The Basic Manual of Policy Modeling

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THE BASIC MANUAL OF POLICY MODELING
(MONOGRAPHS)

BY

Mario Arturo Ruiz Estrada

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CHAPTER XII
The Past, Present and Future of Policy Modeling
Mario Arturo Ruiz Estrada and Donghyun Park

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CHAPTER I
INTRODUCTION

This basic manual about policy modeling is built by a large collection of different papers were published in different journals such as the Journal of Policy Modeling (JPM), Contemporary Economics (CE), and other Journals in the last ten years. The main objective of this basic manual about policy modeling is to make a single document to understand better policy modeling in an easy way for academics, students, and policymakers. Basically, this basic manual has twelve chapters follow by:

The second 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.

The third chapter examines the origins and evolution of policy modeling from a theoretical and technical perspective. This is done through an extensive review and analysis of publications of the journal of policy modeling within a 33-year period (1979-2012). It was observed that at different period in time, economic policy research focused on different national and international issues that invoked different economic practical approaches to facilitate the explanation of the complex and dynamic socio-economic and political phenomena.

In the fourth chapter examines the origins and evolution of economic modelling from a theoretical and technical perspective. This is done through an extensive review and analysis of publications in the journal of economic modelling (JEM) within a 28-year period (1984–2012). It was observed that at different period in time, economic modelling research focused on different national and international issues that invoked different economic practical approaches to facilitate the explanation of the complex and dynamic socio-economic and political phenomena.

Chapter fifth is interested to show graphically how the market is in a dynamic imbalanced state. It is based on the application of the Multi-Functional Pictorial Cartesian Space (MFP-Cartesian Space). The MFP-Cartesian space (Ruiz, 2006 and 2007.a) will generate a multi-dimensional visual effect to observe the market as a whole in a permanent movement state. Therefore, we assume that the market is formed by 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). The five sub-markets are moving together simultaneously in the same space and time. Finally, all these sub-markets can find its “momentum of balance synchronization stage” together in an unexpected and unlimited period of time. The “momentum of balance synchronization stage” is considered as a fleeting momentum originated by the
relaxation (or less instability) of all sub-markets. It is depending on the economic, social, political, technological and natural & environment forces behavior.

The sixth 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.

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

The chapter eight explores the effectiveness of policy modeling papers in analyzing and solving real socio-economic problems. In essence, the paper extends the significance of policy modeling research beyond mere theory, but as practical instruments applicable to solving real socio-economic problems. The chapter proposes the introduction of a new policy implementation section in policy modeling papers that should clearly and logically propose strategic effective policies for action; and the use of a new index called ‘Policy Implementation Effectiveness” (PIE-index), with which the effectiveness of policy modeling papers for real practical purposes could be evaluated. From the analyses carried out, which are based on both primary and secondary data sources, the chapter argues that policy modeling papers could actually be evaluated to understand the degree of their effectiveness to analyzing and solving real socio-economic problems affecting society on different levels.

This chapter nine presents four alternative experimental models for monitoring economic failures. These models include the national production function (NP-Function), the multi-level trade creation and trade diversion analytical framework, the mega-economic structures vulnerability analysis (MSV-Analysis), and the mega-economic surface interactive system. The main objective behind the proposed experimental models in economics is to analyze different macroeconomic scenarios in monitoring and alerting the possible unexpected economic failure(s) under the use of a new mathematical framework and the application of multidimensional graphs. The proposed alternative experimental models are based on the application of Econographicology. Hence, our models are expected to offer policy-makers and researchers new analytical tools to study the impact and trend of economic failures in the economy of any country from a new perspective. Finally, we suggest the application of three new concepts in the study of economic failures such as Omnia Mobilis (everything is moving), the global structural imbalance principle, and the dynamic imbalance state. Therefore, our findings would certainly help both policy makers and researchers
to implement and execute appropriate policies in order to develop their economies and to protect them from the unwanted situations.

The ten chapter proposes a new economic modeling theoretical framework known as multidimensional real-time economic modeling (MRTE-Modeling). The model is an important tool that economists and educators can use to demonstrate the multidimensional aspects of economic behavior. MRTE-Modeling facilitates the analysis of a series of complex and dynamic economic problems that can affect market behavior from a multidimensional perspective. The proposed MRTE-Modeling framework is based on the uses of an alternative mathematical modeling framework, multidimensional graphical modeling approach, and computer algorithm and, thus, allows the possibility to transition from 2-dimensional economic dynamic modeling to multidimensional real-time economic modeling. Therefore, the main objective of using the proposed experimental model in the field of economics is to analyze different macroeconomic scenarios to monitor and provide a warning of possible unexpected economic failure(s). The proposed alternative experimental model is based on the application of Econographicology. Hence, our model is expected to offer policy makers and researchers new analytical tools to study the impact and trend of economic failures in the economy of any country from a new perspective.

In chapter eleven will present a new applicable analytical indicator on the study of market performance and vulnerability. It is based on the observation of a single index that can show the permanent inconsistency of the market performance that is always experienced across different periods in history. Market performance and vulnerability can materialize under the shape of trade, energy or financial crisis. Basically, we assume that the market is affected by five forces: economic forces, social forces, political forces, technological forces and natural forces. All these five forces always interact simultaneously; they affect market behavior directly without any restriction or isolation. Hence, the objective of this opinion chapter is to offer policy-makers and researchers a new analytical tool to study the market performance and vulnerability in the economy of any country from a new perspective. In fact, this chapter intends to establish a new multidisciplinary index to analyze the market performance and vulnerability. This new multidisciplinary index is entitled “The Market Performance and Vulnerability Trend Index (MPVT-Index)”. The MPVT-Index attempts to estimate five forces together that can influence the market trend in the short and long run, the same index is not intended to be a forecasting model in any case. Finally, the MPTV-Index was applied to the study of U.S. market performance and its vulnerability.

The chapter twelve evaluate the past, present, and future of policy modeling from both qualitative and quantitative perspectives. We do this through an extensive review and analysis of papers published in the Journal of Policy Modeling between 1978 and 2018. We find that at different time periods, the policy modeling research literature focused on different aspects. These include a wide range of research topics, research approaches, techniques, theories, methods, and analytical tools applied in the study of national and international issues. All of these dimensions are relevant for the rigorous analysis of complex and dynamic economic phenomena.
CHAPTER II
POLICY MODELING: DEFINITION, CLASSIFICATION AND EVALUATION

Mario Arturo Ruiz Estrada

2.1. 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, 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 chapter 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.

2.2. 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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Source: Journal of Policy Modeling (JPM) - Review Group

Note: The table represents the distribution of papers published from 1979 to 2009.
Figure 1: Papers Published in JPM from 1979 until 2009

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

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<th>Category</th>
<th>Papers</th>
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| 1. Domestic and International Trade Policy Modeling                      | 220    | 15%
| 2. Energy, Communications, Infrastructure and Transportation Policy Modeling | 80     | 5%
| 3. Environmental and Natural Resources Management Policy Modeling         | 70     | 5%
| 4. Fiscal and Government Spending Policy Modeling                         | 50     | 5%
| 5. Institutional, Regulation and Negotiation Policy Modeling              | 55     | 4%
| 6. Labor, Employment and Population Policy Modeling                       | 70     | 5%
| 7. Monetary, Banking and Investment Policy Modeling                       | 410    | 27%
| 8. Production and Consumption Policy Modeling                             | 165    | 11%
| 9. Technological and R&D Policy Modeling                                  | 35     | 2%
| 10. Welfare and Social Policy Modeling                                    | 56     | 4%
| 11. Economic Growth and Development Policy Modeling                      | 150    | 10%
| 12. Miscellaneous Policy Modeling                                         | 110    | 7%
| **Total**                                                               | **1501** | **100%**

Source: Journal of Policy Modeling (JPM) - Editors Group

Note: Miscellaneous: General and Partial Equilibrium Analysis, Macroeconomic Analysis and New Topics in Economics.
2.3. Proposed Approach to Policy Modeling

2.3.1. 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.
2.3.2 ‘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.

Figure 3: The Mega-Surface Coordinate Space

2.4. 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: (X_1) types of research; (X_2) research orientation; (X_3) data sources; (X_4) econometrics methods applied; (X_5) areas of research; (X_6) research theoretical framework; (X_7) policy modeling by sectors; (X_8) economics frameworks; (X_9) geographical analysis; (X_10) paper citation.

There are four basic steps in the implementation of the PMC-Index. These steps are: (i) the use of multi-input-output table; (ii) classification of variables and identification of parameters; (iii) measurement of the PMC-Index; (iv) construction of the PMC-Surface. The PMC-Surface is used to show the strengths and weaknesses in any policy modeling from a multi-dimensional perspective. The mega-surface coordinate space (see Figure 3) (Ruiz Estrada, 2007) is used in the construction of the PMC-Surface.
2.4.1 Steps to Implement PMC-Index

2.4.1(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.

2.4.1(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: (X1) type 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.

I. The first main-variable (X1) (‘types of research’) is formed by seven sub-variables: (X1:1) predicting; (X1:2) monitoring; (X1:3) proposal; (X1:4) descriptive; (X1:5) diagnostic; (X1:6) simulation; (X1:7) experimental. II. The second main-variable (X2) (‘research orientation’) is formed by six sub-variables: (X2:1) empirical; (X2:2) theoretical; (X2:3) technical; (X2:4) historical; (X2:5) quantitative; (X2:6) qualitative. III. The third main-variable (X3) (‘data sources’) consists of six sub-variables: (X3:1) primary data; (X3:2) secondary data; (X3:3) mix data; (X3:4) long term; (X3:5) medium term; (X3:6) short term. IV. The fourth main-variable (X4) (‘econometric methods applied on policy modeling’) is made up of (X4:1) linear regression analysis; (X4:2) multiple regression analysis; (X4:3) times series data; (X4:4) cross-sectional data; (X4:5) panel data; multi-dimensional panel data (X4:6). V. The fifth main-variable (X5) (‘area of research’) comprises eight sub-variables: (X5:1) economics; (X5:2) social; (X5:3) technological; (X5:4) political; (X5:5) environment; (X5:6) institutional; (X5:7) sciences; (X5:8) multi-disciplinary. VI. The sixth main-variable (X6) (‘research theoretical framework’) comprises three sub-variables: (X6:1) original theoretical framework; (X6:2) traditional theoretical framework; (X6:3) extension theoretical framework. VII. The seventh main-variable (X7) (‘policy modeling by sectors’) is made up of three sub-variables: (X7:1) private sector; (X7:2) public sector; (X7:3) public/private sector. VIII. The eighth main-variable (X8) (‘economics frameworks applied on policy modeling’) comprises the following eight sub-variables: (X8:1) macroeconomics analysis; (X8:2) microeconomics analysis; (X8:3) partial equilibrium; (X8:4) general equilibrium; (X8:5) dynamic modeling; (X8:6) static modeling; (X8:7) perfect competition; (X8:8) imperfect competition. IX. The ninth main-variable (X9) (‘geographical analysis’) is affected by three sub-variables: (X9:1) national level; (X9:2) regional level; (X9:3) global level. X. The tenth main-variable (X10) is ‘paper citation’. It is without any sub-variable. (see Table 4).
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.

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<th>Table 4: Application of Binary System in the Multi-Input-Output Table</th>
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Variables:

- **(X1)** Type of research
  - **(X1:1)** Predicting
  - **(X1:2)** Monitoring
  - **(X1:3)** Proposal
  - **(X1:4)** Descriptive
  - **(X1:5)** Diagnostic
  - **(X1:6)** Simulation
  - **(X1:7)** Experimental

- **(X2)** Research orientation
  - **(X2:1)** Empirical
  - **(X2:2)** Theoretical
  - **(X2:3)** Technical
  - **(X2:4)** Historical
  - **(X2:5)** Quantitative
  - **(X2:6)** Qualitative

- **(X3)** Data source
  - **(X3:1)** Primary data
  - **(X3:2)** Secondary data
  - **(X3:3)** Mix data
  - **(X3:4)** Long term
  - **(X3:5)** Medium term

- **(X4)** Applied Econometrics methods
  - **(X4:1)** Linear regression analysis
  - **(X4:2)** Multiple regression analysis
  - **(X4:3)** Time series data
  - **(X4:4)** Cross-sectional data
  - **(X4:5)** Panel data
  - **(X4:6)** Multidimensional panel data

- **(X5)** Area of research
  - **(X5:1)** Economics
  - **(X5:2)** Social
  - **(X5:3)** Technological
  - **(X5:4)** Political
  - **(X5:5)** Environment
  - **(X5:6)** Institutional

- **(X6)** Research theoretical framework
  - **(X6:1)** Original theoretical framework
  - **(X6:2)** Traditional theoretical framework
  - **(X6:3)** Extension of theoretical framework

- **(X7)** Policy modeling by sectors
  - **(X7:1)** Private sector
  - **(X7:2)** Public sector
  - **(X7:3)** Public/private sector

- **(X8)** Economics framework
  - **(X8:1)** Macroeconomics analysis
  - **(X8:2)** Microeconomics analysis

- **(X9)** Geographical analysis
  - **(X9:1)** National level
  - **(X9:2)** Regional level
  - **(X9:3)** Global level

- **(X10)** Paper citation
  - **(X10:1)** Original theoretical framework
  - **(X10:2)** Extension of theoretical framework
2.4.1(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).

\[ X \sim N [0,1] \]  

(1)

\[ X = \{ X \in [0,1] \} \]  

(2)

\[ n \]

\[ X_t(\Sigma X_{ij}/T(x_{ij})) \quad t = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, \ldots, \infty \]  

(3)

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

\[ \text{PMC} = \begin{pmatrix} 
X_{1}(\Sigma X_{i1}/7) + X_{2}(\Sigma X_{i2}/6) + X_{3}(\Sigma X_{i3}/6) + X_{4}(\Sigma X_{i4}/8) + X_{5}(\Sigma X_{i5}/3) + X_{6}(\Sigma X_{i6}/3) + X_{7}(\Sigma X_{i7}/3) + X_{8}(\Sigma X_{i8}/3) + X_{9}(\Sigma X_{i9}/3) + X_{10} 
\end{pmatrix} \]

(4)

2.4.1(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.

