NEW POLICY MODELING APPROACHES TO ACADEMICS AND POLICY MAKERS

by

Mario Arturo Ruiz Estrada
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**ACKNOWLEDGEMENTS**

*To: My Lord God (YHWH)*
# CONTENTS

Acknowledgments 2

Chapter 1 • What is Policy Modeling? 4

Chapter 2 • The Trade Liberalization Monitoring Model (TLM-Model) Theoretical Framework 16

Chapter 3 • The Multi-Level Investment Flows Monitoring Model (MIF-Model) 28

Chapter 4 • The Openness Monitoring Methodology (OM-Methodology) 32

Chapter 5 • The External Sector Development Index (SX_i) 40

Chapter 6 • The Gross Domestic Product Surface (GDP-Surface) 53

Chapter 7 • Unknown Dimensions in the Study of Market Behavior 61

Chapter 8 • Is the Market in a State OF Dynamic Imbalance? 66

Chapter 9 • Economic Waves: The Effect of the U.S. Economy on World Economy 75

Chapter 10 • The Visualization of Complex Economic Phenomena from A Multi-Dimensional Graphical Perspective: A Case Study of the U.S. Economy (1929-2008) 79

Chapter 11 • Why has the Market become More Vulnerable in the 21st Century? 84

Chapter 12 • The Minimum Food Security Quota (MFS-Quota) In Food Security Policy Modeling 90

References 98
(CHAPTER 1)
WHAT IS POLICY MODELING?

Abstract

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 chapter 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.

1. Introduction

This chapter 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 (Elsevier, 2010), 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 chapter 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.

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).
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Total 1501

Source: Journal of Policy Modeling (JPM) – Executive Group
1. Low
TGP: Total of Papers
Figure 1: Papers Published in JPM from 1979 until 2009

Table 2: JPM Papers Distribution by 12 Categories (1979-2009)

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<td>3. Environmental and Natural Resources Management Policy Modeling</td>
<td>70</td>
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<td>4. Fiscal and Government Spending Policy Modeling</td>
<td>80</td>
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<td>5. Institutional, Regulation and Negotiation Policy Modeling</td>
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<td>6. Labor, Employment and Population Policy Modeling</td>
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<td>7. Monetary, Banking and Investment Policy Modeling</td>
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<td>8. Production and Consumption Policy Modeling</td>
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<td>11. Economic Growth and Development Policy Modeling</td>
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Note: Miscellaneous: General and Partial Equilibrium Analysis, Macroeconomic Analysis and New Topics in Economics.
3. Proposed Approach to Policy Modeling

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 chapter 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 chapter 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.
3.2 ‘Omnia Mobilis’ Assumption

The Ceteris Paribus assumption was commonly applied to policy modeling in earlier publications in JPM. This chapter 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 chapter 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.

3.3. The Policy Modeling Consistency Index (PMC-Index)

With the Omnia Mobilis assumption, this chapter 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: (X1) types of research; (X2) research orientation; (X3) data sources; (X4) econometrics methods applied; (X5) areas of research; (X6) research theoretical framework; (X7) policy modeling by sectors; (X8) economics frameworks; (X9) geographical analysis; (X10) 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.

3.4.1 Steps to Implement PMC-Index

3.4.1(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.
3.4.1. (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

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### Table 4. Application of Binary System in the Multi-Input-Output Table

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</tbody>
</table>

### 3.4.1(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).

\[
X \sim N [0,1] \tag{1}
\]

\[
X = \{ X R: [0 \vee 1] \} \tag{2}
\]

\[
X_t(\sum X_{tj}/T(X_{th})) \quad t = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, ..., \infty \tag{3}
\]

\[
i = \text{main variable}; \quad j = \text{sub-variable}; \quad t = \text{total variables in analysis}
\]
3.4.1(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.

\[
\text{PMC-Surface} = \begin{pmatrix} X_1 & X_4 & X_7 \\ X_2 & X_5 & X_8 \\ X_3 & X_6 & X_9 \end{pmatrix}
\] (5)

3.4.1(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’.

3.5. Application of PMC-Index and PMC-Surface: An Example

For demonstration purposes in this chapter, 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

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<td>(X10) Paper citation</td>
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<td><strong>4</strong></td>
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</table>

Results: PMC-index Level

Paper-1:  7 Good consistency
Paper-2:  7 Good consistency
Paper-3:  4 Low consistency

Table 6: PMC-Surface Data

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4. Concluding Remarks
By introducing a definition of policy modeling, a way of classifying as well as a method of evaluating policy modeling, this chapter 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 chapter 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 chapter - 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 2)

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

Abstract
The second 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.

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.

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, 1993). It is important to remember that the customs union (CU) (Viner, 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\(^1\) approach and the regionalism\(^2\) 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)\(^3\).

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 (\(A_{ij}\)) and the frequency indexes (\(F_j\)) 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

---

1 “Multilateralism is considered a basic principle of globalization (Bhagwati, 1993). 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 \textit{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 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).

2 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.

3 ISI applies higher tariffs to protect some specific areas of production based on the infant industry principle.
competitive equilibrium framework to arrive at a general conclusion about a process that is a general equilibrium phenomenon.

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

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.

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 (Xi) 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 (Xi)\(^4\), the heavy industry trade liberalization index (Xh)\(^5\), the light industry trade liberalization index (Xl)\(^6\) and the services trade liberalization index (Xs)\(^7\). 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

---

\(^{4}\) The measurement of the agriculture trade liberalization index (Xi) originates from the calculus obtained from the agriculture multi-input tariff database table (see Table 1). After we have obtained the result of Xi, we can proceed to classify the results into three different parameters. These parameters are lower trade liberalization or level 1 (0 ≤ Xi ≤ 0.33), stagnant trade liberalization or level 2 (0.34 ≤ Xi ≤ 0.66) and higher trade liberalization or level 3 (0.67 ≤ Xi ≤ 1).

\(^{5}\) The measurement of the heavy industry trade liberalization index (Xh) originates from the calculus applied in the heavy industry multi-input tariff database Table (see Table 1). After we have obtained the result of Xh, we can proceed to classify the results into three different parameters. These parameters are lower trade liberalization or level 1 (0 ≤ Xh ≤ 0.33), stagnant trade liberalization or level 2 (0.34 ≤ Xh ≤ 0.66) and higher trade liberalization or level 3 (0.67 ≤ Xh ≤ 1).

\(^{6}\) The measurement of the light industry trade liberalization index (Xl) originates from the calculus applied in the light industry multi-input tariff database Table (see Table 1). After we have obtained the result of Xl, we can proceed to classify the results into three different parameters. These parameters are lower trade liberalization or level 1 (0 ≤ Xl ≤ 0.33), stagnant trade liberalization or level 2 (0.34 ≤ Xl ≤ 0.66) and higher trade liberalization or level 3 (0.67 ≤ Xl ≤ 1).

