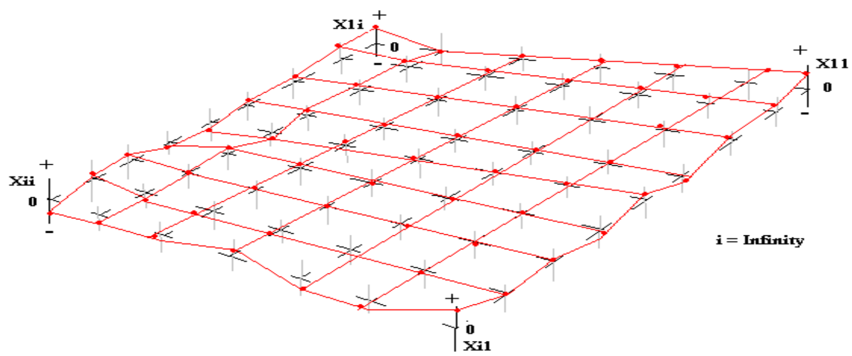
The next step is to measure the MFS-Quota by year. Firstly, we need to find the Minimum Food Security Quota rate (MFS-Quota%).To get the MFS-Quota%, multiply the final determinant of the matrix ($\Delta I_{i:j:v}$) by the total of population growth rate (ΔPop%), then divide the outcome by time (T) such as months or days (See Expression 5).

The final step is to measure the Minimum Food Security Quota (MFS-Quota) volume: multiply the total annual agriculture production ($GDP_{annual\text{-}agriculture\text{-}Sector}$) by the MFS-Quota% (See Expression 6).

$$(5.)\ \ MFS\text{-}Quota\% = (\Delta I_{ij:v})\ x\ (\Delta Pop\%)/T$$

$$(6.)\ \ MFS_{Volume} = GDP_{Agriculture\text{-}Sector}\ x\ MFS\text{-}Quota\%$$

Figure 1
MFS-Quota Surface



Source: Econographicology

24.5. Conclusion

The construction of the MFS-Quota requires multi-dimensional mathematical economics modeling in real time, together with the application of multi-dimensional graphical modeling conceptualized under "Econographicology". Therefore, the MFS-Quota can be constructed for any country and region around the world to prepare for any natural or social disaster.

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APPENDIX

APPENDIX 1: MULTIDIMENSIONAL PARTIAL DIFFERENTIATION RULES

(1) $dy_{ij}/dx_{ij} = 0$ or $f^{'}(x_{ij}) = 0$

(2) $d/dx_{ij} = nx^{n-1}{}_{ij}$ or $f^{'}(x_{ij}) = nx^{n-1}{}_{ij}$

(3) $d/dcx_{ij} = cnx^{n-1}{}_{ij}$ or $f^{'}(x_{ij}) = cnx^{n-1}{}_{ij}$

(4) $d/dx_{ij}\ [\alpha_{ij}(x_{ij}) \pm \theta_{ij}(x_{ij}) \pm\ldots\pm.\lambda_{ij}(x_{ij})] = d/dx_{ij}\ \alpha(x_{ij}) \pm d/d_{ij}\ \theta_{ij}(x_{ij}) \pm\ldots\pm.\lambda_{ij}(x_{ij})$
or $\alpha^{'}(x_{ij}) \pm \theta'(x_{ij}) \pm\ldots\pm.\lambda'(x_{ij})$

(5) $d/dx_{ij}\ [\alpha_{ij}(x_{ij})\ \theta_{ij}(x_{ij})\ \ldots\ \lambda_{ij}(x_{ij})] = \alpha(x_{ij})\ d/dx_{ij} + \theta_{ij}(x_{ij}) +\ldots+ .\lambda_{ij}(x_{ij})$
$\alpha(x_{ij}) + \theta_{ij}(x_{ij})\ d/dx_{ij} +\ldots+ .\lambda_{ij}(x_{ij})$
$\alpha(x_{ij}) + \theta_{ij}(x_{ij}) +\ldots+ .\lambda_{ij}(x_{ij})\ d/dx_{ij}\ldots$