2.4.1(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.
2.4.1(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’.

2.5. 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).
Figure 4: PMC-Surface
2.6. 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.

2.7. References
CHAPTER III
THE ORIGINS AND EVOLUTION OF POLICY MODELING

Mario Arturo Ruiz Estrada and Su Fei Yap

3.1. Origin of Policy Modeling
This section of the chapter is interested to give a short brief about the origin of the policy modeling. Initially, we like to mention the first pioneers on policy modeling such as Dr. Antonio Maria Costa (editor in chief of the journal of policy modeling (JPM) and former executive director of UN office on drugs and crime), Professor Dominick Salvatore (Co-Editor of the journal of policy modeling (JPM) and full time Professor at Fordham University, New York, U.S.), and Professor Douglas O. Walker (editorial board member of the journal of policy modeling (JPM) and full time Professor at Regent University, Virginia, U.S.) respectively. According to Antonio Maria Costa (2011) the origin of the Policy modeling: “The origin of policy modeling was born into the United Nations (UN) at the end of the 1970’s, when it was agreed upon by experts that the profession was not all that useful to people engaged in macroeconomic management. As such, they proposed a scientific policy modeling research approach that always rooted in empirical validation, unfortunately there was none around. In fact, there was the feeling that economics had become too mathematical, too abstract and basically unreadable. Hence, the economics research field was being invaded by mathematicians that had failed in their discipline and wanted to impress economists with complicated and sophisticated mathematical models. Policy modeling with its inherent rigours became necessary in order to avoid the ambling books that lacked focus and application”.

However, the origin of policy modeling according to Professor Douglas O. Walker (2011), he said: “Back in the 1950s and 1960s before journal of policy modeling was started, development policy stressed "Big Push" capital fundamentalist ideas that linked economic growth to investment, which replaced traditional economic practices with more modern technologies and institutions. Policy models reflected this orientation. The 1970s saw a period of turmoil, stagnation and inflation increasing concern on issues of foreign investment and dependency and the introduction of price and income controls. In the 1980s, policy returned to the idea of the preeminence of markets and the need for structural adjustment in the face of external debt problems and the rise of social development as a key concern in the formulation of long-term strategies for development. With the collapse of central planning in the late '80s and early '90s, the transition to more market-oriented economies led to major policy reforms and a concern for better economic governance. Along with issues of human rights and globalization, the first decade of the 21st century has seen terrible financial instability and a focus on dealing with the large-scale imbalances that have developed in the trade and fiscal accounts of the major developed countries. Throughout the years, JPM has seen a change in its policy focus. At the start, it published what had been the virtually unanimous view that a high rate of economic growth was the secret to achieving social development and political stability. Over time, however, this view has been challenged as environmental and poverty issues took center stage in policy discussions. Capital fundamentalism is now dead. In short, this change in policy
focus, especially at the international level should be reflected in the different articles and subjects covered by JPM. Similarly, I would suspect that the balance between "internationally-oriented" and "nationally-oriented papers" as well as the kinds of quantitative techniques used as computers becomes more readily available and easier to use would change systematically over the years. In 1968, the first revision of the systems of national account (SNA) was introduced and it slowly but steadily led to a better, more comprehensive and detailed data series, on which other data developments along a wide range of subjects may be added, notably on income distribution. “

It is pertinent from the comments of the two scholars above that there is consensus on the origin of policy modeling. Both authors agree to the deep transformation in the analysis, formulation and orientation of policies across different periods of time and geographical spaces. Moreover, it is obvious that the use of more economic practical approaches could facilitate the explanation of a dynamic and complex economic and social phenomenon. The main idea behind the use of practical economic approaches is to find suitable and applicable policies that can help to reduce the negative impact of any economic and social problem(s) in the society by the most efficient and realistic way.

In the 20th century the use and application of economic modeling among economists were often based on sophisticated mathematical and statistical techniques, methods and models introduced during the development of new economic models. In particular, calculus, trigonometry, geometry and statistical and forecasting methods were employed by economists in policy modeling. Consequently, the application of sophisticated mathematical and statistical techniques, methods, and models can be seen in the development of the following economic models: The Foundations of Welfare Economics (Hicks, 1939), Foundations of Economics Analysis (Samuelson, 1947), Monetary Theory and Fiscal policy (Hansen, 1949), The Bargaining Problem (Nash, 1950), Econometric Models and the Evidence of Times Series Analysis (Klein, 1956), A Contribution to the Theory of Economic Growth (Solow, 1956), Economic Policy: Principles and Design (Tinbergen, 1956), A Theory of Consumption Function (Friedman, 1957), The Relationship Between Unemployment and Rate of Change of Money Wages in the United Kingdom 1861-1957 (Phillips, 1958), The Input-Output Economics (Leontief, 1966), and The Rational Expectations and the Role of Monetary Policy (Barro, 1976).

It is important to note the difference and similarity that exist between economic modeling and policy modeling. The main difference is based on the research focus and theoretical approaches applied to the analysis of different economic phenomena. In terms of similarity, both fields focus on the analysis of different economic phenomena to study the irrational and chaotic behaviors through time (history) and space (geographical). To study the difference and similarity that exists between economic modeling and policy modeling, the bibliographical references of two prestigious journals viz. the journal of policy modeling (Elsevier, 2011a) and the economic modeling journal (Elsevier, 2011b) are employed.

3.2. The Evolution of the Policy Modeling from 1979 to 2012
The study of the evolution of policy modeling evolution is based on the study of the different volumes and issues of JPM between 1979 and 2012 (see Table 1 and Figure 1). It could be observed that the application of different research approaches in the policy modeling keeps a constant quantitative transformation (volume of research output) and a qualitative transformation (content and form).
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</tr>
<tr>
<td>32</td>
<td>2011</td>
<td>11</td>
<td>13</td>
<td>15</td>
<td>12</td>
<td>13</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td>33</td>
<td>2012</td>
<td>15</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total by Issue</strong></td>
<td><strong>327</strong></td>
<td><strong>320</strong></td>
<td><strong>291</strong></td>
<td><strong>257</strong></td>
<td><strong>183</strong></td>
<td><strong>167</strong></td>
<td><strong>68</strong></td>
<td><strong>51</strong></td>
<td><strong>16</strong></td>
<td><strong>1680</strong></td>
<td><strong>1680</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Journal of Policy Modeling (JPM) from Sciences Direct by Elsevier Group (2011a)  
Policy modeling according to Ruiz Estrada (2011: p.524): is “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.”

Moreover, the present chapter assumes that the absence of non-economic variables could 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 *inter alia*, trends of natural disaster, climate change, terrorism, crime and violence, poverty expansion, religious beliefs, educational system, social events, social norms and behavior and so on. This chapter maintains that it is necessary to incorporate these factors in policy modeling in order to formulate strong policies of minimal
vulnerability. However, it should be taken that these factors maintain a constant quantitative and qualitative transformation(s) in different historical periods of the society concerned.

Basically, the study of the evolution of policy modeling in this chapter is based on the analysis of 1680 papers by the application of individual categories of the policy modeling identified by Ruiz Estrada (2011: p.525). Additionally, the same chapter will study common modeling approaches used by different papers in the past thirty-three years (1979-2011) in JPM. Hence, the individual categories can be classified into the following fifteen (15) categories (see Table 2).

### Table 2: Classification and Distribution of JPM Papers by 15 Categories (1979-2012)

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>PAPERS</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 The domestic and international trade policy modeling</td>
<td>235</td>
<td>14%</td>
</tr>
<tr>
<td>2 The energy, communications and transportation policy modeling</td>
<td>81</td>
<td>5%</td>
</tr>
<tr>
<td>3 The agriculture, environmental and natural resources management policy modeling</td>
<td>70</td>
<td>4%</td>
</tr>
<tr>
<td>4 The fiscal, subsidies and government spending policy modeling</td>
<td>149</td>
<td>9%</td>
</tr>
<tr>
<td>5 The institutional, regulation, planning, intervention and negotiation policy modeling</td>
<td>55</td>
<td>3%</td>
</tr>
<tr>
<td>6 The labor, wages, unemployment, education and population policy modeling</td>
<td>73</td>
<td>4%</td>
</tr>
<tr>
<td>7 The monetary, finance, banking, exchange rate and investment policy modeling</td>
<td>524</td>
<td>31%</td>
</tr>
<tr>
<td>8 The production, prices, income and consumption policy modeling</td>
<td>172</td>
<td>10%</td>
</tr>
<tr>
<td>9 The technological policy modeling</td>
<td>37</td>
<td>2%</td>
</tr>
<tr>
<td>10 The social welfare policy modeling</td>
<td>56</td>
<td>3%</td>
</tr>
<tr>
<td>11 The economic growth and development policy modeling</td>
<td>160</td>
<td>10%</td>
</tr>
<tr>
<td>12 The military and national security policy modeling</td>
<td>7</td>
<td>0%</td>
</tr>
<tr>
<td>13 The gender, culture, discrimination, racism policy modeling</td>
<td>3</td>
<td>0%</td>
</tr>
<tr>
<td>14 The natural disasters and food security policy modeling</td>
<td>3</td>
<td>0%</td>
</tr>
<tr>
<td>15 The miscellaneous policy modeling</td>
<td>55</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1680</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

**Source:** Journal of Policy Modeling (JPM) from Sciences Direct by Elsevier Group (2011a)

Following the evolution of policy modeling by decades, the trend of policy modeling in the 1970s is oriented first to the production, prices, consumption policy modeling (11 papers = 31%). Second place is shared by two categories with variables such as the energy, communication, transportation policy modeling (5 papers = 14%) in one category and institutions, regulation, planning, intervention, and negotiation policy modeling (5 papers = 14%) in the other category. Third place is the domestic and international trade policy modeling (4 papers = 11%).

In the 1980s, the trend of the policy modeling research changed dramatically, for example the domestic and international trade policy modeling (68 papers = 21%) moved from third place to the second place in the list of categories. The third place is taking over by the monetary, finance, banking, exchange rate and investment policy modeling (49 papers = 15%). Whereas the production, prices, income and consumption policy modeling (70 papers = 22%) remained in the first place among all categories. In the 1990s the trend of policy modeling shows remarkable changes with the first place taken over by the monetary, finance, banking, exchange rate and investment policy modeling (99 papers = 27%). Similarly, the second place was occupied by the domestic and international trade policy modeling (65 papers = 18%). While the third place moved from the economic growth and development policy modeling to the fiscal, subsidy, and government spending

**Source:** Journal of Policy Modeling (JPM) from Sciences Direct by Elsevier Group (2011a)  
policy modeling (40 papers = 11%). Finally, between 2000-2012 the first place among the list of categories has the monetary, finance, banking, exchange rate and investment policy modeling (374 papers = 39%) in first place. The second place remained under the control of the international trade policy modeling (98 papers = 10%). While the third place is taking over once again by the economic growth and development policy modeling (89 papers = 9%) (see Table 3 and Figure 3).

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>1970s</th>
<th>1990s</th>
<th>2000/12</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 The domestic and international trade policy modeling</td>
<td>4</td>
<td>65</td>
<td>98</td>
<td>235</td>
</tr>
<tr>
<td>2 The energy, communications and transportation policy modeling</td>
<td>5</td>
<td>12</td>
<td>44</td>
<td>81</td>
</tr>
<tr>
<td>3 The agriculture, environmental and natural resources management policy modeling</td>
<td>0</td>
<td>15</td>
<td>34</td>
<td>70</td>
</tr>
<tr>
<td>4 The fiscal, subsidies and government spending policy modeling</td>
<td>1</td>
<td>40</td>
<td>75</td>
<td>149</td>
</tr>
<tr>
<td>5 The institutional, regulation, planning, intervention and negotiation policy modeling</td>
<td>3</td>
<td>8</td>
<td>37</td>
<td>55</td>
</tr>
<tr>
<td>6 The labor, wages, unemployment, education and population policy modeling</td>
<td>1</td>
<td>19</td>
<td>46</td>
<td>73</td>
</tr>
<tr>
<td>7 The monetary, finance, banking, exchange rate and investment policy modeling</td>
<td>2</td>
<td>99</td>
<td>374</td>
<td>521</td>
</tr>
<tr>
<td>8 The production, prices, income and consumption policy modeling</td>
<td>11</td>
<td>37</td>
<td>54</td>
<td>171</td>
</tr>
<tr>
<td>9 The technological policy modeling</td>
<td>0</td>
<td>1</td>
<td>35</td>
<td>37</td>
</tr>
<tr>
<td>10 The social welfare policy modeling</td>
<td>3</td>
<td>10</td>
<td>40</td>
<td>56</td>
</tr>
<tr>
<td>11 The economic growth and development policy modeling</td>
<td>3</td>
<td>33</td>
<td>89</td>
<td>160</td>
</tr>
<tr>
<td>12 The military and national security policy modeling</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>13 The gender, culture, discrimination, racism policy modeling</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>14 The natural disasters and food security policy modeling</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>15 The miscellaneous policy modeling</td>
<td>0</td>
<td>27</td>
<td>28</td>
<td>55</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>36</td>
<td>369</td>
<td>958</td>
<td>1680</td>
</tr>
</tbody>
</table>

Source: Journal of Policy Modeling (JPM) from SciencesDirect by Elsevier Group (2011a)
It is pertinent that the trend of research among all authors in the JPM follow the monetary, finance, banking, exchange rate and investment policy modeling; the domestic and international trade policy modeling; the economic growth and development policy modeling; the fiscal, subsidy, and the government spending policy modeling. Based on our evaluation, the only category that keeps a constant growth is the monetary, finance, banking, exchange rate and investment policy modeling with 14% growth rate in the 1980s. In the 1990s the number of papers doubled to a growth rate of 26%. Finally, the monetary, finance, banking, exchange rate and investment policy modeling in the period between 2000-2012 registered a growth rate of 38% (see Table 4). Hence, we can observe that papers relating to the monetary, finance, banking, exchange rate and investment policy modeling registered a constant expansion, which is an indication of preference among researchers and readers of JPM. Furthermore, it can be observed that in the four decades-sample, the analysis in the 1980s shows JPM with an impressive research output growth rate of 82%, but dropped to 79% (-3) in the 1990s. However, the growth rate expansion has been favorable within the period 2000-2012 as it registered 86% (+7%) (see Table 4).