\(^{7}\) The measurement of the services trade liberalization index (Xs) originates from the calculus applied in the services multi-input tariff database Table (see Table 1). After we have obtained the result of Xs, we can proceed to classify the results into three different parameters. These parameters are lower trade liberalization or level 1 (0 ≤ Xs ≤ 0.33), stagnant trade liberalization or level 2 (0.34 ≤ Xs ≤ 0.66) and higher trade liberalization or level 3 (0.67 ≤ Xs ≤ 1).
rate based on limits (e.g. we have tariff rate acceptable (TRA)\(^8\) 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.)

---

\(^8\) 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.
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

---

**TABLE 1**

**MULTI-INPUT TARIFF DATABASE TABLE**

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TOTAL | ΣATS | ΣTPR |
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 TL-E-Methodology to the case of trade liberalization trends and stages between developing and developed country.

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:

\[
\sum_{i=1}^{4} X_i = \frac{\sum_{i} AS_i \times 100}{\sum_{i} TPR_i}
\]

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).
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 (Xi) 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 Xi indexes in the short and long term. The liberalization index by production sector (Xi) 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.

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 (Xi) of a country. Therefore, the TLT index is a means of analyzing the evolution of any trade liberalization process from a global perspective.

2.4.1. Steps to Obtain the TLT Index

The first step is to plot each (Xi) index: the agriculture trade liberalization index (X1), the heavy industry trade liberalization index (X2), the light industry trade liberalization index (X3) and the services trade liberalization index (X4) 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.)

![TLT Index Measurement and Areas of Rotation](image)

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 H$_1$, followed by the application of (2.1.) The same steps and expression are used for 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 \( \text{base} (=B_i) \times \text{height} (=H_i)/2 \). Therefore, the triangle areas have to be summed up in order to derive the total surface area (see expression 2.5.)

\[
\sum_{i=1}^{4} \left( \sum_{i=1}^{4} \frac{\text{Base} (=X_i) \times \text{Height} (=H_i)}{2} \right) \]

\[
2.1.) \quad [B_1 = H_4]: \quad \text{RD}_1 = \frac{X_1(=B_1) \times X_2(=H_1)}{2}
\]
\[
2.2.) \quad [B_2 = H_1]: \quad \text{RD}_2 = \frac{X_2(=B_2) \times X_3(=H_2)}{2}
\]
\[
2.3.) \quad [B_3 = H_2]: \quad \text{RD}_3 = \frac{X_3(=B_3) \times X_4(=H_3)}{2}
\]
\[
2.4.) \quad [B_4 = H_3]: \quad \text{RD}_4 = \frac{X_4(=B_4) \times X_1(=H_4)}{2}
\]
\[
2.7.) \quad \text{RD} = \text{RD}_1 + \text{RD}_2 + \text{RD}_3 + \text{RD}_4
\]

B= Base \quad 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.

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 this case, the study compares two periods (i.e. first period and second period) to compare the total TLT index. 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.

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.)

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 ≤ TLS ≤ 0.33)
(b) The trade liberalization at a developing stage or level 2 (0.34 ≤ TLS ≤ 0.66)
(c) The trade liberalization at a developed stage or level 3 (0.67 ≤ TLS ≤ 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:

\[ Y = TLS = aX_1 + bX_2 + cX_3 + dX_4 \leq 1 \]

3.1. \( a = 0.25, b = 0.25, c = 0.25, d = 0.25 = 1 \Rightarrow \) FTP homogeneous

3.2. \( a = 0.40, b = 0.20, c = 0.20, d = 0.20 = 1 \Rightarrow \) FTP agriculture

3.3. \( a = 0.20, b = 0.40, c = 0.20, d = 0.20 = 1 \Rightarrow \) FTP Heavy Industry

3.4. \( a = 0.20, b = 0.20, c = 0.40, d = 0.20 = 1 \Rightarrow \) FTP Light Industry

3.5. \( a = 0.20, b = 0.20, c = 0.20, d = 0.40 = 1 \Rightarrow \) FTP services

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.
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):

\[
(4) \quad Y = F (X_1, X_2, X_3, X_4) \leq 1
\]

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 3)

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

Abstract

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.

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).

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).

\[ \text{DDI} = \sum_{i=1}^{\infty} \text{ISDI}_i \]

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).

\[
(2.) \quad \text{DDI} = f(\text{ISDI}_1, \text{ISDI}_2, \ldots, \text{ISDI}_\infty)
\]

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.

\[
(3.) \quad \text{IDI} = \sum_{j=1}^{\infty} \text{IDI}_j
\]

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).

\[
(4.) \quad \text{IDI}_{\text{member-i}} = f(\text{IDI}_{\text{member-1}}, \text{IDI}_{\text{member-2}}, \ldots, \text{IDI}_{\text{member-n}})
\]

i 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).

\[
(5.) \quad \text{TIF} = f(\text{ISDI}, \text{DDI}, \text{IDD}, \text{FDI})
\]

\[
(6.) \quad \text{TIF} = \sum_{i=1}^{\infty} \text{DDI}_i + \sum_{j=1}^{\infty} \text{IDI}_j + \sum_{k=1}^{\infty} \text{FDI}_k
\]
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 (Ik) - is also used concurrently (Ruiz Estrada, 2004). The Ik 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 Ik (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 Ik is twofold. The first application is the Ik Homogeneous Interest. In this application, each Ik has the same level of importance in the analysis [Refer to expression (7.1.).]. The second application is the Ik 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 Ik 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 ≤ IRP ≤ 0.33), (b) acceptable performance investment reception stage (0.34 ≤ IRP ≤ 0.66) and (c) good performance reception stage (0.67 ≤ IRP ≤ 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 Ik in the measurement of the IRP:

\[
TIF = \sum_{i=1}^{\infty} DDI_i \alpha + \sum_{j=1}^{\infty} IDI_j \beta + \sum_{k=1}^{\infty} FDI_k \lambda \leq 1
\]

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

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.
(CHAPTER 4)

THE OPENNESS MONITORING METHODOLOGY
(OM-METHODOLOGY)

Abstract

The fourth 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-Methdoology, in effect, is a simple and flexible scheme. The general objective of the openness monitoring methodology (OM-Methdoology) is to analyze the impact of average openness growth on the average income growth in a specific period of time (the short run). The period under study in this research is from 1995 to 2001.

The fourth 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-Methdoology)”.

The OM-Methdoology 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 (O); (iii) harmonization of openness (HO); (iv) average openness growth rate (ΔO); (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-Methdoology in different countries and regions.

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, 1998); Sachs and Warner openness index (1995); Leamer’s openness index (Barro,1991); trade liberalization index (Lopez,1990); average coverage of NTB -QR- (Edwards, 1998); 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-Methdoology)” The OM-Methdoology (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-Methdoology 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.