(6) $d/dx_{ij}[\alpha_{ij}(x_{ij})/\theta_{ij}(x_{ij})\ldots\lambda_{ij}(x_{ij})]=\alpha(x_{ij})\ d/dx_{ij}+\theta_{ij}(x_{ij})+\ldots+\lambda_{ij}(x_{ij})/\ [\theta_{ij}(x_{ij}) +\ldots+ \lambda_{ij}(x_{ij})]^2$
$d/dx_{ij}\ [\theta_{ij}(x_{ij})/\alpha_{ij}(x_{ij})\ldots\lambda_{ij}(x_{ij})]=\alpha(x_{ij})+\theta_{ij}(x_{ij})d/dx_{ij}+\ldots+\lambda_{ij}(x_{ij})/[\alpha_{ij}(x_{ij})+\ldots+ \lambda_{ij}(x_{ij})]^2$
$d/dx_{ij}\ [\lambda_{ij}(x_{ij})/\alpha_{ij}(x_{ij})\ldots\ \theta_{ij}(x_{ij})]=\alpha(x_{ij})+\theta_{ij}(x_{ij})+\ldots+\lambda_{ij}(x_{ij})d/dx_{ij}/[\alpha_{ij}(x_{ij})+\ldots+ \theta_{ij}(x_{ij})]^2$

(7) $d/dx_{0j}\ [\alpha_{0j}^{'}(x_{0j}) \text{╦} \theta_{0j}^{'}(x_{0j}) \text{╦} \ldots \text{╦} \lambda_{0j}^{'}(x_{0j})]\ldots$
$d/dx_{1j}\ [\alpha_{1j}^{'}(x_{1j}) \text{╦} \theta_{1j}^{'}(x_{1j}) \text{╦} \ldots \text{╦} \lambda_{1j}^{'}(x_{1j})]\ldots$
$d/dx_{\infty j}\ [\alpha_{\infty j}^{'}(x_{\infty j}) \text{╦} \theta_{\infty j}^{'}(x_{\infty j}) \text{╦} \ldots \text{╦} \lambda_{\infty j}^{'}(x_{\infty j})]\ldots$

(8) $d/dx_{0j}\ [\alpha_{0j}^{'}(x_{0j}) \text{╦} \theta_{0j}^{'}(x_{0j}) \text{╦} \ldots \text{╦} \lambda_{0j}^{'}(x_{0j})] \text{╬}$
$d/dx_{1j}\ [\alpha_{1j}^{'}(x_{1j}) \text{╦} \theta_{1j}^{'}(x_{1j}) \text{╦} \ldots \text{╦} \lambda_{1j}^{'}(x_{1j})] \text{╬}$
$d/dx_{\infty j}\ [\alpha_{\infty j}^{'}(x_{\infty j}) \text{╦} \theta_{\infty j}^{'}(x_{\infty j}) \text{╦} \ldots \text{╦} \lambda_{\infty j}^{'}(x_{\infty j})] \text{╬}$

APPENDIX 2: ECONOMIC MODELING IN REAL TIME

Initially, economic modeling in real time is based on both the application of Econographicology and the construction of powerful and sophisticated software and an efficient network system. Hence, Econographicology can supply different multi-dimensional coordinate spaces to fix different multi-dimensional graphs. The construction of powerful and sophisticated software and an efficient network system follows a series of steps. Firstly, there must be a standard format to input information daily online. Secondly, all this information (I) is transferred to different databases (DB). At the same time, these databases (DB) are interconnected to a unique information data center. Thirdly, the same software can proceed immediately to plot different sets of information (I) from different databases (DB) into each axis in the multi-dimensional physical space, where each information database (DB) depends on different statistical sources such as the central bank, central government agencies, private companies, national statistics departments and public and private research institutes (see Diagram 1). Each point plotted on the multi-dimensional coordinate space is always changing position in real time. We are using the concept of data changes in real time (see Expression 3). Basically, data changes in real time compare the information (I) between two periods of time (the past period of time and the present period of time), while the data changes in real time are simultaneously fixed into the multi-dimensional coordinate space that is itself changing position all the time. Additionally, all data changes in real time plotted in the multi-dimensional coordinate spaces are linked together by straight lines until they form a single surface in the same physical space (see Figure 2). Initially, economic modeling in real time starts with this input data function:

$$(2.)\quad I_{C:R} = Q_1 : Q_2 : \ldots : Q_\infty$$

I = Input answer **Q** = Question(s) **C** = Column **R** = Row

The next step is storage in the database (DB) equation, represented by

$$(3.)\quad DB_{C:R} = ☼SI_{C:R} ╬ \ldots ╬ ☼SI_{C:R}\ldots$$

$$C = \{1, 2, 3\ldots n\}\ n = \infty$$
$$R = \{1, 2, 3\ldots n\}\ n = \infty$$

DB = Database **C** = Column **R** = Row ☼ = Running information in real time **SI** = Save Information
╬ = Interlink Database