Source: Journal of Policy Modeling (JPM) from SciencesDirect by Elsevier Group (2011a)
Among the 1680 papers published in JPM in the past thirty-three years (1979-2011), the following research approaches were the most common: benefit/cost, probabilistic or forecasting analysis through the application of econometric methods and use of microeconomic and macroeconomic level secondary data. Also, among the 1680 papers in the past thirty-three years, there has been an increasing dependency of policy modeling on economics models, methods and techniques. Ninety-five percent (95%) or 1596 of these papers adopted the economics research approach in policy modeling. Only 5% or 84 of these papers adopted a multidisciplinary approach (entailing several disciplines such as history, sociology, politics, technology and so on) in policy modeling.

In the case of the policy modeling evaluation by research approach, we applied fifty-three (53) variables to analyze paper by paper (1680 papers) from the journal of policy modeling to study different research modeling approaches. Based on the paper, the fifty-three (53) variables are used to evaluate the different policy modeling approaches in different papers from journal of policy modeling (see Table 5).

Based on the final analysis drawn from this paper, we could observe in JPM that almost all papers focus on monitoring policy modeling (65%) and empirical policy modeling (90%) on one hand. While on the other hand, the balance of papers between quantitative and qualitative policy modeling maintained closed results between 55% and 45% respectively. In the case of data analysis policy modeling, 90% of all the

### Table 4: Classification and Distribution of JPM Papers by 15 Categories per Decade (Growth Rate)

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>1970s</th>
<th>1980s</th>
<th>1990s</th>
<th>2000/12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 The domestic and international trade policy modeling</td>
<td>0</td>
<td>20</td>
<td>17</td>
<td>9</td>
</tr>
<tr>
<td>2 The energy, communications and transportation policy modeling</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3 The agriculture, environmental and natural resources management policy modeling</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4 The fiscal, subsidies and government spending policy modeling</td>
<td>0</td>
<td>9</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>5 The institutional, regulation, planning, intervention and negotiation policy modeling</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>6 The labor, wages, unemployment, education and population policy modeling</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>7 The monetary, finance, banking, exchange rate and investment policy modeling</td>
<td>0</td>
<td>14</td>
<td>26</td>
<td>38</td>
</tr>
<tr>
<td>8 The production, prices, income and consumption policy modeling</td>
<td>0</td>
<td>21</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>9 The technological policy modeling</td>
<td>0</td>
<td>0</td>
<td>-1</td>
<td>3</td>
</tr>
<tr>
<td>10 The social welfare policy modeling</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>11 The economic growth and development policy modeling</td>
<td>0</td>
<td>10</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>12 The military and national security policy modeling</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-1</td>
</tr>
<tr>
<td>13 The gender, culture, discrimination, racism policy modeling</td>
<td>0</td>
<td>0</td>
<td>-1</td>
<td>-1</td>
</tr>
<tr>
<td>14 The natural disasters and food security policy modeling</td>
<td>0</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>15 The miscellaneous policy modeling</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>82</td>
<td>79</td>
<td>86</td>
</tr>
</tbody>
</table>

Source: Journal of Policy Modeling (JPM) from Sciences Direct by Elsevier Group (2011a)
papers are based on the use of secondary data modeling that originated from different bibliographical and statistical sources. Similarly, the time framework in the data analysis modeling is based on the long run policy modeling (45%) and short run policy modeling (35%). Usually, the econometric approaches applied by different authors in the JPM include; the use of times series data modeling (54%), cross-sectional data modeling (20%) and panel data modeling (15%). In fact, the research approaches used by all papers in the JPM (65%) focused on the economic policy modeling, the social policy modeling (10%), the technological policy modeling (15%) and others (10%). Another interesting result in this research is that 95% of all the published papers in the JPM applied the traditional theoretical framework policy modeling approach, while only 5% applied the extension theoretical framework policy modeling approach. In addition, 96% of the JPM papers are oriented to the public sector policy modeling. In the case of analysis under macroeconomic and microeconomic modeling approach levels are distributed by 75% and 25% respectively. It was also observed that the JPM papers are supported by the general equilibrium modeling (75%), static modeling (85%) and imperfect competition modeling (75%). In terms of geographical coverage of research by JPM, papers are distributed by national level policy modeling (55%) and global level policy modeling (35%). Moreover, the most common theoretical modeling approaches applied in all JPM papers are in the following order: Keynesian modeling approach (45%), monetary modeling approach (28%), neo-classic economic modeling approach (16%) and classic economic modeling approach (10%). Finally, based on the type of graphical modeling applied by JPM papers, it was observed that virtually all papers applied the 2-dimensional graphical modeling (99%) while only 1% of all papers from JPM applied the 3-dimensional and multidimensional graphical modeling (see Table 5).

It is apparent from the analysis that the future of policy modeling depends on the flexibility and dynamism of the policy modeling research approaches adapted to the real world through the application of practical research techniques, methods, methodologies and research focus through the integration of different knowledge fields. Hence, policy modeling can be considered as a multi-discipline research approach that could facilitate the study of different socio-economic and political problems that could have negative impacts on society. It is apt to stress that policy modeling is an important technical-theoretical analytical tool for future academics, economists, policy makers and supranational institutions such as World Bank (WB), United Nations (UN) and others. More importantly, the relative rise in the impact factor of the JPM from 0.763 in the year 2010 to 0.911 in the year 2011 based on the Institute for Science Information (ISI) convincingly justifies the relevance of policy modeling to a large array of socio-economic and political issues. (Thomson Reuters, 2011).
<table>
<thead>
<tr>
<th>No.</th>
<th>Modeling Approach</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Predicting policy modeling approach</td>
<td>430</td>
<td>25%</td>
</tr>
<tr>
<td>2</td>
<td>Monitoring policy modeling approach</td>
<td>1120</td>
<td>65%</td>
</tr>
<tr>
<td>3</td>
<td>Simulation policy modeling approach</td>
<td>20</td>
<td>1%</td>
</tr>
<tr>
<td>4</td>
<td>Descriptive policy modeling approach</td>
<td>110</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1680</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>5</td>
<td>Empirical policy modeling approach</td>
<td>1510</td>
<td>90%</td>
</tr>
<tr>
<td>6</td>
<td>Theoretical policy modeling approach</td>
<td>170</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1680</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>7</td>
<td>Quantitative policy modeling approach</td>
<td>930</td>
<td>55%</td>
</tr>
<tr>
<td>8</td>
<td>Qualitative policy modeling approach</td>
<td>750</td>
<td>45%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1680</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>9</td>
<td>Primary data policy modeling approach</td>
<td>85</td>
<td>5%</td>
</tr>
<tr>
<td>10</td>
<td>Secondary data policy modeling approach</td>
<td>1500</td>
<td>90%</td>
</tr>
<tr>
<td>11</td>
<td>Mix data policy modeling approach</td>
<td>95</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1680</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>12</td>
<td>Long run policy modeling approach</td>
<td>770</td>
<td>45%</td>
</tr>
<tr>
<td>13</td>
<td>Medium run policy modeling approach</td>
<td>355</td>
<td>20%</td>
</tr>
<tr>
<td>14</td>
<td>Short run policy modeling approach</td>
<td>555</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1680</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>15</td>
<td>Linear regression analysis policy modeling approach</td>
<td>90</td>
<td>5%</td>
</tr>
<tr>
<td>16</td>
<td>Multiple regression analysis policy modeling approach</td>
<td>90</td>
<td>5%</td>
</tr>
<tr>
<td>17</td>
<td>Times series data policy modeling approach</td>
<td>910</td>
<td>54%</td>
</tr>
<tr>
<td>18</td>
<td>Cross-sectional data policy modeling approach</td>
<td>320</td>
<td>20%</td>
</tr>
<tr>
<td>19</td>
<td>Panel data modeling policy approach</td>
<td>260</td>
<td>15%</td>
</tr>
<tr>
<td>20</td>
<td>Multi-dimensional panel data policy modeling approach</td>
<td>10</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1680</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>21</td>
<td>2-Dimensional graphical modeling</td>
<td>1650</td>
<td>99%</td>
</tr>
<tr>
<td>22</td>
<td>3-Dimensional graphical modeling</td>
<td>5</td>
<td>0%</td>
</tr>
<tr>
<td>23</td>
<td>Multidimensional graphical modeling</td>
<td>6</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1680</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>24</td>
<td>Economics policy modeling approach</td>
<td>980</td>
<td>65%</td>
</tr>
<tr>
<td>25</td>
<td>Social policy modeling approach</td>
<td>210</td>
<td>10%</td>
</tr>
<tr>
<td>26</td>
<td>Technological policy modeling approach</td>
<td>260</td>
<td>15%</td>
</tr>
<tr>
<td>27</td>
<td>Political policy modeling approach</td>
<td>30</td>
<td>1%</td>
</tr>
<tr>
<td>28</td>
<td>Environment policy modeling approach</td>
<td>100</td>
<td>5%</td>
</tr>
<tr>
<td>29</td>
<td>Institutional policy modeling approach</td>
<td>45</td>
<td>2%</td>
</tr>
</tbody>
</table>
### Table 3: Evaluation of the JPM by Modeling Approach (50 Variables)

<table>
<thead>
<tr>
<th>30</th>
<th>Sciences policy modeling approach</th>
<th>25</th>
<th>1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>Multi-disciplinary policy modeling approach</td>
<td>30</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1680</td>
<td><strong>100%</strong></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Original theoretical framework policy modeling approach</td>
<td>55</td>
<td>2%</td>
</tr>
<tr>
<td>33</td>
<td>Traditional theoretical framework policy modeling approach</td>
<td>1555</td>
<td>95%</td>
</tr>
<tr>
<td>34</td>
<td>Extension theoretical framework policy modeling approach</td>
<td>70</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1680</td>
<td><strong>100%</strong></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Private sector policy modeling approach</td>
<td>55</td>
<td>3%</td>
</tr>
<tr>
<td>36</td>
<td>Public sector policy modeling approach</td>
<td>1590</td>
<td>96%</td>
</tr>
<tr>
<td>37</td>
<td>Public/private sector policy modeling approach</td>
<td>35</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1680</td>
<td><strong>100%</strong></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Macroeconomics analysis policy modeling approach</td>
<td>1270</td>
<td>75%</td>
</tr>
<tr>
<td>39</td>
<td>Microeconomics analysis policy modeling approach</td>
<td>410</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1680</td>
<td><strong>100%</strong></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Partial equilibrium policy modeling approach</td>
<td>400</td>
<td>25%</td>
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<tr>
<td>41</td>
<td>General equilibrium policy modeling approach</td>
<td>1280</td>
<td>75%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1680</td>
<td><strong>100%</strong></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Dynamic policy modeling approach</td>
<td>250</td>
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</tr>
<tr>
<td>43</td>
<td>Static policy modeling approach</td>
<td>1430</td>
<td>85%</td>
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<tr>
<td><strong>Total</strong></td>
<td>1680</td>
<td><strong>100%</strong></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>Perfect competition policy modeling approach</td>
<td>400</td>
<td>25%</td>
</tr>
<tr>
<td>45</td>
<td>Imperfect competition policy modeling approach</td>
<td>1280</td>
<td>75%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1680</td>
<td><strong>100%</strong></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>National level policy modeling approach</td>
<td>950</td>
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<td>47</td>
<td>Regional level policy modeling approach</td>
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<td>48</td>
<td>Global level policy modeling approach</td>
<td>575</td>
<td>35%</td>
</tr>
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<td><strong>Total</strong></td>
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<td><strong>100%</strong></td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>Keynesian policy modeling approach</td>
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<td>50</td>
<td>Monetary policy modeling approach</td>
<td>475</td>
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<td>51</td>
<td>Classic Approach policy modeling approach</td>
<td>110</td>
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<td>52</td>
<td>Neo-Classic Approach policy modeling approach</td>
<td>275</td>
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<tr>
<td>53</td>
<td>Others policy modeling approaches</td>
<td>20</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1680</td>
<td><strong>100%</strong></td>
<td></td>
</tr>
</tbody>
</table>
3.4. The Application of Dynamic Imbalance State (DIS) on the Policy Modeling

In broad terms, the necessity to have an alternative basic premise to support the policy modeling in this chapter suggests the application of the dynamic imbalance state (DIS) (Ruiz Estrada, 2008) to support all possible uncertain economic, social, technological and political scenarios in the policy modeling under study. The DIS is based on the application of Omnia Mobilis assumption (everything is moving) (Ruiz Estrada, 2011). The DIS is not chaos; it is an unconditional and unexpected complex sensitive reaction of all possible uncertain events that is generated by different economic, political, social, technological, natural and environment forces simultaneously under unpredictable scenarios. Therefore, the policy modeling in any case does not necessarily need to be in equilibrium simultaneously, because all possible uncertain events can affect the policy modeling in a dynamic imbalanced state. This chapter argues that policy modeling is not a static and isolated research field, rather a transitional and evolutionary research field that cannot be controlled and determined arbitrarily. Moreover, we need to remember that the study of the policy modeling is not the study of a natural phenomenon that can be measured or exactly demonstrated by science. In the study of policy modeling we need to take account of different factors such as (i) the study of economic, social, political, technological and natural forces behavior simultaneously; (ii) the study of different historical events that impact on the humanity though the time (different periods) and space (geographically); (iii) Find the efficient way to allocate resources to minimize cost maximize human necessities (profit or consumption). Therefore, we believe that the study of policy modeling cannot be forecasted with accuracy due to the forces mentioned above, which are unpredictable and uncertain in time and space. But it is possible to evaluate the benefit/cost of any policy and its impact on the society.