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 (ΔO) 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 (Oi)
(ii) Average openness rate (Ô)
(iii) Average openness growth rate (ΔÔ)
(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 (Oi)

The degree of openness by production sector (Oi) 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 (Oi) (see Diagram 10). The Oi 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).

\[ \sum_{i=1}^{4} O_i = \frac{(X_{i\text{-FOB}} \text{ constant prices by production sector} + M_{i\text{-CIF}} \text{ constant prices by production sector})}{\text{real GDP}} \]

Degree of openness in the agriculture sector (O_a)

\[ O_a = \frac{(X_{a\text{-real}} + M_{a\text{-real}})}{\text{GDP}_{\text{real}}} \]

Degree of openness in the manufacturing sector (O_m)

\[ O_m = \frac{(X_{m\text{-real}} + M_{m\text{-real}})}{\text{GDP}_{\text{real}}} \]

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

\[ O_e = \frac{(X_{e\text{-real}} + M_{e\text{-real}})}{\text{GDP}_{\text{real}}} \]

Degree of openness in the services sector (O_s)

\[ O_s = \frac{(X_{s\text{-real}} + M_{s\text{-real}})}{\text{GDP}_{\text{real}}} \]

**Analysis of O_i Rate Results**

The results of the \( \Delta O_i \) reflect two possible scenarios:

(i) If the \( \Delta O_i \) is positive (+) or high, then the country has an open economy

(ii) If the \( \Delta O_i \) is negative (-) or low, then the country has a closed economy

**Step 2: Measurement of Average Openness Rate (\( \bar{O} \))**

The \( \bar{O} \) is equal to the sum of the degree of openness (\( \sum O_i \)) of all the production sectors divided by four (i.e. number of production sectors under analysis) (see Expression 3).

\[ \bar{O} = \frac{\sum (O_a + O_m + O_e + O_s)}{4} \]

**Step 3: Measurement of Openness Growth Rate (\( \Delta \bar{O} \))**

The \( \Delta \bar{O} \) 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).

\[ \Delta \bar{O} = \frac{(\bar{O}') - (\bar{O}_o)}{(\bar{O}_o)} \]

**Analysis of \( \Delta \bar{O} \) Results**

(i) If the \( \Delta \bar{O} \) Rate is high, then the country experiences a strong openness growth

(ii) If the \( \Delta \bar{O} \) 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 ($\bar{O}$) (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).

\[ (4.) \quad HO_i = (O_{i,\text{Max}}) - (O_{i,\text{Min}}) / (\bar{O}) \]

\[ i = 1, 2, 3, 4 \]

**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 ($\Delta Y$)**

The $\Delta Y$ is equal to the *per capita* GNI in a given period ($\Delta Y_1$) minus the *per capita* GNI of the previous period ($\Delta Y_0$) divided by the *per capita* GNI of the previous period ($\Delta Y_0$) (See Expression 5). The *per capita* GNI ($Y$) income level is based on the World Bank data classification. These are high income\(^9\), middle income\(^10\) and low income\(^11\) under the World Bank classification (2003).

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\(^9\) “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.” (World Bank, 2003).

\(^10\) “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.” (World Bank, 2003).

\(^11\) “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.” (World Bank, 2003).
\[
\Delta Y = \frac{(\Delta Y') - (\Delta Y_o)}{(\Delta Y_o)}
\]

### 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

### 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 (ΔÔ) and Y_2 (ΔY). They are positioned in the center of the graph which is the meeting point of the other four axes.
Step 7: Creation of the Openness/Income Growth Rate (O:Y) Chart

Based on all the results of the average openness growth rate ($\Delta \tilde{O}$) and income growth rate ($\Delta Y$) 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 ($\Delta \tilde{O}$) with the trend of the income growth rate ($\Delta Y$) (see Figure 2).
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 ($\Delta Y$). 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 ($\Delta Y$) 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) = $\Delta \bar{O} : \Delta Y$

Results of the (O:Y) Sensitivity Analysis

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

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

($\Delta \bar{O}$): average openness growth rate  
($\Delta Y$): income growth rate  
$\uparrow$: increase  
$\downarrow$: decrease
Diagram 1
Steps to apply the Openness Monitoring Methodology (OM-Methodology)

3. Concluding Remarks
Chapter fourth 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 5)
THE EXTERNAL SECTOR DEVELOPMENT INDEX (SXi)

Abstract
The fifth chapter introduces an alternative index to measure the external sector from a different focus. Called “the external sector development index (SXi)”, this indicator is a new analytical tool for studying the external sector behavior of any country or region. The SXi 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 ESi and GDP growth rates. The fourth objective is to evaluate the external sector (SXi) cycle based on the table of possible combinations between ESi and GDP.

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) and the openness index (Oi). 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 (SXi)”. The SXi is strongly affiliated with the openness index (Oi). The difference between these two indices is that the measurement of SXi 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 SXi analysis will also introduce a new variable called “the external sector main variable (ESi)”. The ESi 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, Oi and SXi) 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).

12 The terms of trade (ToT) is considered an analytical tool which can explain the relationship between the ratio of export prices (export index price = IPx) and the ratio of import prices (import index price = IPm) 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 = IPx/IPm x 100%

13 The openness index (Oi), on the other hand, studies the relationship between the total trade volume (i.e. Exports plus Imports) and GDP (Edwards, 1998). It measures the level of trade liberalization as well as the orientation of the trade policy of any country. The objective of the Oi 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.

Oi = X+M/GDP x 100%
2. The External Sector Development Index (SX<sub>i</sub>)

The objective of the external sector development index (SX<sub>i</sub>) 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<sub>i</sub> 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<sub>i</sub> Index requires four preceding steps detailed below (see Diagram 1).
DIAGRAM 1:
PROCEDURE TO MEASURE THE EXTERNAL SECTOR DEVELOPMENT INDEX ($S_{Xi}$)

Step 1
Trade Volume Growth Rate ($\Delta T$)

Step 2
FDI Growth Rate ($\Delta FDI$)

Step 3
GDP Growth Rate ($\Delta GDP$)

Step 4
External Sector Main Variable ($ES_{Xi}$)

Step 5
External Sector Development Index ($S_{Xi}$)
2.1. **Step 1:** Trade Volume Growth Rate ($\Delta T$)

The trade volume growth rate ($\Delta T$) 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$ $(X+M)_n$.

\[
\Delta T = \frac{(X+M)_{n+1} - (X+M)_n}{(X+M)_n}
\]

2.2. **Step 2:** Foreign Direct Investment Growth Rate ($\Delta FDI$)

The foreign direct investment growth rate ($\Delta FDI$) 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$ $(FDI)_n$.