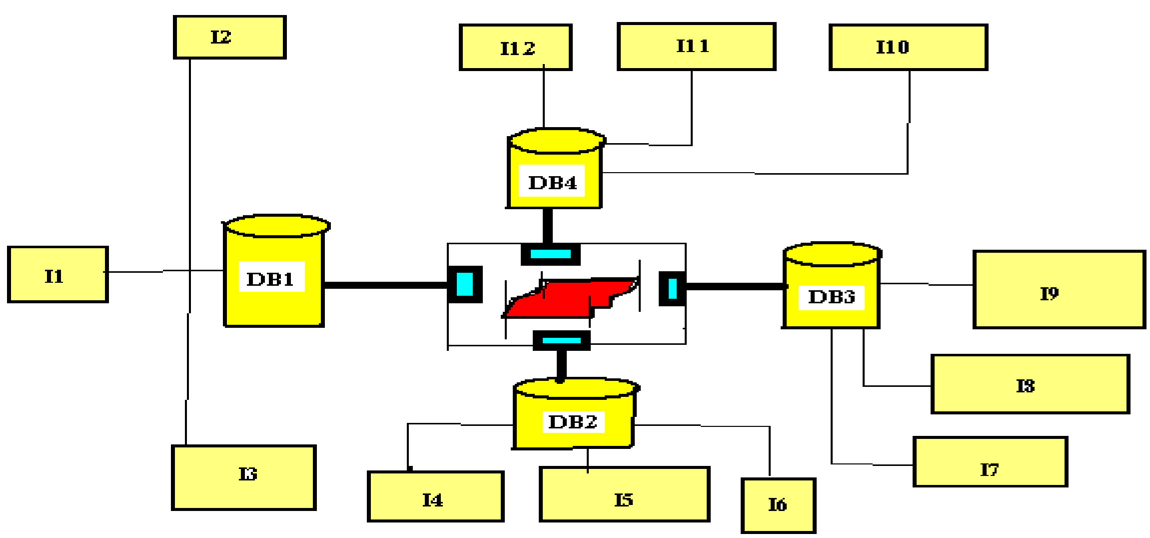
In the case of data changes in real time ($☼\Delta \mathbf{I}_{\mathbf{C:R}}$), we compare the information we received a day before (**t-1** = past period of time) and the information received today (**t** = actual period of time) (see Expression 3).

$$(4.)\quad ☼\Delta I_{C:R} = ☼SI(t) – ☼SI(t\text{-}1)/ ☼SI(t\text{-}1)$$

Finally, the plotting of real time data is as follows:

$$(5.)\quad Y_{sf} = f\ (☼\Delta I_{11} ╬ \ldots ╬ ☼\Delta I_{\infty\infty})$$

Diagram 1
Economic Modeling in Real Time



APPENDIX 3: THE INTERCONNECTIVITY OF MULTI-DIMENSIONAL PHYSICAL SPACES

Initially, the interconnectivity of multi-dimensional physical spaces is started by building a large number of n-dimensional coordinate spaces (vertical position) around the general vertical axis (see Figure 1). Each n-dimensional coordinate space (vertical position) can plot an infinite number of sub-exogenous variables into an infinite number of axes ($Y_{L:n}$) and a single sub-endogenous variable into its single axis ($X_{L:i:n}$).

After all these variables have been plotted into its respective axes, all sub-endogenous variables ($S_{L:i:n}$) located in the center part of each n-dimensional coordinate space (vertical position) are joined to the general vertical axis through the application of straight lines until a single surface is built.

Hence, this single surface is pending among all n-dimensional coordinate spaces and the general vertical axis. This is possible under the application of the partial interconnectivity condition (╦) (see Expression 1) and the general interconnectivity condition (╬) (see Expression 2).

$$S_0 = Y_{0:i} = f\,(X_{0:0:i} \text{ ╦ } X_{0:1:i} \text{ ╦ } \ldots \text{ ╦ } X_{0:\infty:i})$$

$$S_1 = Y_{1:i} = f\,(X_{0:0:i} \text{ ╦ } X_{0:1:i} \text{ ╦ } \ldots \text{ ╦ } X_{0:\infty:i})$$

$$\bullet\bullet\bullet\bullet\bullet\bullet\bullet\bullet\bullet\bullet$$

$$S_\infty = Y_{\infty:i} = f\,(X_{0:0:i} \text{ ╦ } X_{0:1:i} \text{ ╦ } \ldots \text{ ╦ } X_{0:\infty:i})$$

(1.) $$I = S_{0\,(YL:n)} \text{ ╬ } S_{1\,(YL:n)} \text{ ╬ } \ldots \text{ ╬ } S_{\infty\,(YL:n)} \ldots$$

From a graphical perspective, we can finally observe a large surface that is pending among all n-dimensional coordinate spaces and the general vertical axis. We assume that each n-dimensional coordinate space is moving at different speeds of time, and that the general vertical axis does so as well.

Figure 1

The Interconnectivity of Multi-Dimensional Physical Spaces