3.5. Conclusion

This chapter concludes that policy modeling can open a new research field to academics, policy makers and social scientist in the study of complex and dynamic behavior of socio-political-economic problems that can affect our society anytime and anywhere without borders. This conclusion is drawn from the review and analysis of 1680 articles published 33 years ago (1979-2012) by the journal of policy modeling. The trend of the policy modeling is changing remarkably fast, with its origins invoked by uses of new research approaches and research focus. Finally, the policy modeling can become a powerful analytical tool that accept the adaptation of any technique, methodology, method and research approach such as economics, finances, sociology, political sciences, technology, environment, econometrics, sciences to explain deeply complex socio-political and economic problems that affect different social groups in the society at different geographical areas under different historical events.

3.6. References

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   201.
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   of Economics. 70(1): 65-94.
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   z/isi_web_of_knowledge/ (accessed June 25, 2011)
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   December 11, 2011)
CHAPTER IV
DEFINITION, CLASSIFICATION, AND TREND OF ECONOMIC MODELING

Mario Arturo Ruiz Estrada

4.1. Introduction

This chapter makes several observations pertaining to economic modelling. Based on a careful study of the total of 1775 research papers published in the journal of economic modelling (JEM) Journal between 1984 and 2012, it presents the percentages of papers published in individual categories of economic modelling identified. Second, based on an observation of the common approaches used in economic modelling papers in the past 28 years in JEM, this chapter recommends multidisciplinary approach to economic modelling. It suggests the incorporation of multidisciplinary, non-economic variables in economic modeling to formulate strong policies. Third, in connection with the multidisciplinary approach, it proposes the application of the ‘multidisciplinary modeling’ to economic modeling, a good range of variables should be included and no relevant variables should be neglected in economic modelling. Moreover, it is obvious that the use of more economic practical approaches could facilitate the explanation of a dynamic and complex economic and social phenomenon. The main idea behind the use of practical economic approaches is to find suitable and applicable models that can help to reduce the negative impact of any economic and social problem(s) in the society by the most efficient and realistic way. In the 21st century the use and application of economic modelling among economists were often based on sophisticated mathematical and statistical techniques, methods and models introduced during the development of new economic models. In particular, statistical and forecasting methods were employed by economists in economic modeling. Consequently, the application of sophisticated mathematical and statistical techniques, methods, and models can be seen in the development of the following economic models: The Foundations of Economics Analysis (Samuelson, 1947), Monetary Theory and Fiscal policy (Hansen, 1949), Econometric Models and the Evidence of Times Series Analysis (Klein, 1956), A Contribution to the Theory of Economic Growth (Solow, 1956), Economic Policy: Principles and Design (Tinbergen, 1956), The Input–Output Economics (Leontief, 1966). In fact, the rapid development of economic modelling has been facilitated by high technology and sophisticated analytical instruments such as the electronic calculator and the computer. The development of analysis instruments in economics took place in two stages. The first stage involved “basic computational tools”, where electronic calculators were used to compute basic mathematical expressions. This took place between the 1950s and 1960s. The second stage which involved “advance computational tools” began in the middle of the 1980s up to the present day. This marks the era when high speed and efficient storage-capacity computers that are installed with sophisticated software were introduced for the first time. The use of sophisticated software, solutions and simulators enables easy information management, application of difficult simulations as well as the creation of high resolution graphs. Obviously, the analysis instruments contributed substantially to the development and research in economics. Over the years the high
computational instruments backed by sophisticated software have been used to formulate large economic models which are largely beneficial for secondary data uses. Economic modelling approaches basically comprise of the “descriptive modelling” and analytical modelling, both of which can be categorized according to functions and database sizes. In terms of function, the two economic modeling approaches are either descriptive or analytical. The “descriptive economic modelling” on the one hand shows arbitrary information that is used to observe a long historical data behavior from a simple perspective. While “analytical modelling” on the other hand is used to generate time-series, cross-section modelling to show the trends and relationships between two or more variables from a dynamic perspective. The research leading to this chapter shows a strong link between the introduction of new economic modelling and the development of theories, methods and techniques in statistics and mathematics. It is important to note the difference and similarity that exist between economic modelling and policy modeling (Ruiz Estrada and Yap, 2013). The main difference is based on the research focus and theoretical approaches applied to the analysis of different economic phenomena. In terms of similarity, both fields focus on the analysis of different economic phenomena to study the irrational and chaotic behaviors through time (history) and space (geographical). To study the difference and similarity that exists between economic modelling and policy modelling, the bibliographical references of two prestigious journals viz. the journal of policy modeling (Elsevier, 2012a) and the journal of economic modeling (Elsevier, 2012b) are employed.

4.2. Definition and Classification of Economic Modelling

“Economic modelling” can be defined as “an academic research work, that is supported by the use of different theories as well as quantitative or qualitative models and techniques, to analytically evaluate the causes and effects of any economic phenomenon that affect on society, anywhere and anytime.” As an integral part of this definition, “modelling” 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.” Economic modelling can also be classified. Based on a study of all the one thousand seven hundred seventy five (1775) papers that were published in the Economic Modelling (EM) journal from 1984 to 2012 (28 years) (see Table 1 and Figure 1), economic modelling can be classified into the following twelve (12) categories: (i) domestic and international trade economic modelling; (ii) energy, communications and transportation economic modelling; (iii) agriculture, environmental and natural resources management modelling; (iv) fiscal policy, subsidies, and government spending economic modelling; (v) institutional, regulation, planning, intervention, and negotiation modelling; (vi) labor, wages, education, unemployment and population economic modelling; (vii) monetary, finance, banking, exchange rate, and investment policy modelling; (viii) production, consumption, and inflation economic modelling; (ix) technological and R&D economic modelling; (x) welfare economics modelling; (xi) economic growth and development modelling; (xii) miscellaneous economic modelling. Based on the same study and the same classification above, the percentages of papers in the individual categories of economic modelling were found to be as follows: (i) domestic and international trade economic modelling (25 papers = 1%); (ii) energy, communications and transportation economic modelling (40 papers = 2%); (iii) agriculture, environmental and natural resources management economic modelling (85 papers = 5%); (iv) fiscal policy, subsidies, and government spending economic modelling (260 papers = 15%); (v) institutional, regulation, planning, intervention, and negotiation
economic modelling (5 papers = 0 %); (vi) labor, education, wages, unemployment and population economic modelling (90 papers = 5%); (vii) monetary, finance, banking, exchange rate, and investment economic modelling (365 papers = 21%); (viii) production, inflation, and inflation economic modelling (320 papers = 18%); (ix) technological and R&D economic modelling (90 papers = 5%); (x) welfare economics modelling (20 papers = 1%); (xi) economic growth and development modelling (450 papers = 25%); (xii) miscellaneous economic modelling (25 papers = 1%).

**Table 1:** Total Papers Output from JEM by Volume and Issues (1984-2012)

<table>
<thead>
<tr>
<th>VOL</th>
<th>YEAR</th>
<th>Issues</th>
<th>PAPERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1984</td>
<td>I-1 8</td>
<td>22</td>
</tr>
<tr>
<td>2</td>
<td>1985</td>
<td>I-2 5</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>1986</td>
<td>I-3 6</td>
<td>23</td>
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<tr>
<td>4</td>
<td>1987</td>
<td>I-4 1</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>1988</td>
<td>I-5 8</td>
<td>22</td>
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<tr>
<td>6</td>
<td>1989</td>
<td>I-6 5</td>
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<td>I-7 3</td>
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<td>1991</td>
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<td>I-6 5</td>
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<td>1996</td>
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<td>I-1 7</td>
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<td>2009</td>
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<td>2010</td>
<td>I-4 2</td>
<td>161</td>
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<tr>
<td>28</td>
<td>2011</td>
<td>I-3 7</td>
<td>286</td>
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<tr>
<td>29</td>
<td>2012</td>
<td>I-2 6</td>
<td>295</td>
</tr>
<tr>
<td>Total by Issue</td>
<td>322</td>
<td>312</td>
<td>345</td>
</tr>
</tbody>
</table>

Figure 1: Total Papers Output from JEM by Volume and Issues

Source: Journal of Economic Modelling (JEM) http://www.sciencedirect.com/science/journal/02649993
### Table 2: Classification and Distribution of JEM Papers by 12 Categories (1984-2012)

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>PAPERS</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  The Domestic and International Trade Economic Modelling</td>
<td>20</td>
<td>1%</td>
</tr>
<tr>
<td>2  Energy, Communications and Transportation Economic Modelling</td>
<td>30</td>
<td>1%</td>
</tr>
<tr>
<td>3  Agriculture, Environmental and Natural Resources Management Economic Modelling</td>
<td>85</td>
<td>5%</td>
</tr>
<tr>
<td>4  Fiscal Policy, Subsidies, and Government Spending Economic Modelling</td>
<td>250</td>
<td>17%</td>
</tr>
<tr>
<td>5  Institutional, Regulation, Planning, Intervention, and Negotiation Economic Modelling</td>
<td>65</td>
<td>0%</td>
</tr>
<tr>
<td>6  Labor, Wages, Education, Unemployment and Population Economic Modelling</td>
<td>70</td>
<td>3%</td>
</tr>
<tr>
<td>7  Monetary, Finance, Banking, Exchange Rate, and Investment Economic Modelling</td>
<td>365</td>
<td>18%</td>
</tr>
<tr>
<td>8  Production, Consumption, and Inflation Economic Modelling</td>
<td>320</td>
<td>21%</td>
</tr>
<tr>
<td>9  Technological and R&amp;D Economic Modelling</td>
<td>85</td>
<td>5%</td>
</tr>
<tr>
<td>10 Welfare Economics Modelling</td>
<td>15</td>
<td>1%</td>
</tr>
<tr>
<td>11 Economic Growth and Development Modelling</td>
<td>450</td>
<td>27%</td>
</tr>
<tr>
<td>12 Miscellaneous Economic Modeling</td>
<td>20</td>
<td>1%</td>
</tr>
</tbody>
</table>

Total 1775 100%

**Source:** Journal of Economic Modelling (JEM) [http://www.sciencedirect.com/science/journal/02649993](http://www.sciencedirect.com/science/journal/02649993)
4.3. Multidisciplinary Approach

Among the 1775 papers published in the journal of economics modelling (JEM) journal in the past 28 years (1984-2012), 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 1775 papers, and for the past 28 years, there has been an increasing dependency on econometrics models, methods and techniques. Ninety-seven percent (97%) or 1722 of these papers adopted the economics research approach. Only 1% or 53 of these papers adopted a multidisciplinary approach (entailing several disciplines such as history, economics, sociology, politics, technology and social sciences et cetera).

This chapter is of the view that the absence of non-economic variables can considerably increase the vulnerability of any economic modelling. Therefore, it suggests that any economic modelling 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 economic modelling 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 (Ruiz Estrada, 2011). Moreover, this chapter makes a deep analysis about economic modelling evolution. We are taking in account a careful study of a total of 1775 papers. It presents the percentages of papers published in individual categories of economic modelling identified by Ruiz Estrada. Additionally, we are going to study the common modelling approaches used in different papers at the last twenty-seven years in the journal of economic modelling (JEM) journal. At the same time, this chapter recommends multidisciplinary approach to economic modelling. It suggests the incorporation of multidisciplinary, non-economic variables in economic modelling to formulate strong policies. Secondly, the evolution of the journal of economic modelling (JEM) journal is possible to observe through different volumes from year 1984 until year 2012 that the application of different research approaches into economic modelling keeps a constant quantitative transformation (volume of research output) and a qualitative transformation (content and form). Especially, these quantitative and qualitative transformations can be observed in different manuscripts in this specific journal by the application of different quantitative and qualitative methods, innovative policies and recommendations.