\[
\Delta FDI = \frac{(FDI)_{n+1} - (FDI)_n}{(FDI)_n}
\]

2.3. **Step 3:** GDP Growth Rate ($\Delta GDP$)

The domestic product growth rate ($\Delta GDP$) 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$ $(GDP)_n$.

\[
\Delta GDP = \frac{(GDP)_{n+1} - (GDP)_n}{(GDP)_n}
\]

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 ($\Delta O$) and foreign direct investment growth rate ($\Delta FDI$) (see Table 2).

\[
ES_i = \Delta T + \Delta FDI
\]

**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 $ES_i = 0$ then this value is included in the category of weak external sector performance.
TABLE 2: Possible Combinations of $\Delta T$ and $\Delta FDI$ to Obtain $ES_i$

<table>
<thead>
<tr>
<th>$\Delta FDI/\Delta T$</th>
<th>$+\Delta T$</th>
<th>$-\Delta T$</th>
<th>$\Delta T = 0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$+\Delta FDI$</td>
<td>$\Delta T + \Delta FDI = ES_{i+}$</td>
<td>$\Delta(-\Delta T) + \nabla\Delta FDI = ES_{i-}$</td>
<td>$0 + (\Delta FDI) = ES_{i+}$</td>
</tr>
<tr>
<td>$-\Delta FDI$</td>
<td>$\nabla\Delta T + \nabla(-\Delta FDI) = ES_{i-}$</td>
<td>$\nabla(-\Delta T) + \nabla(-\Delta FDI) = ES_{i-}$</td>
<td>$0 + (-\Delta FDI) = ES_{i-}$</td>
</tr>
<tr>
<td>$\Delta FDI = 0$</td>
<td>$\Delta T + 0 = ES_{i+}$</td>
<td>$-\Delta T + 0 = ES_{i-}$</td>
<td>$0 + 0 = ES_{i0}$</td>
</tr>
</tbody>
</table>

$\nabla = $ High $\nabla = $ Low $\Delta FDI =$ Foreign Direct Investment Growth Rate
$\Delta T =$ 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 ($\Delta GDP$)

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

**Analysis of the $SX_i$ Results**

**High Vulnerability**
If the $ES_i$ and $\Delta GDP$ are located in these parameters ($+ES_i+/\Delta GDP$) or ($-ES_i-/\Delta GDP$) or ($ES_i = 0 / \Delta GDP = 0$), then the $SX_i$ 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 $\Delta GDP$ 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\textsubscript{i} and GDP are located in these parameters (-ES\textsubscript{i} / +ΔGDP) or (-ES\textsubscript{i} / 0) or (0 / +ΔGDP) or (0/-ΔGDP), then the SX\textsubscript{i} can be classified in the category of low vulnerability (see Table 3). The category of low vulnerability shows how the ES\textsubscript{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\textsubscript{i} Cycle Levels**

<table>
<thead>
<tr>
<th>ΔGDP</th>
<th>+ΔGDP</th>
<th>-ΔGDP</th>
<th>ΔGDP=0</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES\textsubscript{i}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ES\textsubscript{i}</td>
<td>Level 1.1</td>
<td>Level 1.2</td>
<td>Level 1.3</td>
</tr>
<tr>
<td></td>
<td>High Vulnerability</td>
<td>Normal Vulnerability</td>
<td>Normal Vulnerability</td>
</tr>
<tr>
<td></td>
<td>+ES\textsubscript{i} / +ΔGDP = +SX\textsubscript{i}</td>
<td>+ES\textsubscript{i} / -ΔGDP = -SX\textsubscript{i}</td>
<td>+ES\textsubscript{i} / 0 = SX\textsubscript{i} = ∞</td>
</tr>
<tr>
<td></td>
<td>Acceptable performance</td>
<td>Weak performance</td>
<td>Acceptable performance</td>
</tr>
<tr>
<td>-ES\textsubscript{i}</td>
<td>Level 2.1</td>
<td>Level 2.2</td>
<td>Level 2.3</td>
</tr>
<tr>
<td></td>
<td>Low Vulnerability</td>
<td>High Vulnerability</td>
<td>Low Vulnerability</td>
</tr>
<tr>
<td></td>
<td>-ES\textsubscript{i} / +ΔGDP = -SX\textsubscript{i}</td>
<td>-ES\textsubscript{i} / -ΔGDP = +SX\textsubscript{i}</td>
<td>-ES\textsubscript{i} / 0 = SX\textsubscript{i} = ∞</td>
</tr>
<tr>
<td></td>
<td>Weak performance</td>
<td>Acceptable performance</td>
<td>Weak performance</td>
</tr>
<tr>
<td>ES\textsubscript{i}=0</td>
<td>Level 3.1</td>
<td>Level 3.2</td>
<td>Level 3.3</td>
</tr>
<tr>
<td></td>
<td>Low Vulnerability</td>
<td>Low Vulnerability</td>
<td>High Vulnerability</td>
</tr>
<tr>
<td></td>
<td>0 / +ΔGDP = SX\textsubscript{i} = 0</td>
<td>0 / -ΔGDP = SX\textsubscript{i} = 0</td>
<td>0 / 0 = SX\textsubscript{i} = 0</td>
</tr>
<tr>
<td></td>
<td>Weak performance</td>
<td>Weak performance</td>
<td>Weak performance</td>
</tr>
</tbody>
</table>

**Variables:**

\(\triangleleft\) = High \(\nabla\) = Low \(\Delta\)GDP = Gross Domestic Growth Volume Growth Rate
ES\textsubscript{i} = External Sector Main Variable \((-\) = Negative and \((+) = Positive\) 0 = Zero
3. Application of the External Sector Development Index (SX\textsubscript{i})

The external sector development index (SX\textsubscript{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\textsubscript{i} is to observe performance, vulnerability and SX\textsubscript{i} cycles. The objective for applying the SX\textsubscript{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\textsubscript{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\textsubscript{i} to the above countries shows that the countries most affected by the 1997 financial crisis were the Philippines SX\textsubscript{i}-1998 = -23 (see Figure 5), Singapore SX\textsubscript{i}-1997 = -20 (see Figure 2), Thailand SX\textsubscript{i}-1997 = -6 (see Figure 4), Malaysia SX\textsubscript{i}-1997 = -4 (see Figure 3), Indonesia SX\textsubscript{i}-1997 = -3 (see Figure 1) and China SX\textsubscript{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\textsubscript{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\textsubscript{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\textsubscript{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\textsubscript{i} cycles between 1986 and 2001 (16 years) among these ASEAN-5 members and China, we observe that the SX\textsubscript{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 SX\textsubscript{i} 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\textsubscript{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 SXi 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.

**Figure 1: SXi Index Indonesia 1985-2001**

![Graph](image)

Source: World Bank

**Average SXi Index: Indonesia 1985-2001**

![Graph](image)
Figure 2: SXi Index Singapore 1985-2001

Source: World Bank

Average SXi Index: Singapore 1985-2001
Average SXi Index: Malaysia 1985-2001

Source: World Bank
Average SXi Index: Thailand 1985-2001

Source: World Bank
Figure 5: SXi Index Philippines 1985-2001

Average SXi Index: Philippines 1985-2001

Source: World Bank
4. Concluding Remarks
With the application of the external sector development index (SX$i$) 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 (SX$i$) can thus be used as an alternative index to study trade liberalization cycles effectively. In fact, the SX$i$ can be considered a complementary analytical tool together with terms of trade (ToT) and the openness index (O$i$).
(CHAPTER 6)
THE GROSS DOMESTIC PRODUCT SURFACE
(GDP–SURFACE)

Abstract
The sixth 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.

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 “ΔX₁”, investments growth rate “ΔX₂”, government growth rate “ΔX₃” and net trade growth rate “(X-M) = ΔX₄” respectively, shown in the expressions below. For demonstration purposes, the following data is used: consumption growth rate (ΔX₁), investment growth rate (ΔX₂), government growth rate (ΔX₃) and net trade growth rate (ΔX₄) 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:

\[ \Delta Y = f(\Delta X_1, \Delta X_2, \Delta X_3, \Delta X_4) \]

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

\[ (2.1.) \Delta X_1 = \left[\frac{X_1\text{-Final period} - X_1\text{-Initial period}}{X_1\text{-Final period}}\right] \times 100\% \]
\[ (2.2.) \Delta X_2 = \left[\frac{X_2\text{-Final period} - X_2\text{-Initial period}}{X_2\text{-Final period}}\right] \times 100\% \]
\[ (2.3.) \Delta X_3 = \left[\frac{X_3\text{-Final period} - X_3\text{-Initial period}}{X_3\text{-Final period}}\right] \times 100\% \]
\[ (2.4.) \Delta X_4 = \left[\frac{X_4\text{-Final period} - X_4\text{-Initial period}}{X_4\text{-Final period}}\right] \times 100\% \]
\[ (2.5.) \Delta Y = \left[\frac{Y\text{-Final period} - Y\text{-Initial period}}{Y\text{-Final period}}\right] \times 100\% \]

The GDP–Surface suggests the application of four vectors to show the magnitude and direction of each ΔXi (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 ℓ₁, ℓ₂, ℓ₃, ℓ₄ (see Figure 1).
(3.1.) \( \ell_1 = \Delta X_1 \Delta X_2 \)

(3.2.) \( \ell_2 = \Delta X_2 \Delta X_3 \)

(3.3.) \( \ell_2 = \Delta X_3 \Delta X_4 \)

(3.4.) \( \ell_4 = \Delta X_4 \Delta X_1 \)

**Figure 1**

*The GDP-Surface Platform*

The next step is to find the vectors to join \( \Delta X_1, \Delta X_2, \Delta X_3, \Delta X_4 \) with \( \Delta Y \) respectively to build the main structure of the GDP-Surface (see Figure 2).

(4.1.) \( \ell_5 = \Delta X_1 \Delta Y \)

(4.2.) \( \ell_6 = \Delta X_2 \Delta Y \)

(4.3.) \( \ell_7 = \Delta X_3 \Delta Y \)

(4.4.) \( \ell_8 = \Delta X_4 \Delta Y \)
Finally, the GDP-Surface is the sum of all vectors from vector $\ell_1$ until vector $\ell_8$ (see Figure 3).

\[ \text{The GDP-Surface} = \ell_1 + \ell_2 + \ell_3 + \ell_4 + \ell_5 + \ell_6 + \ell_7 + \ell_8 \]
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).

\[
+\Delta Y = f (+\Delta x_1, +\Delta x_2, +\Delta x_3, +\Delta x_4)
\]

**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).

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

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

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

The GDP-Surface shows how the national income growth rate “\(\Delta Y\)” or endogenous variable is affected by four exogenous variables, which are consumption growth rate “\(\Delta X_1\)”, investments growth rate “\(\Delta X_2\)”, government growth rate “\(\Delta X_3\)” and net trade growth rate “\((X-M) = \Delta X_4\)” 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 (ΔX₁), investment growth rate (ΔX₂), government growth rate (ΔX₃), net trade growth rate (ΔX₄) 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).


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

Source: NBER (2008)
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 ($X_1, X_2, X_3 \ldots \infty$) and a single endogenous variable ($Y$) in the same graphical space.
(CHAPTER 7)
UNKNOWN DIMENSIONS IN THE STUDY OF MARKET BEHAVIOR

Abstract

The seventh 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.

1. Introduction

In the study of economics, market behavior is based on the use of the supply 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 \((\varepsilon)\) is represented by expression 5.

\[
\begin{align*}
(1.) \quad Q_d &= \alpha - \beta P \\
(2.) \quad Q_s &= \lambda P - \pi \\
(3.) \quad Q_d &= Q_s \Rightarrow P^* \\
(4.) \quad Q^* &= Q_d = \alpha - \beta P^* \\
(5.) \quad \varepsilon &= (P^*, Q^*)
\end{align*}
\]

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.

\[
\begin{align*}
(6.) \quad Q_d &= \alpha - P^2 \\
(7.) \quad Q_s &= \lambda P - \pi \\
(8.) \quad f(P) &= Q_d + Q_s \\
(9.) \quad P_1^*, P_2^* &= \frac{-b \pm (b^2 - 4ac)^{1/2}}{2a} \Rightarrow P_1^*, P_2^* \cap R_+ \\
(10.) \quad Q^* &= Q_d = \alpha - (P^*)^2 \\
(11.) \quad \varepsilon &= (P^*, Q^*)
\end{align*}
\]

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.

\[
\begin{align*}
(12.) \quad Q_d &= Q_d(P_1, P_2, \ldots, P_\infty) \quad i = 1, 2, \ldots, \infty \\
(13.) \quad Q_s &= Q_s(P_1, P_2, \ldots, P_\infty) \quad i = 1, 2, \ldots, \infty \\
(14.) \quad \varepsilon &= (P_1, P_2, \ldots, P_\infty) = 0
\end{align*}
\]
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 \textit{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 unexpectedly 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.

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 (\(\Delta\)) in real time (\(\tau\)) (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 \( (Q_d^*) \), Quantity-Supplied Equilibrium \( (Q_s^*) \) 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 ($P^*$).

\begin{align*}
(15.) & \quad Q_d^* = Q_d^* (\circ\Delta V_1, \circ\Delta V_2, \ldots, \circ\Delta V_\infty) \\
(16.) & \quad Q_s^* = Q_s^* (\circ\Delta V_1, \circ\Delta V_2, \ldots, \circ\Delta V_\infty) \\
(17.) & \quad \circ Q_d^* \approx \circ P^* \approx \circ Q_s^*
\end{align*}

**Figure 2**
The Supply Surface and the Demand Surface

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 synchronized 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 8)

IS THE MARKET IN A STATE OF DYNAMIC IMBALANCE?