4.4. The Economic Modeling Trend

Among the 1775 papers published in the journal of economic modelling (JEM) journal in the past twenty-eight years (1984-2012), 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. Therefore, we are using forty (40) variables to evaluate all papers were published by the economic modelling (EM) journal until today. The following forty (40) variables are (1.) predicting economic modelling; (2.) monitoring economic modelling; (3.) simulation economic modelling; (4.) empirical economic modelling; (5.) theoretical economic modelling; (6.) primary data economic modelling; (7.) secondary data economic modelling; (8.) long run economic modelling; (9.) short run economic modelling; (10.) linear regression analysis; (11.) multiple regression analysis; (12.) times series data analysis; (13.) cross-sectional data analysis; (14.) panel data analysis; (15.) 2-Dimensional graphical modelling; (16.) 3-Dimensional graphical modelling; (17.) economics policy modelling approach; (18.) technological policy modelling; (19.) environment policy modelling; (20.) original theoretical framework; (21.) traditional theoretical framework; (22.) extension theoretical framework; (23.) private sector modelling; (24.) public sector modelling; (25.) macroeconomics modelling; (26.) microeconomics modelling; (27.) partial equilibrium modelling; (28.) general equilibrium modelling; (29.) dynamic economic modelling; (30.) static economic modelling; (31.) perfect competition modelling; (32.) imperfect competition modelling; (33.) national level modelling; (34.) regional level modelling; (35.) global level modelling; (36.) Keynesian modelling approach; (37.) monetary modelling approach; (38.) classic economic modelling approach; (39.) neo-classic economic modelling approach; (40.) planning economic modelling approach. (see Table 3). Based on the same study and the same classification of variables above, the percentages of papers in the individual modelling approaches in the journal of economic modelling (JEM) was found to be as follows: (1.) predicting economic modelling (1456 papers = 82%); (2.) monitoring economic modelling (142 papers = 8%); (3.)
simulation economic modelling (178 papers = 10%); (4.) empirical economic modelling (1331 papers = 75%); (5.) theoretical economic modelling (444 papers = 25%); (6.) primary data economic modelling (18 papers = 1%); (7.) secondary data economic modelling (1757 papers = 99%); (8.) long run economic modelling (1686 papers = 95%); (9.) short run economic modelling (89 papers = 5%); (10.) linear regression analysis (89 papers = 5%); (11.) multiple regression analysis (302 papers = 17%); (12.) times series data analysis (408 papers = 23%); (13.) cross-sectional data analysis (568 papers = 32%); (14.) panel data analysis (408 papers = 23%); (15.) 2-Dimensional graphical modelling (1757 papers = 99%); (16.) 3-Dimensional graphical modelling (18 papers = 1%); (17.) economic policy modelling (1740 papers = 98%); (18.) technological policy modelling (18 papers = 1%); (19.) environment policy modelling (18 papers = 1%); (20.) original theoretical framework (18 papers = 1%); (21.) traditional theoretical framework (1633 papers = 92%); (22.) extension theoretical framework (124 papers = 7%); (23.) private sector modelling (0 papers = 0%); (24.) public sector modelling (1775 papers = 100%); (25.) macroeconomics modelling (1740 papers = 98%); (26.) microeconomics modelling (36 papers = 2%); (27.) partial equilibrium modelling (178 papers = 10%); (28.) general equilibrium modelling (1598 papers = 90%); (29.) dynamic economic modelling (1598 papers = 90%); (30.) static economic modelling (178 papers = 10%); (31.) perfect competition modelling (89 papers = 5%); (32.) imperfect competition modelling (1686 papers = 95%); (33.) national level modelling (1633 papers = 92%); (34.) regional level modelling (53 papers = 3%); (35.) global level modelling (89 papers = 5%); (36.) Keynesian modelling approach (479 papers = 27%); (37.) monetary modelling approach (763 papers = 43%); (38.) classic economic modelling approach (178 papers = 10%); (39.) neo-classic economic modelling approach (337 papers = 19%); (40.) planning economic modelling approach (18 papers = 1%). (see Table 3). Moreover, it is possible to observe in the journal of economic modelling (JEM) journal almost all papers are focused on predicting economic modelling (82%) and empirical economic modelling (75%) according to our final results. In the case of data analysis modelling 99% of these papers are used secondary data economic modelling from different bibliographic and statistical sources. In the case of time framework in the data analysis modelling all these papers are based on the long run economic modelling (95%) and short run economic modelling (5%). Usually, the econometric approaches apply by different authors in the journal of economic modeling (JEM) journal is following by the uses of cross-sectional data analysis (32%), time series data analysis (23%) and panel data analysis (23%) respectively. In fact, the research approaches are used by the journal of economic modelling (JEM) journal all his papers are focused on economic policy modeling (98%) and in less amounts in technological policy modeling (5%) and others (1%). Another interesting result in this research paper is that 92% of the papers were published in the journal of economic modeling (JEM) journal. These papers are based on the uses of the traditional theoretical framework and only 1% of all these papers are based on an original theoretical framework. Additionally, 100% in the journal of economic modelling (JEM) journal papers are oriented to the public sector modelling. In the case of analysis under macroeconomics and microeconomics modelling levels are possible to be observed a distribution of 98% and 2% respectively. In addition, the journal of economic modelling (JEM) papers are supported by the general equilibrium economic modelling (90%), static policy economic modelling (10%) and imperfect competition modelling (95%). In the case of geographical coverage of research by the journal of economic modelling (JEM) journal papers are distributed by national level modelling (92%) and global level modelling by (5%). Moreover, the most
common economic theoretical framework is used by the journal of economic modelling (JEM) journal papers is followed by Keynesian modelling approach (27%), monetary modelling approach (43%), neo-classic economic modelling approach (19%) and classic economic modelling approach (10%). Finally, in the type of graphical modelling is applied by the journal of economic modelling (JEM) journal papers are based on the common use of 2-dimensional graphical modelling (99%) and only 1% applied 3-dimensional graphical modelling (see Table 3).

Table 3: Evaluation of the EM by Economic Modeling Approach (40 Variables)

<table>
<thead>
<tr>
<th>No.</th>
<th>Modeling Approach</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Predicting economic modelling</td>
<td>1456</td>
<td>82%</td>
</tr>
<tr>
<td>2</td>
<td>Monitoring economic modeling</td>
<td>142</td>
<td>8%</td>
</tr>
<tr>
<td>3</td>
<td>Simulation economic modelling</td>
<td>178</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1775</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>4</td>
<td>Empirical economic modelling</td>
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<td>75%</td>
</tr>
<tr>
<td>5</td>
<td>Theoretical economic modelling</td>
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<td>Primary data economic modelling</td>
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<tr>
<td>7</td>
<td>Secondary data economic modelling</td>
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</tr>
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<td><strong>Total</strong></td>
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<td><strong>100%</strong></td>
</tr>
<tr>
<td>8</td>
<td>Long run economic modelling</td>
<td>1686</td>
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<tr>
<td>9</td>
<td>Short run economic modelling</td>
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<td>Linear regression analysis</td>
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<td>11</td>
<td>Multiple regression analysis</td>
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</tr>
<tr>
<td>12</td>
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<tr>
<td>13</td>
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<td>14</td>
<td>Panel data analysis</td>
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</tr>
<tr>
<td>15</td>
<td>2-Dimensional graphical modelling</td>
<td>1757</td>
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</tr>
<tr>
<td>16</td>
<td>3-Dimensional graphical modelling</td>
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<td><strong>100%</strong></td>
</tr>
<tr>
<td>17</td>
<td>Economics policy modelling</td>
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</tr>
<tr>
<td>18</td>
<td>Technological policy modelling</td>
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<td>1%</td>
</tr>
<tr>
<td>19</td>
<td>Environment policy modelling</td>
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<tr>
<td>21</td>
<td>Traditional theoretical framework</td>
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<td>92%</td>
</tr>
<tr>
<td>22</td>
<td>Extension theoretical framework</td>
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<td>7%</td>
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<td><strong>Total</strong></td>
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<tr>
<td><strong>23</strong> Private sector modelling</td>
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<tr>
<td><strong>24</strong> Public sector modelling</td>
<td>1775</td>
<td>100%</td>
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<td><strong>Total</strong></td>
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<tr>
<td><strong>25</strong> Macroeconomics modelling</td>
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<tr>
<td><strong>26</strong> Microeconomics modelling</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td><strong>27</strong> Partial equilibrium modelling</td>
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<tr>
<td><strong>28</strong> General equilibrium modelling</td>
<td>1598</td>
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<td></td>
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<td><strong>Total</strong></td>
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<td>100%</td>
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</tr>
<tr>
<td><strong>29</strong> Dynamic economic modelling</td>
<td>1598</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td><strong>30</strong> Static economic modelling</td>
<td>178</td>
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<td></td>
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<td><strong>Total</strong></td>
<td>1775</td>
<td>100%</td>
<td></td>
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<tr>
<td><strong>31</strong> Perfect competition modelling</td>
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<td><strong>32</strong> Imperfect competition modelling</td>
<td>1686</td>
<td>95%</td>
<td></td>
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<tr>
<td><strong>Total</strong></td>
<td>1775</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td><strong>33</strong> National level modelling</td>
<td>1633</td>
<td>92%</td>
<td></td>
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<tr>
<td><strong>34</strong> Regional level modelling</td>
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<td><strong>35</strong> Global level modelling</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>36</strong> Keynesian modelling approach</td>
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<tr>
<td><strong>37</strong> Monetary modelling approach</td>
<td>763</td>
<td>43%</td>
<td></td>
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<tr>
<td><strong>38</strong> Classic economic modelling approach</td>
<td>178</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td><strong>39</strong> Neo-Classic economic modelling approach</td>
<td>337</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td><strong>40</strong> Planning Economy Modelling Approach</td>
<td>18</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1775</td>
<td>100%</td>
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</tbody>
</table>

**Source:** Journal of Economic Modelling (JEM) [http://www.sciencedirect.com/science/journal/02649993](http://www.sciencedirect.com/science/journal/02649993)

**4.5. The Future of Economic Modelling:**

According to this chapter the economic modelling can show a great future for social scientists. Hence, the economic modelling can be considered as an alternative flexible and dynamic research field that is available to adapt the uses of any research technique, method, methodology and research focus. According to our research economic modelling can be considered as a multi-discipline research approach that can facilitate the study of different socio-economic-political problems that can impact negatively on the society anywhere and anytime. However, we can say that economic modelling became an important technical-theoretical analytical tool for future academics, economists, policy makers and supranational institutions such as World Bank (WB), International Monetary Fund (IMF) and others. On another hand, the fast expansion of the economic modelling can be observed by the fast growth of his impact factor of economic modelling journal just recently got 0.701 in the year 2012 according Thomson Reuters report.
4.6. Conclusion

This chapter concludes that economic modelling can open a new research field to academics, policy makers and social scientist in the study of complex and dynamic behavior of sociopolitical–economic problems that can affect our society anytime and anywhere without borders. This conclusion is drawn from the review and analysis of 1775 articles published 28 years ago (1984–2012) by the journal of economic modelling (JEM). The trend of the economic modeling is changing remarkably fast, with its origins invoked by uses of new research approaches and research focus. Finally, the economic modelling can become a powerful analytical tool that accept the adaptation of any technique, methodology, method and research approach such as economics, finances, sociology, political sciences, technology, environment, econometrics, sciences to explain deeply complex socio-political and economic problems that affect different social groups in the society at different geographical areas under different historical events.

4.6. References

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

Mario Arturo Ruiz Estrada

5.1. 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).

5.2. The Model

This model attempts to use a multi-dimensional mathematical and multi-dimensional graphical approach. We propose the use of the 6-dimensional coordinate space (vertical position). This specific coordinate space offers six axes to plot five exogenous variables and one endogenous variable; this makes it possible to observe the changes of each exogenous variable and the endogenous variable within its axis separately and simultaneously in the same graphical space. We also suggest the application of the *Omnia Mobilis* assumption to generate the relaxation of the five global forces of the market. The main objective of this is to observe in real time the behavior of the market without any isolated variables. In this case, each market force is fixed into its axis. These global forces are: economic global forces ($X_1$) (See Expression 1), social global forces ($X_2$) (see Expression 2), political global forces ($X_3$) (see Expression 3), technological global forces ($X_4$) (see Expression 4) and natural global forces ($X_5$) (see Expression 5). Each global force has its specific function with a large number of factors (i) that always keep changing in real time ($\bigodot$). 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 ($\partial$), everything is running in real time ($\bigodot$) and everything directly affects the final market vulnerability trend index ($/\bigodot Y*$).

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

The measurement of each global force is based on Equation 6, where several partial derivatives ($\partial$) are running in real time ($\bigodot$) between different periods of time: past time $<t-1>$ and future time $<t+1>$.

$$
\bigodot X_i = \bigodot [\partial X_{i<+1>} / \partial X_{i<-1>}] \quad \Rightarrow \quad i = \{1,2,3,4,5\}
$$
Each global force in our model can be measured by Expression 7, 8, 9, 10 and 11. Later, each of the five global forces will be plotted directly onto its respective axis in the 6-dimensional coordinate space:

(7.) \[ \odot X_1 = \odot \left[ \frac{\partial X_{1\leq 1}}{\partial X_{1\leq 1}} \right] \]
(8.) \[ \odot X_2 = \odot \left[ \frac{\partial X_{2\leq 1}}{\partial X_{2\leq 1}} \right] \]
(9.) \[ \odot X_3 = \odot \left[ \frac{\partial X_{3\leq 1}}{\partial X_{3\leq 1}} \right] \]
(10.) \[ \odot X_4 = \odot \left[ \frac{\partial X_{4\leq 1}}{\partial X_{4\leq 1}} \right] \]
(11.) \[ \odot X_5 = \odot \left[ \frac{\partial X_{5\leq 1}}{\partial X_{5\leq 1}} \right] \]

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.) \[ /\Y/ = \frac{1}{5} \sum \left[ \frac{\partial X_i\leq 1}{\partial X_i\leq 1} \right] \Rightarrow i = \{1, 2, 3, 4, 5\} \]

However, the final measurement of the market vulnerability trend index (/\Y/) (see Expression 13) continues to apply an infinite number of partial derivatives (\(\partial\)) running in real time (\(\odot\)) (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 (\(\odot\)).