Abstract

This chapter demonstrates from a graphical view how the market maintains a state of dynamic imbalance. It is based on the application of inter-linkage coordinate space. The inter-linkage coordinate space will generate a multi-dimensional visual effect to observe the market as a whole in a permanent state of movement. Therefore, we assume that the market is divided into five sub-markets: 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. These five sub-markets move simultaneously in the same space and time. Finally, all these sub-markets can find their “momentum of balance synchronization stage” together in an unexpected and unlimited period of time. The “momentum of balance synchronization stage” is considered a fleeting momentum caused by the relaxation (or less instability) of all sub-markets. It depends on the behavior of economic, social, political, technological, and natural or environmental forces.

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.

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 (A₀, A₁, A₂, A₃ and A₄) at different perimeter levels (PL₀, PL₁, PL₂ and PL₃...) and a large number of windows refractions¹⁴ (W₀, W₁ ,..., Wₙ ...). 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

¹⁴ The Window Refraction Space is a concept based on the joining of different quadrants in the same vector address.
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.

3. The Goods Sub-Market Analysis under the General Axis 0 (A₀): IS Curve

The first analysis section is the study of the goods sub-market under the general axis (A₀). The A₀ is divided by three windows refractions (see Expression 1). The first window refraction on the general axis 0 (A₀) 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 A₀, 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 A₀ 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 A₀ 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 (A₀) is fixed in three different windows refractions:

(1.) \( A₀ = /I = f (i)/ \odot / O = f (i)/ \odot / Y = f (O)/ \)
b. **The Money Sub-Market Analysis under the General Axis 1 (A₁): 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 \( \Delta M/s, \Delta M/d \). 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 (A₁), 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 (A₁) is fixed into the three windows refractions:

\[
\text{(2.)} \quad A_1 = \frac{\Delta M/s}{\Delta M/d} \times \frac{f(i)}{\Delta O} = \frac{f(i)}{\Delta Y} = f(O)
\]
c. The Exports Sub-Market Analysis under the General Axis 2 (A₂): 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 A₂ 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 (A₂) 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:

$A_2 = \frac{P}{i} = \frac{f}{X} = \frac{f}{Y} = \frac{f}{X}$

**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:

\[
A_3 = \frac{I}{Ld} = f(I) / \frac{Ld}{\frac{UE}{\frac{Y}{f(UE)}}} \]

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

![Labor Sub-Market Analysis under the General Axis 3 ($A_3$): IL Curve](image)

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 ($Y$) 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.) $A_4 = f(I) / Pro = f(I) / X = f(Pro) / Y = f(X)$

**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)**

4. 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 9)
ECONOMIC WAVES: THE EFFECT OF THE U.S. ECONOMY ON WORLD ECONOMY

Abstract

The ninth chapter graphically demonstrates the patterns of economic recession from one of the largest economies in the world, i.e. the U.S. economy. This can generate economic waves on different markets (countries or regions). This chapter evaluates the way in which an economic recession from the U.S. economy can simultaneously affect five different markets economic hotspots viz. Japan, China, ASEAN, Latin America and the European Union (EU). To visualize how an economic recession in the U.S. economy can generate economic waves on world economy, it is necessary to apply the inter-linkage coordinate space. Finally, this chapter proposes the use of computer graphical animation, which is based on the construction of a large number of slides joined together through the production of a video. In our case, we will use Windows Microsoft movie maker software to generate the real time effect of these economic waves in the same graphical space.

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.

First is the assumption held in this chapter 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 GDPUS, 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 that comes from a deep economic recession, which revolves around the largest economy in the world – the U.S. economy. To observe the negative effects 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 (Ruiz Estrada, 2007) 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

<table>
<thead>
<tr>
<th>Country 1 or Region 1:</th>
<th>Country 2 or Region 2:</th>
<th>Country 3 or Region 3:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Windows Refraction:</strong></td>
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<td>Windows Refraction 1quito Windows Refraction 2quito Windows Refraction 3quito ... Windows Refraction ∞quito...</td>
</tr>
<tr>
<td>Country 4 or Region 4:</td>
<td>Country 5 or Region 5:</td>
<td>Country ∞ or Region ∞:</td>
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<td>Windows Refraction 1quito Windows Refraction 2quito Windows Refraction 3quito ... Windows Refraction ∞quito...</td>
</tr>
</tbody>
</table>

Therefore, this chapter outlines the economic recession in the U.S. economy between 2007 and 2008, and its effects on two large economies (Japan and China) and three economic 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 (quito)” concept. The windows refraction links (quito) facilitates 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. In this chapter, the economic waves originate from the low GDP growth rate of the U.S. economy and spreads to the rest of the world economies with significant impact particularly, on the employment and poverty levels in Japan and China and the economic regions of ASEAN, EU and Latin America (see Figure 1). Figure 1 presents the economic waves, which shows the growth of poverty among countries and regions between 2007-2008, where the poverty intensity in the U.S registered 10%, Japan (8%),
EU (5%), China (3%), ASEAN (2%) and Latin America (12%) (see Figure 1 and Table 2). With these scores, it is pertinent that the problem of poverty can no longer be restricted solely to a description of developing and less developed countries (LDCs), since the developed countries now exhibit powerful indices of poverty. This line of argument is apparent given the fast and increasing expansion of “global poverty” that is sweeping much of the developed world, with countries such as the U.S, Japan and some large members of the EU viz. Spain, Portugal, Greece, Italy and Ireland; well immersed in economic recessions and its attendant consequence - poverty.

Given the tremendous importance, which the GDP growth rate of the U.S. economy has on the performance and sustainability of markets in countries and regions around the world, it is highly relevant to identify some of the causes that give rise to the poor performance of U.S.’ GDP growth rate. Most likely causes include; high budget deficit; high military spending; weak financial controls; China’s competitive advantage and rapid economy expansion; weak U.S. dollar; large international trade deficit; high speculation in the real estate market; weak health and education programs, and amongst many other factors, the unstable behavior of oil prices in the international market. It is in the context of defining the GDP growth rate of the U.S economy as the epicenter of economic continuity of countries and regions that the economic waves modeling can serve to provide clear and logical description of how a global financial crisis can quickly spark a global poverty crisis in all countries and regions of the world. In the same vein, 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.