(13.) \[ /\Y/ = \odot \left[ \frac{\partial X_{1\leq 1}}{\partial X_{1\leq 1}} \right] \\odot \left[ \frac{\partial X_{2\leq 1}}{\partial X_{2\leq 1}} \right] \\odot \left[ \frac{\partial X_{3\leq 1}}{\partial X_{3\leq 1}} \right] \\odot \left[ \frac{\partial X_{4\leq 1}}{\partial X_{4\leq 1}} \right] \\odot \left[ \frac{\partial X_{5\leq 1}}{\partial X_{5\leq 1}} \right] \]

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
5.3. 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 (/\textcircled{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>/\textcircled{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 (/\textcircled{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.
5.4. 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 VI
IS THE MARKET IN A DYNAMIC IMBALANCED STATE?

Mario Arturo Ruiz Estrada

6.1. Introduction

In the study of market equilibrium from partial or general view by different theories, models and theorems, there are represented graphically in 2-Dimensions under the application of the Cartesian plane coordinate system (X,Y). The partial equilibrium shows how the independent variable “Y” (price) can affect directly on the dependent variable “X” (quantity demand) in the same graph. The partial equilibrium analysis by Marshall (1890) is supported by the assumption of Ceteris Paribus (all other things [being] the same). The idea to apply Ceteris Paribus is to isolating the rest of variables (different prices and products) can affect on the dependent variable “X” (quantity demand). In other hand, the general equilibrium assumes different prices and large number of products need to be in equilibrium in its initial stage according to Léon Walras (1874), but we also can observe that the general equilibrium from a graphical point of view continue with a strong dependency under the application of 2-D Cartesian plane.

Moreover, the application and uses of 3-Dimensional graphs and 2-D manifolds become more common among academics and researchers to explain and analyze the market equilibrium. Therefore, this research is focused to apply multi-dimensional Cartesian spaces to facilitate the visualization of complex theories, models and theorems related to the market equilibrium from a multi-dimensional view. However, we are considered into our analysis the graphical visualization of the IS-LM model by John Hicks (1934); Hicks developed a large number of pictorial diagrams to demonstrate economic principles and techniques of the economic analysis. The idea to build the IS-LM model is originated from the unclear Keynesian theory never made clear the relationship between the goods market and money market. According to Hicks, the goods market and money market need to achieve equilibrium simultaneously.

The IS curve represents the equilibrium of goods market and the LM curve shows the equilibrium of money market respectively (Pressman, 2006). If we analyzed the graphical display of both curves in the 2-D Cartesian plane (X,Y); the IS curve (goods market) need to be draw on two different 2-D Cartesian planes separately. First 2-D Cartesian plane shows the relationship between interest rate (independent variable “Y”) and investment (dependent variable “X”). The second 2-D Cartesian plane is fixed by the IS curve (goods market), it is based on the relationship between interest rate (independent variable “Y”) and output level (dependent variable “X”). In the case of the LM curve (money market) also is draw in two different 2-D Cartesian planes. The first 2-D Cartesian plane in the construction of LM curve is based on the relationship between interest rate (independent variable “Y”) and money demand/supply (dependent variable “X”) and the second 2-D Cartesian plane is possible to be observed LM curve (money market), it is based on the relationship between interest rate (independent variable “Y”) and output level (dependent variable “X”).

Finally, we can observe that in the initial state to build these two curves (IS-LM) are plotted separately in different 2-D Cartesian planes in the first quadrant. Therefore, we are not available to observe different steps in the construction of each curve (or market) in the same space and time, each curve (or market) only can be displayed separately, but it is possible to visualize both markets in equilibrium until both curves (IS-LM curves) join in the same 2-D Cartesian plane. The IS-LM curve from a graphical view
also can help to visualize the effect of fiscal policy on the goods market performance through the IS curve allocation in its quadrant.

On another side, the monetary policy effect on the money market performance through the LM curve allocation into its 2-D Cartesian plane respectively. In fact, this chapter proposes the application of MFP-Cartesian spaces to join all curves (or sub-markets) in the same Cartesian space to visualize the market behavior as a whole. The MFP-Cartesian space will open the possibility to generate 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 MFP-Cartesian space is available to show eleven independent variables and fifteen dependent variables in the same Cartesian space. At the same time, the MFP-Cartesian space can offer the possibility to observe clearly how large numbers of dependent variables interact with its independent variable simultaneously.

6.2. The Application of Multi-Functional Pictorial Cartesian Space (MFP-Cartesian Space) in the Graphical Modeling of Dynamic Imbalanced State of the Market

The MFP-Cartesian space (see Ruiz, 2006) will accommodate into its analysis five sub-markets in the same Cartesian space. The MFP-Cartesian Space comprises five sub-markets are fixed into five general axes (A₀, A₁, A₂, A₃ and A₄) in different perimeters levels (PL₀, PL₁, PL₂ and PL₃…) and large number of windows refractions¹ (W₀, W₁, …, Wₙ…). We assume that the market is divided by five sub-markets are: 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 idea to exclude exports sub-market (PE curve) and technological sub-market (IT curve) from goods sub-market (IS curve) is originated by the necessity to observe separately how the exports sub-market and technological sub-market dynamicity and vulnerability. Another reason to take out exports and technological sub-markets from goods sub-market is to propose an alternative methodology to apply in the policy modeling and policy implementation and evaluation. This approach can show a different analytical approach from the traditional IS-LM model (goods market and money market). The idea to dismember the exports sub-market and technological sub-market from the goods sub-market by parts, it is to have a better understanding of exports sub-market and technological sub-market behavior independently. Finally, the last assumption in this approach suggests that all sub-markets are in a permanent movement all the time in the same space (graph). Therefore, MFP-Cartesian space is available to generate this multi-dimensional effect to visualize several numbers of sub-markets in the same time and space.

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

The first analysis section is the study of goods sub-market under the general axis (A₀). The A₀ is divided by three windows refraction (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) to build the first curve, the same curve is moving in different positions into the same window refraction continuously. The changes into the same curve or different positions of the curve in the first window refraction, it is depending on the interest growth rate (i) behavior. To show some examples about possible changes into the same curve in the first window refraction on the A₀, we like to mention two possible scenarios follow by: (i) First scenario, if the interest growth rate (i) increases then the investment growth rate (I) fall. (ii) The second scenario, if interest growth rate (i) decrease then the investment growth rate (I) rise. The second window refraction on A₀ exhibit the construction of IS curve, the IS curve is based on the relationship between the interest growth rate (i) and the output growth rate (O). Moreover, the IS curve
show two scenarios follow by: (iii) First scenario, if the interest growth rate (i) increase then the output growth rate (O) fall and (iv). Second scenario, if the interest growth rate (i) decrease then the output growth rate (O) rise (see Figure 1). Finally, the A0 show 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 into its windows refraction respectively, it is based on the application of Omnia Mobilis assumption (everything is moving) by Ruiz, Shyamala and Yap (2007). The IS curve in the short or long run can find anytime its “momentum of balance synchronization stage” together with the another four sub-markets (money sub-market –LM curve-, exports sub-market –PE curve-, labor sub-market –IL- and technological sub-market –IT curve-). The goods sub-market under general axis 0 (A0) is fixed in three different windows refractions follow by:

\[
A_0 = I = f(i) / O = f(i) / Y = f(O)/
\]

**Figure 1: The Goods Sub-Market Analysis under the General Axis 0 (A0): IS 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 demand/supply growth rates (Md/s). Basically, this chapter apply a basic assumption in the construction of LM curve: The money demand growth rate and the money supply growth rate are in permanent imbalance state all the time. Therefore, the money demand growth rate does not necessarily be equal to the money supply growth rate. The second window refraction space, on the other hand, it shows the relationship between the interest growth rate (i) and the output growth rate (O) that LM curve is constructed. The LM curve (money sub-market) show infinity possibilities to be located in different places into the second window refraction in the short or long run. To simplify the LM curve (or money sub-market) behavior, the LM curve can show two scenarios. (i) First scenario, if the interest growth rate (i) increase then the output growth rate (O) rise. Finally, (ii) the second scenario, if the interest growth rate (i) decrease then the output growth rate (O) fall respectively. In the same general axis 1 (A1)
on the third window refraction is included 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 IS, PE, IL and IT curves simultaneously. The momentum of balance synchronization stage is depending on the relaxation of these five sub-markets originated from the economic, social, political, technological natural & environment forces behavior. Therefore, the LM curve is moving all time (never stop) into its windows refraction. It is based on the application of Omnia Mobilis assumption (Ruiz, Shyamala and Yap, 2007) to simulate a real time environment. The money sub-market under general axis 1 \( (A_1) \) is fixed into the three windows refraction follow by:

\[
A_1 = \frac{\text{M}_{\text{d/s}}}{\text{O}} = f(\text{i}) / \frac{\text{O}}{\text{Y}} = f(\text{O})/\text{Y} = f(\text{O})/
\]

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

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

The third section of the MFP-Cartesian Space shows the analysis of exports sub-market through the production/exports (PE) curve (see Figure 3). The PE curve will explain how the interest growth rate \( (i) \) can affect the production growth rate \( (P) \) and the exports growth rate \( (X) \) respectively. We assume the three windows refractions apply Omnia Mobilis assumption. It is to keep all the windows refraction on \( A_2 \) in permanent movement in the same space and time. To show some simple examples about possible scenarios, 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, if the interest growth rate \( (i) \) increases then the total production growth rate \( (P) \) falls. And (ii) second effect, if the interest growth rate \( (i) \) decrease then the total production growth rate \( (P) \) rise. In the second window refraction space show 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 \( (P) \) increase then the exports growth rate \( (X) \) rise, or (iv) if the total production growth rate \( (P) \) decrease then the exports growth rate \( (X) \) fall in the economy (See Figure 3). In the last window refraction in the same general axis 2 \( (A_2) \) shows the relationship between the income
growth rate (Y) in different levels of exports growth rate (X) (see Expression 3). Finally, the PE curve also searching for its “momentum of balance synchronization stage” anytime together with IS, LM, IL and IT curves simultaneously anytime. The exports sub-market under general axis 2 (A2) is fixed in three windows refraction follow by:

\[
A_2 = \frac{P}{X} = f(P) \quad \text{and} \quad Y = f(X)
\]

**Figure 3: The Exports Sub-Market Analysis under the General Axis 2 (A2): PE Curve**

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d. The Labor Sub-Market Analysis under the General Axis 3 (A3): IL Curve

The labor sub-market is represented graphically by the investment/labor demand (IL) curve. All windows refraction on the general axis A3 applied the Omnia Mobilis assumption (everything is moving). This part of the chapter is interested to show 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 multidimensional 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). We have two scenarios, there are: (i) First scenario, if the interest growth rate (i) increase then the investment growth rate (I) fall. (ii) Second scenario, if the interest growth rate (i) decrease then the investment growth rate (I) rises in the first window refraction. In 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) increase then it can generate a high labor demand growth rate (Ld), but (iv) if the investment growth rate (I) decrease then it can only generate a low labor demand growth rate (Ld) into the labor market (See Figure 4).

The third window refraction on A3 shows a downward slope in the relationship between the labor demand growth rate (Ld) and unemployment growth rate (UE). Finally, in the last window refraction on the general axis 3 (A3), it is showing the relationship between the income growth rate (Y) under different levels of unemployment growth rate (UE) (see Expression 4). The IL curve also can find its “momentum of balance synchronization stage” anytime together with IS, LM, PE and IT curves simultaneously. The momentum of balance synchronization stage among the five markets is unexpected and faster according
to economic, political, technological, social and natural & environment forces behaviors. The labor sub-market under general axis 3 (A₃) is fixed into four windows refraction follow by:

\( A₃ = /I=f (i)/ \mathbb{R}/ /Ld = f (I)/ \mathbb{R}/ /UE = f (Ld)/ \mathbb{R}/ /Y = f (UE)/ \)

**Figure 4: The Labor Sub-Market Analysis under the General Axis 3 (A₃): IL Curve**

\[ \text{Figure 4: The Labor Sub-Market Analysis under the General Axis 3 (A₃): IL Curve} \]

Lastly, the study of the technological sub-market under the general axis (A₄) is divided by four windows refraction (see Expression 5). The first window refraction on the general axis 4 (A₄) 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 (A₄) shows the relationship between the productivity growth rate \(Pro\) and the investment growth rate in technology \(I\).

The last window refraction on A₄ exhibits the relationship between the income growth rate \(Y\) based on different levels of the exports growth rates \(X\). Moreover, the third window refraction show two scenarios follow by: (i) First scenario, if the exports growth rate \(X\) increases then the income growth rate \(Y\) rises. (ii) The second scenario, if the productivity growth rate \(Pro\) decrease then the income growth rate \(Y\) fall (see Figure 5).