### TABLE 2:
The Economic Waves U.S., Japan, China, ASEAN, Latin America and Europe Union (2007-2008)

<table>
<thead>
<tr>
<th>Country 1: Japan</th>
<th>Country 2: China</th>
<th>Region 3: ASEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows Refraction:</td>
<td>Windows Refraction:</td>
<td>Windows Refraction:</td>
</tr>
<tr>
<td>WR1: GDP/ U.S. 1.5%</td>
<td>WR1: GDP/ U.S. 1.5%</td>
<td>WR1: GDP/ U.S.</td>
</tr>
<tr>
<td>WR2: Exports to US 3%</td>
<td>WR2: Exports to US 3%</td>
<td>WR2: Exports to US 1%</td>
</tr>
<tr>
<td>WR3: FDI from US 1%</td>
<td>WR3: FDI from US 2%</td>
<td>WR3: FDI from US 0.5%</td>
</tr>
<tr>
<td>WR4: Stock Market 0.5%</td>
<td>WR4: Stock Market 1%</td>
<td>WR4: Stock Markets 0.7%</td>
</tr>
<tr>
<td>WR5: Unemployment 10%</td>
<td>WR5: Unemployment 7%</td>
<td>WR5: Unemployment 7%</td>
</tr>
<tr>
<td>WR6: Poverty 8%</td>
<td>WR6: Poverty 3%</td>
<td>WR6: Poverty 2%</td>
</tr>
<tr>
<td><strong>ASEAN:</strong> We take only in consideration Malaysia Thailand and Singapore</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Region 4: Latin America</th>
<th>Sub-Market 5: European Union</th>
</tr>
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<tbody>
<tr>
<td>Windows Refraction:</td>
<td>Windows Refraction:</td>
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<tr>
<td>WR1: GDP/ U.S. 1.5%</td>
<td>WR1: GDP/ U.S. 1.5%</td>
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<tr>
<td>WR2: Exports to US 0.75%</td>
<td>WR2: Exports to US 1%</td>
</tr>
<tr>
<td>WR3: FDI from US 0.5%</td>
<td>WR3: FDI from US 1%</td>
</tr>
<tr>
<td>WR4: Stock Markets 0.6%</td>
<td>WR4: Stock Markets 2%</td>
</tr>
<tr>
<td>WR5: Unemployment 8%</td>
<td>WR5: Unemployment 7%</td>
</tr>
<tr>
<td>WR6: Poverty 10%</td>
<td>WR6: Poverty 5%</td>
</tr>
</tbody>
</table>

**Note:** The forecasting results are based on the application of the Mega-Space distributed lag model.

**Statistical Sources:** NBER, UN, ADB, EU, INTAL-IADB, WB and IMF
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. 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 and poverty growth rates of all markets.
Abstract

This chapter shows the behavior of different macroeconomic variables together in the same graphical space. The case study in this chapter is the U.S. economy from the year 1929 to 2009. To visualize the behavior of large macroeconomic data graphically, we suggest the application of the inter-linkage coordinate space to plot different statistical or econometrical results simultaneously in the same graphical space.

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

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<th>Sub-Market 1:</th>
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<td>Windows Refraction ∞:</td>
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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>
<thead>
<tr>
<th>Sub-Market</th>
<th>Markets</th>
<th>Windows Refraction</th>
<th>Windows Refraction</th>
<th>Windows Refraction</th>
<th>Windows Refraction</th>
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<tr>
<td></td>
<td></td>
<td>Windows Refraction 2: Interest Rate</td>
<td>Windows Refraction 3: Investment</td>
<td>Windows Refraction 4: Income</td>
<td>Windows Refraction 5: Real Estate</td>
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<td></td>
<td></td>
<td>Windows Refraction 2: Interest Rate</td>
<td>Windows Refraction 3: Money: Supply and Demand</td>
<td>Windows Refraction 4: Income</td>
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<td>Sub-Market 3</td>
<td>Social Market</td>
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<td>Windows Refraction 2: Education</td>
<td>Windows Refraction 3: Low Cost Housing</td>
<td>Windows Refraction 4: Health Care</td>
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<td>Windows Refraction 3: Exports and Imports</td>
<td>Windows Refraction 4: Income</td>
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<td>Windows Refraction 3: Public Investment</td>
<td>Windows Refraction 4: Income</td>
<td>Windows Refraction 5: Real Estate</td>
</tr>
</tbody>
</table>
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 11
WHY HAS THE MARKET BECOME MORE VULNERABLE IN THE 21ST CENTURY?

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).

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 (X₁) (See Expression 1), social global forces (X₂) (see Expression 2), political global forces (X₃) (see Expression 3), technological global forces (X₄) (see Expression 4) and natural global forces (X₅) (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/**).

\[
\begin{align*}
(1.) \ X_1 &= f(☼f_{11}, ☼f_{12}, \ldots, ☼f_{1n}) \text{ and } n = \infty \\
(2.) \ X_2 &= f(☼f_{21}, ☼f_{22}, \ldots, ☼f_{2n}) \text{ and } n = \infty \\
(3.) \ X_3 &= f(☼f_{31}, ☼f_{32}, \ldots, ☼f_{3n}) \text{ and } n = \infty \\
(4.) \ X_4 &= f(☼f_{41}, ☼f_{42}, \ldots, ☼f_{4n}) \text{ and } n = \infty \\
(5.) \ X_5 &= f(☼f_{51}, ☼f_{52}, \ldots, ☼f_{5n}) \text{ and } n = \infty \\
\end{align*}
\]

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>.

\[
\begin{align*}
(6.) \ ☼X_i &= ☼ \left[ \partial X_{i,t+1} / \partial X_{i,t-1} \right] \Rightarrow i = \{1,2,3,4,5\}
\end{align*}
\]

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:
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.

\[
(12.) \ /☼Y*/ = \sum_{i=1}^{5} \left[ \frac{\partial X_i}{\partial X_i \mid_{t-1}} \right] \Rightarrow i = \{1, 2, 3, 4, 5\}
\]

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 (∥∥).

\[
(13.) \ /☼Y*/ = \sum [\frac{\partial X_{1_{t+1}}}{\partial X_{1_{t-1}}}] \parallel \sum [\frac{\partial X_{2_{t+1}}}{\partial X_{2_{t-1}}}] \parallel \sum [\frac{\partial X_{3_{t+1}}}{\partial X_{3_{t-1}}}] \parallel \sum [\frac{\partial X_{4_{t+1}}}{\partial X_{4_{t-1}}}] \parallel \sum [\frac{\partial X_{5_{t+1}}}{\partial X_{5_{t-1}}}]
\]

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
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 (/\(\odot Y^*\)/) (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>
<thead>
<tr>
<th>Variable Century</th>
<th>Global Economic Forces (X1)</th>
<th>Global Social Forces (X2)</th>
<th>Global Political Forces (X3)</th>
<th>Global Technological Forces (X4)</th>
<th>Global Natural Forces (X5)</th>
<th>(\odot Y^*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20th Century</td>
<td>0.6852114</td>
<td>0.425143</td>
<td>0.454813</td>
<td>0.468715</td>
<td>0.558741</td>
<td>0.61852468</td>
</tr>
<tr>
<td>21st Century</td>
<td>0.8521247</td>
<td>0.512544</td>
<td>0.885484</td>
<td>0.852414</td>
<td>0.858713</td>
<td>0.81025594</td>
</tr>
</tbody>
</table>

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 (/\(\odot Y^*\)/) 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.
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 12)
THE MINIMUM FOOD SECURITY QUOTA (MFS–QUOTA)
IN FOOD SECURITY POLICY MODELING

Abstract
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”.