The technological sub-market under the general axis 4 (A₄) is fixed into four windows refraction respectively under the application of Omnia Mobilis assumption. The IS curve can find its "momentum of balance synchronization stage" together with the another four sub-markets (goods sub-market –IS-, money sub-market –LM curve-, exports sub-market –PE curve- and labor sub-market –IL-) anytime. The technological sub-market under the general axis 4 (A₄) is fixed into four windows refraction respectively follows by:

\( A₄ = /I=f(i)/ \mathbb{R}/ /Pro =f(I)/ \mathbb{R}/ /X=f(Pro)/ \mathbb{R}/ /Y=f(X)/ \)
f. Dynamic Imbalance State (DIS)

In broad terms, the MFP-Cartesian Space provides a platform to analyze five different sub-markets that are incorporated in the same Cartesian space: (i) goods sub-market (IS curve), (ii) money sub-market (LM curve), (iii) exports sub-market (PE curve) and (iv) the labor sub-market (IL curve) (v) the technological sub-market (IT curve) (See Figure 6). It is assumed that all sub-markets are operated simultaneously in the same space and time; thereby presenting the Dynamic Imbalance State (DIS) that will support all possible sub-market environments under study. The DIS is based on the application of Omnia Mobilis assumption (everything is moving).

The dynamic imbalanced state is not chaos; it is an unconditional and unexpected complex sensitive reaction of all sub-markets that it is generated by different economic, political, social, technological, natural & environment 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) does not necessarily need to be in equilibrium simultaneously, because all markets are in a dynamic imbalanced state. 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 anytime. Therefore, the equilibrium state will be replaced by “the momentum of balance synchronization stage”, the time to appear “the momentum of balance synchronization stage” depend on the relaxation of the five sub-markets anytime.

This chapter argument is that the market equilibrium does not a static and isolated phenomenon, it is a transitional and evolutionary stage cannot be controlled and determined arbitrarily. We need to remember that the study of the market equilibrium, it is not a natural phenomenon can be measured or demonstrate exactly by sciences. The market equilibrium is in a dynamic imbalance state all the time, where the market is defined as the interaction among humans to satisfy necessities in different levels, it is depending on two basic conditions: First, the economic, social, political, technological and natural & environmental forces behavior. Second, it is the historical period of time and the efficient allocation of resources to maximize human necessities (profit or consumption). Therefore, the market behavior cannot
be forecasting easily because the all forces mentioned before, there are unpredicted and uncertain in time and space.

**Figure 6: The Dynamic Imbalance State (DIS)**

6.3. Concluding Remarks

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

6.4. Endnotes

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

CHAPTER VII
BEYOND THE CETERIS PARIBUS ASSUMPTION:
MODELING DEMAND AND SUPPLY ASSUMING OMNIA MOBILIS

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7.1. Introduction

The *ceteris paribus* assumption can be considered a vital tool in the process of building economic models to explain complex economic phenomenon. This assumption translated from Latin means “all other things [being] the same”. It facilitates the description of how a variable of interest changes in response to changes in other variables by examining the effect of one variable at a time. An extremely important contribution of Alfred Marshall, it supports the understanding of the application of *ceteris paribus* assumption in economic models. According to Marshall (1890, v.v.10):

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

Marshall’s approach thus allows the analyses of complex economic phenomena by parts where each part of the economic model can be joined to generate an approximation of the real world. This approach can be termed the Isolation Approach and according to Marshall (Schlicht, 1985, p.18) originates from two possible Isolation clauses. First the *ceteris paribus* assumption allows some variables to be considered unimportant. This clause is called Substantive Isolation. Substantive Isolation considers that some unimportant variables cannot significantly affect the final result of the economic model. Second, the *ceteris paribus* assumption allows the influence of some important factors to be disregarded. The application of the *ceteris paribus* assumption in this case is purely hypothetical; therefore, the second clause is called Hypothetical Isolation. It allows parts of the model to be managed more easily.

In other words, to explain a complex economic phenomenon, the *ceteris paribus* approach considers the effect partially of each variable in a set of m variables (termed usually independent variables, \( X_j , j = 1, 2, \ldots, m \)) upon a variable of interest (usually termed the dependent variable, \( Y \)). From a mathematical point of view, the *ceteris paribus* assumption in an economic model is equivalent to the partial derivative, which explains how one independent variable, say \( X_k \), in a set of independent variables can affect the dependent variable \( Y \) while the other independent variables are being held constant. From a graphical point of view, the *ceteris paribus* assumption supports the elaboration of scenarios that can be visualized on 2-Dimensional (X,Y) space. More precisely if \( Y \) is a function of, say, \( X_1 \) and \( X_2 \), the (partial) relationship between \( Y \) and \( X_1 \) can be visualized in the 2-D space describing \( Y \) and \( X_1 \), assuming \( X_2 \) is...
held constant. In order to approximate real world, Marshall (1890, v.v.10) goes on to propose that “With each step more things can be let out of the pound; exact discussions can be made less abstract, realistic discussions can be made less inexact than was possible at an earlier stage.” The real-world scenario is thus approximated by the cumulative effect of the partial effects of the X variables on Y.

With the availability of multi-dimensional graphs based on the application of Cartesian Spaces (Ruiz, 2007, p.5), it is possible to visualize what we call the Omnia Mobilis (everything is moving) assumption. The Cartesian space is used to generate is used to generate multi-dimensional-graphs with different dimensions that can be shown to move with time. But more than that, the multi-dimensional graph provides an alternative to the Marshall view of step-by-step cumulative partial approach to modeling a complex economic phenomenon.

In this chapter we are concerned with the application of multi-dimensional graphs in visualizing and modeling total change in an independent in response to changes in any or all of the (many) independent variables affecting it within the same framework of space and time. The multidimensional-graph can also be used to describe dynamic and multi-functional analyses that represent changes within the total function of an economic variable. The next section discusses the application of multi-dimensional graphs to model demand and supply. The third section concludes the chapter.

7.2. Visualizing and Modeling Demand and Supply Surfaces

Concerning the graphical methods for modeling demand and supply, it is necessary to mention the significant contributions of Antoine Augustin Cournot. Cournot (1897, p.427) derived the first formula for the rule of supply and demand as a function of price. He was also the first economist to draw supply and demand curves on a graph (2-Dimensional view). Cournot believed that economists should utilize graphs only to establish probable limits and express less stable facts in more absolute terms. He further held that the practical use of mathematics in economics involves not only strict numerical precision, but also graphical visualization. Besides Cournot, other innovative economists who contributed to the analytical graph system in economic models over time were William Stanley Jevons, Marie-Auguste Léon Walras, Vilfredo Pareto, Alfred Marshall and Francis Ysidro Edgeworth (McClelland, 1976, p. 97).

In this section, we describe the application of multi-dimensional graphs to the analysis of demand and supply. The supply and demand model determines the quantity sold in the market. The usual model predicts that in a competitive market, price will function to equalize the quantity demanded by consumers and the quantity supplied by producers, resulting in an economic equilibrium of quantity. The application of multi-dimensional graphs allows the visualization and modeling of the effect of other variables on quantity demanded and supplied. With this application, the quantity sold in the market will equal quantity demanded only under certain circumstances. In other cases, the quantity sold in the market will be a balance between the demand and supply quantities.

The application of the Infinity Cartesian Space (I-Cartesian Space) (Ruiz, 2006, p.3) is used to obtain demand and supply surfaces that replace the usual 2-Dimensional (and 3-Dimensional) demand and supply lines. The general function to build demand and supply cylinders is given below by:

\[ Y_{C:L} = f_C ([X_{C:L,j}, P_{C:L,j}, R_{C:L,j}], j = 1, \ldots, mc) \]

Where:

- \( C = \{1, 2\} \) is the Cylinder, \( C = 1 \) for the demand cylinder and \( C = 2 \) for the supply cylinder
- \( L = \{1, 2, 3, \ldots, n\}, n \to \infty \), is the Level
is the number of independent variables in cylinder C
\( X_{C:1:j} \) is the independent variable \( j \) in cylinder C at level L lying in position \( P_{C:1:j} \) with value \( R_{C:1:j} \);
\( P_{C:1:j}, 0^\circ \leq P_{C:1:j} < 360^\circ \), is the position of \( X_{C:1:j} \) in cylinder C at level L;
\( R_{C:1:j} \) is the radius corresponding to the \( X_{C:1:j} \) in cylinder C at level L
\( Y_{C:L} \) is the dependent variable, quantity demanded (C=1) and quantity supplied (C=2) at level L

**Assumptions**

1. Application of *Omnia Mobilis* assumption.
2. The set of independent variables affecting demand are not necessarily the same as that for supply; however price is common to both sets.
3. The set of independent variables for demand and for supply are available for the same number of levels, that is, “n”. Usually the level represents time.
4. The unit of measurements of all variables is the same. For example, all variables can be measured in terms of growth.
5. Price is the independent variable \( X_{C:1:1} \), located at position \( P_{C:1:1} = 1^\circ \) in both cylinders and for all levels. Since price in the demand cylinder must equal price in the supply cylinder, the radius \( R_{1:1:1} = R_{2:1:1} \)

**Definitions**

1. The Balance Line, \( BL_L \), is the line that joins \( Y_{1:L} \) and \( Y_{2:L} \) at level L.
2. The Balance Point is a point on \( BL_L \) that indicates the quantity sold at level L.
3. The Balance Quantity Line (BQL) is the vertical line that connects all the Balance Points, \( L = 1, \ldots, n \). It forms the hinge between the demand and supply cylinders and at each level L and in each cylinder it is located at \( P_{C:L:0} = 0^\circ \).

**The Demand Cylinder**

As seen from Figure 1, the demand cylinder is a series of \( n \) sub-cylinders, one for each level. For a given sub-cylinder, say for \( L=1 \), the values of the \( m_1 \) independent variables \( X_{1:1:j} \) affecting demand \( Y_{1:L} \) are plotted on the base of the sub-cylinder as the radii. The value of a specific independent variable at time point 1, say \( X_{1:1:1} \) is plotted as \( R_{1:1:1} \) the radius pictured lying on a flat surface at angle \( P_{1:1:1} \) measured from \( 1^\circ \) line used for price as its reference line. The points from the end of the radii are joined to meet in a single point on the top of each sub-cylinder at height \( Y_{1:1} \), the quantity demanded at time L. The diameter of the sub-cylinder is twice the maximum radius. The demand function is expressed as:

\[
Y_{1:L} = f_1 ([X_{1:L:j}, P_{1:L:j}, R_{1:L:j}], j = 1, \ldots, m_1)
\]

**The Supply Cylinder**

Similarly, the supply cylinder is a series of \( n \) sub-cylinders, one for each level. For a given sub-cylinder, say for \( L=1 \), the values of the \( m_2 \) independent variables \( X_{2:1:j} \) affecting demand \( Y_{2:L} \) are plotted on the base of the sub-cylinder as the radii. The value of a specific independent variable at time point 1, say \( X_{2:1:1} \) is plotted as \( R_{2:1:1} \) the radius pictured lying on a flat surface at angle \( P_{2:1:1} \) measured from \( 1^\circ \) line used for price as its reference line. The points from the end of the radii are joined to meet in a single point on the top of each sub-cylinder at height \( Y_{2:1} \), the quantity supplied at time L. The diameter of the sub-cylinder is twice the maximum radius. The supply function is expressed as

\[
Y_{2:L} = f_2 ([X_{2:L:j}, P_{2:L:j}, R_{2:L:j}], j = 1, \ldots, m_2)
\]
The Demand and Supply Surfaces

The demand and supply surfaces are placed side by side as shown in Figure 2, the sub-cylinder for level L for demand being adjacent to the sub-cylinder for level L for supply. The maximum height of the sub-cylinders at level L will be the maximum of $Y_{1:L}$ and $Y_{2:L}$. The demand and supply surfaces are then two oblique cylinders consisting of sub-cylinders of varying diameters. The two cylinders are hinged on a common line located at position $P_{C_{L,0}} = 0^\circ$. This common line is called the Balance Quantity Line (BQL) and connects all the Balance Points which show the quantities sold in the market at all the different levels.
The Balance Line, Balance Point and Changes in Demand and Supply

The balance line, BLₗ, is the line that connects Y₁,₁ₗ and Y₂,₁ₗ in sub-cylinder L. This line may be linear as shown in Figure 3 or non-linear. The quantity sold in the market lies somewhere on this line given by the Balance Point, BPₗ. The quantity sold is thus viewed as a “balance” between demand and supply quantities. Thus,

\[ BPₗ = g(Y₁,₁ₗ, Y₂,₁ₗ) \]

In other words, the quantity sold in the market is a function not only of the common price but also of all the factors that affect supply and demand. This suggests that demand and supply quantities can remain in disequilibrium at time L.
Example
If we assume that BLₜ is a straight line, then its slope is given by
\[ S_L = \frac{|Y_{1:L} - Y_{2:L}|}{\max_j \{R_{1:L:j}\} + \max_j \{R_{1:L:j}\}} \]

As demand or supply changes from one level to the next, the slope of the line will change. The Balance Point, however, may or may not change as that depends on the joint effect of all variables that affect quantity. In order to understand the Balance Line, it is useful to consider three scenarios:

Scenario 1: Only one independent variable, price; demand equals supply
Scenario 2: More than one independent variable; demand equals supply
Scenario 3: More than one independent variable; demand does not equal supply

Figure 3 shows the demand and supply surfaces for each of these scenarios for levels L=1, 2 and 3 with assumed data.

Scenario 1
In this case, the two cylinders will be of same diameter and will be straight cylinders, that is, the midpoints of the cross-sectional circles will be on the same line. Quantity demanded equals quantity supplied, and the quantity sold in the market is the equilibrium quantity under the *ceteris paribus* assumption. With \( Y_{1:1} = Y_{2:1} \), \( S_L = 0 \). The Balance Line is thus a horizontal line (See figure 3).