1. Introduction
This chapter 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 chapter 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 chapter 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.

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.
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).

a. 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).

\[
\Delta I_{ij:v} = \begin{bmatrix}
X_{11:v} & X_{12:v} & \ldots & X_{1\infty:v} \\
X_{21:v} & X_{22:v} & \ldots & X_{2\infty:v} \\
\vdots & \vdots & \ddots & \vdots \\
X_{\infty:v} & X_{\infty2:v} & \ldots & X_{\infty\infty:v}
\end{bmatrix}
\]

\[v = \text{Input data} \quad X = \text{Variable(s)} \quad j = \text{Column} \quad i = \text{Row}\]

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 (Km²) 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 (╬)
In the case of the data changes in real time ($\Delta$), 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).

$$
\Delta X_{ij:v} = X_{ij:v}(t) - X_{ij:v}(t-1) / X_{ij:v}(t-1)
$$

The calculation of the final determinant is based on the Expression (4) below:

$$
\Delta I_{ij:v} = \begin{pmatrix}
\Delta X_{11:v} & \Delta X_{12:v} & \cdots & \Delta X_{1\infty:v} \\
\Delta X_{21:v} & \Delta X_{22:v} & \cdots & \Delta X_{2\infty:v} \\
\vdots & \vdots & \ddots & \vdots \\
\Delta X_{\infty 1:v} & \Delta X_{\infty 2:v} & \cdots & \Delta X_{\infty\infty:v}
\end{pmatrix}
$$

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 ($\Delta I_{ij:v}$) by the total of population growth rate ($\Delta\text{Pop}$%), 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 ($\text{GDP}_{\text{Annual-agriculture-Sector}}$) by the MFS-Quota% (See Expression 6).

$$
\text{MFS-Quota} = (\Delta I_{ij:v}) \times (\Delta\text{Pop}) / T
$$

$$
\text{MFS-Volume} = \text{GDP}_{\text{Agriculture-Sector}} \times \text{MFS-Quota}\%
$$

Figure 1

MFS-Quota Surface

Source: Econographicology
4. 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.

APPENDICES

APPENDIX 1: MULTIDIMENSIONAL PARTIAL DIFFERENTIATION RULES

(1) \( \frac{dy_i}{dx_i} = 0 \) or \( f'(x_i) = 0 \)

(2) \( \frac{d}{dx_i} = nx^{n-1}_i \) or \( f'(x_i) = nx^{n-1}_i \)

(3) \( \frac{d}{dcx_i} = cnx^{n-1}_i \) or \( f'(x_i) = cnx^{n-1}_i \)

(4) \( \frac{d}{dx_i} [\alpha_i(x_{ij}) \pm \theta_i(x_{ij}) \pm \ldots \pm \lambda_i(x_{ij})] = \frac{d}{dx_i} \alpha(x_{ij}) \pm \frac{d}{dx_i} \theta_i(x_{ij}) \pm \ldots \pm \frac{d}{dx_i} \lambda_i(x_{ij}) \)

(5) \( \frac{d}{dx_i} [\alpha_i(x_{ij}) \theta_i(x_{ij}) \ldots \lambda_i(x_{ij})] = \alpha(x_{ij}) \frac{d}{dx_i} + \theta_i(x_{ij}) \frac{d}{dx_i} + \ldots + \lambda_i(x_{ij}) \frac{d}{dx_i} \)

(6) \( \frac{d}{dx_i} [\alpha_i(x_{ij})/\theta_i(x_{ij}) \ldots \lambda_i(x_{ij})] = \alpha(x_{ij}) \frac{d}{dx_i} + \theta_i(x_{ij}) \frac{d}{dx_i} + \ldots + \lambda_i(x_{ij}) \frac{d}{dx_i} \)

(7) \( \frac{d}{dx_j} [\alpha_j(x_{ij}) \theta_j(x_{ij}) \ldots \lambda_j(x_{ij})] = \alpha(x_{ij}) \frac{d}{dx_j} + \theta_j(x_{ij}) \frac{d}{dx_j} + \ldots + \lambda_j(x_{ij}) \frac{d}{dx_j} \)

(8) \( \frac{d}{dx_j} [\alpha_j(x_{ij}) \theta_j(x_{ij}) \ldots \lambda_j(x_{ij})] = \alpha(x_{ij}) \frac{d}{dx_j} + \theta_j(x_{ij}) \frac{d}{dx_j} + \ldots + \lambda_j(x_{ij}) \frac{d}{dx_j} \)

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. Initially, economic modeling in real time starts with this input data function:

\[ \text{Input answer} : \text{Question(s)} : \text{Column} : \text{Row} \]

The next step is storage in the database (DB) equation, represented by

\[ \text{DB} = \text{Database} \quad \text{C} = \text{Column} \quad \text{R} = \text{Row} \quad \text{Running information in real time} \quad \text{Save Information} \quad \text{Interlink Database} \]

In the case of data changes in real time (\(\text{Running information in real time} \)), 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).

\[ \text{Running information in real time} (t) - \text{Running information in real time} (t-1) \]

Finally, the plotting of real time data is as follows:

\[ \text{Plotting function} (\text{Running information in real time}) \]
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 ($\overline{\gamma}$) (see Expression 1) and the general interconnectivity condition ($\overline{\delta}$) (see Expression 2).

\[
\begin{align*}
S_0 &= Y_{0:i} = f (X_{0:0:i} \overline{\gamma} X_{0:1:i} \overline{\gamma} \ldots \overline{\gamma} X_{0:\infty:i}) \\
S_1 &= Y_{1:i} = f (X_{0:0:i} \overline{\gamma} X_{0:1:i} \overline{\gamma} \ldots \overline{\gamma} X_{0:\infty:i}) \\
\cdots \\
S_{\infty} &= Y_{\infty:i} = f (X_{0:0:i} \overline{\gamma} X_{0:1:i} \overline{\gamma} \ldots \overline{\gamma} X_{0:\infty:i})
\end{align*}
\]
(2.) \[ I = S_0 (Y_L:n) \mathbin{\|} S_1 (Y_L:n) \mathbin{\|} \ldots \mathbin{\|} S_\infty (Y_L:n) \ldots \]

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_
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