The demand and supply functions are
\[ Y_{1:1} = f_1 ([X_{1:1:1}, P_{1:1:1}, R_{1:1:1}]) \quad Y_{2:1} = f_2 ([X_{2:1:1}, P_{2:1:1}, R_{2:1:1}]) \]

The graph for level L=1 is:
Demand Cylinder Supply Cylinder
\( Y_{1:1} = 4 \) \( Y_{2:1} = 4 \)
\( R_{1:1:1} = 3 \) (price) \( R_{2:1:1} = 3 \) (price)

The slope of the Balance Line is
\( S_L = (4-4)/(3+3) = 0/6 = 0 \)

The Balance Point showing the quantity sold in the market at level 1 is
\( BP_1 = Y_{1:1} = Y_{2:1} = 4 \)

Scenario 2
Since \( Y_{1:2} = Y_{2:2} \), the slope of the Balance Line will be zero and quantity demanded equals quantity supplied and the quantity sold in the market equals the equilibrium quantity under the *ceteris paribus* assumption. In this situation, the quantity sold under the *omnia mobilis* assumption does not differ from that under the *ceteris paribus* assumption. That is, the other variables besides price have the same effect as price on the quantity supplied or demanded (see figure 3).

The demand and supply functions are
\[ Y_{1:2} = f_1 ([X_{1:2:j}, P_{1:2:j}, R_{1:2:j}], j = 1, \ldots, 9) \quad Y_{2:2} = f_2 (X_{2:2:j}, P_{2:2:j}, R_{2:2:j}, j = 1, \ldots, 9) \]

The graph for level L=2 is:
Demand Cylinder Supply Cylinder
\( Y_{1:2} = 5 \) \( Y_{2:2} = 5 \)
\( R_{1:2:1} = 5 \) (price) \( R_{2:2:1} = 5 \) (price)
The slope of the Balance Line is
\[ S_L = \frac{(5-5)}{(5+5)} = 0/10 = 0 \]

The Balance Point showing the quantity sold in the market at level 2 is
\[ BP_2 = Y_{1:2} = Y_{2:2} = 5 \]

**Scenario 3**

Finally consider Scenario 3, where \( Y_{1:3} \neq Y_{2:3} \). In this case, the diameters of each sub-cylinder for the two cylinders would be different; the cylinders become oblique. Then the Balance Line will slope down towards the sub-cylinder with the lower quantity. The quantity sold will be shown by the Balance Point, a point on this line determined by all the independent variables in both the demand and supply cylinders. In this situation, the quantity sold under the *omnia mobilis* assumption differs from that under the *ceteris paribus* assumption (see figure 3).

The demand and supply functions are
\[ Y_{1:L} = f_1 ([X_{1:3:j}, P_{1:3:j}, R_{1:3:j}], j = 1, \ldots, 9) \]
\[ Y_{2:L} = f_2 ([X_{2:3:j}, P_{2:3:j}, R_{2:3:j}], j = 1, \ldots, 9) \]

The graph for level \( L=3 \) is:

**Demand Cylinder**

<table>
<thead>
<tr>
<th>( X_{1:3:1} = 5 ) (price)</th>
<th>( X_{2:3:1} = 5 ) (price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( X_{1:3:2} = 3 )</td>
<td>( X_{2:3:2} = 4 )</td>
</tr>
<tr>
<td>( X_{1:3:3} = 5 )</td>
<td>( X_{2:3:3} = 2 )</td>
</tr>
<tr>
<td>( X_{1:3:4} = 5 )</td>
<td>( X_{2:3:4} = 4 )</td>
</tr>
<tr>
<td>( X_{1:3:5} = 6 )</td>
<td>( X_{2:3:5} = 4 )</td>
</tr>
<tr>
<td>( X_{1:3:6} = 3 )</td>
<td>( X_{2:3:6} = 4 )</td>
</tr>
<tr>
<td>( X_{1:3:7} = 5 )</td>
<td>( X_{2:3:7} = 5 )</td>
</tr>
<tr>
<td>( X_{1:3:8} = 5 )</td>
<td>( X_{2:3:8} = 6 )</td>
</tr>
<tr>
<td>( X_{1:3:9} = 6 )</td>
<td>( X_{2:3:9} = 5 )</td>
</tr>
</tbody>
</table>

The slope of the Balance Line is
\[ S_L = \frac{(5-4)}{(6+6)} = 1/12 \]

The Balance Point showing the quantity sold in the market at level 3 will lie between 4 and 5.
\[ BP_3 \neq Y_{1:3} = 5 \text{ and } BP_3 \neq Y_{2:3} = 4 \]
7.3. Conclusion:

The use of the *ceteris paribus* assumption is linked to the type of graphs used such as 2-Dimensional and conventional 3-Dimensional graphs. The multi-dimensional graph goes beyond the traditional approach to allow the visualization of the *omnia mobilis* (everything is moving) assumption and further provides an alternative to modeling total change in a dependent variable. In order to demonstrate the applicability of multi-dimensional graphs we have used it in the context of demand and supply. The approach shows that quantity sold in the market is not necessarily equal to the quantity demanded or supplied when the effect of independent variables other than just price is taken into account. Quantity demanded and supplied are mostly in disequilibrium and the quantity sold is a joint function of all the independent variables that affect supply and demand.
7.4. References:
CHAPTER VIII
HOW EFFECTIVE IS POLICY MODELING IN ANALYZING AND SOLVING REAL SOCIO-ECONOMIC PROBLEMS?

Mario Arturo Ruiz Estrada and Ibrahim Ndova

8.1. Introduction
This chapter evaluates the effectiveness of policy modeling in analyzing and solving real socio-economic problems through the use of secondary data (bibliographical sources) primarily from the journal of policy modeling and primary data, mainly questionnaires used to draw a range of diverse opinions from analysts and columnists specialized in finance and economic issues, academics, government advisers, supranational institutions’ researchers, and think tank analysts. In light of the fact that policy formulation and policy implementation go hand in hand for optimal effectiveness, we propose the need for subsequent policy modeling studies to acutely present a policy implementation section in their research manuscripts. In the same way, there is need for some degree of credibility in any proposed policy implementation strategies that may be drawn from policy modeling studies. To this end, we find appropriate the use of a new index called ‘Policy Implementation Effectiveness (PIE-index)’, a tool to evaluate policy modeling papers. It is pertinent to note that the use of effectiveness in this chapter is particularly in light of the applicability of policy modeling papers to analyze and solve fully or partially real socio-economic problems that affect society on different levels. The chapter is organized in seven sections starting with the methodology in section two. Section three presents the general aspects of the perception about policy modeling, while an introduction to our proposed ‘policy implementation’ section in policy modeling papers is presented in section four. Similarly, section five presents our new index, the policy implementation effectiveness index (PIE-index), with which policy modeling papers could be evaluated. In section six, we illustrate the application of PIE-Index and PIE-Surface, while section seven closes the chapter with discussion and conclusion.

8.2. Methodology
We devised a simple yet concrete methodology primarily based on both primary and secondary data. The methodology is divided into three basic stages. The first stage involves the reading of a single paper entitled “The Crisis of European Monetary Union – Lessons to be Drawn” by Otmar Issing (2011). This paper was placed among the top twenty-five hottest articles in economics, econometrics and finance by the journal of policy modeling in the year 2011 (sciences direct – Elsevier group, 2013). The main reason why we chose this paper had to do with its readability, clear methodology, and its relevance in terms of the huge amount of information it supplies to readers. Importantly, the paper fits appropriately to realizing the main objective of the present article. Moreover, deconstructing such a paper is highly relevant to our understanding and approach to the economic and financial crisis in the Eurozone that affects us in different ways.
The second stage involves the design of a multi-input-output table specifically for the research, which is based on nine main-variables (nine main questions) and forty sub-variables (forty sub-questions). Still on this stage, we sent by E-mail a short questionnaire with its feedback deemed helpful to completing our multi-input-output table. Specifically, the email questionnaire was sent to a group of prestigious analysts and columnists specialized on finance and economics issues (five readers), academics (five readers), government advisers (five readers), supranational institutions’ researchers (five readers), and think tank analysts (five readers). In addition, the entire twenty-five experts were given a period of one month to finalize their readings of Issing’s (2011) paper and hence, expected to return by email their respective responses to the questionnaire.

The last stage pertains to the storage and analysis of our database drawn from the twenty-five expert readers. Each question was evaluated and analyzed carefully for a much better understanding of the perception about policy modeling in analyzing and solving real socio-economic problems from different points of view. Finally, results from each questionnaire were transferred to the multi-input-output table (see Table 1). The multi-input-output table helps to calculate the PIE-Index as well as the visual representation of multidimensional graphs that could be used to observe the trend of readers about the applicability of policy modeling papers in analyzing and solving socio-economic problems. Furthermore, we propose the introduction of a new section called ‘Policy Implementation’ to be featured in subsequent policy modeling papers. The policy implementation section in policy modeling papers is highly relevant in that it makes possible the applicability of policy modeling papers to solving real socio-economic problems through the use of Policy Implementation Effectiveness index (PIE-index)’ from where analysis of policy modeling papers and the degree of their strengths to solving real socio-economic problems are drawn.

8.3. General Aspects about the Perception of Policy Modeling
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. To this end, policy modeling according to Ruiz Estrada (2011) is 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. Though this definition gives a clear view of what policy modeling entails, however, there is a huge array of divergences in its interpretation by experts in the different niches of society’s superstructure. This is particularly evident in the opinions of our twenty-five experts sampled for the study.

Recent publications by the lead author of this article in the journal policy modeling (JPM) entitled ‘Policy modeling: definition, classification and evaluation’ (Ruiz Estrada, 2011) and ‘The origins and evolution of policy modeling’ (Ruiz Estrada and Yap, 2013) provide deep insights into policy modeling following the introduction of a basic theoretical framework of policy modeling. Hence, this third paper is complementary as it attempts to finalize the cycle of policy modeling theoretical papers in the journal of policy modeling with a more pragmatic approach to analyzing and solving real socio-economic problems that affects society on different levels.
Since we are more concerned about the applicability of policy modeling studies to solving real life issues, the gold question here is how large is the gap between theory and reality that sometimes limits our understanding, makes us unsafe and suspicious in the praxis of policy modeling? The answer to this question could be found in the results generated from the different point of views of our expert readers, which follows subsequently.

It was observed that some of the expert readers expressed some level of distrust about academic papers on policy modeling after reading the paper authored by Issing (2011). Similarly, quite a number of them found certain difficulties in the course of reading and understanding complicated econometrics models. A tangible explanation to these responses could be attributed to the origin of database sources used for analysis in the said paper. Also, the use of complex economic terms and different economic theories makes understanding almost impossible and hence, drastically reduces readers’ interest in the said academic paper. This opinion is shared by analysts and columnists specialized in finance and economics issues as well as government advisers. Apparently, these experts tend to prefer simple and straightforward articles that make for easy reading, understanding, and a source of basic knowledge from where basic cause-effect deductions can be made. However, the reactions of other readers such as academics, supranational institutions’ researchers and think tanks analysts were positive in that they expressed deep interest in reading the academic paper. In light of these observations, it is apt to stress that the impact of this academic paper in analyzing and solving real socio-economic problems is ready-witted according to the different readers. Nevertheless, the present research is particularly curious to gather the perceptions of all expert readers about policy modeling after their readings of the academic paper by Issing (2011).

From the frequency distribution, we found that 63% classified policy modeling as a theoretical tool, 23% considered it a technical tool while the remaining readers (15%) classified it a mix of both tools. Another issue touched on in this research relates to the difficulty in reading the academic paper. To this end, we found that 36% of all readers encountered some form of problem trying to read this paper, whereas 64% of them had a clear picture about the European financial crisis. In addition, we asked the expert readers to adjudge the possibility of applying this academic paper to analyzing and solving the European financial crisis. Following their responses, 28% fully agreed that the paper can be considered relevant to understanding the present situation of the European financial crisis and even providing possible solutions, but the large part of readers 72% disagreed fully. The next question solicits from the readers their conviction on the question if the database used by the said academic paper can be trusted in analyzing the European financial crisis in our days? The results show that 46% of readers find useful the database of the academic paper and 54% of readers disagree with the paper’s database. With regards to the last question about which part of the academic paper they find more interesting to read; it was observed that a large number of readers (46%) were only interested to read the comments. This is followed by those (23%) that prefer to search for data, while 20% of them prefer to read the possible scenarios in the future about the European financial situation, with 20% solely interested to get only a general idea about the European financial crisis.
8.4. An Introduction to the ‘Policy Implementation’ Section in Policy Modeling Papers

Following the results from our research on the effectiveness of policy modeling papers in analyzing and solving real socio-economic problems, we propose the need to include a ‘policy implementation’ section in policy modeling papers. The main reason behind the policy implementation section as a complementary to policy modeling papers is to empirically assist such academic papers to propose clear, practical, suitable, realistic, and effective policies that could solve fully or partially real socio-economic problems that affect society on different levels. This is a special section that should be strategically positioned after the conclusions and before the references, with its applicable policy implementation strategies for management and institutional levels cogently and lucidly summarized, at most, within a page. Moreover, the credibility of this section as an appendage of policy modeling papers in solving real socio-economic problems affecting society largely depends on the evaluation of policy modeling, which leads us to propose a new index to that effect called ‘policy implementation effectiveness (PIE-index).

8.5. The Policy Implementation Effectiveness (PIE-index)

With the Omnia Mobilis assumption (Ruiz Estrada, 2011), this chapter proposes the ‘Policy Implementation Effectiveness (PIE-index)’ as a tool to evaluate policy modeling in analyzing and solving real socio-economic problems. This purpose-built index performs the following functions: (i) to evaluate the consistency level of any policy; (ii) to identify the strengths and weaknesses of any policy.

The construction of the PIE-Index involves the use of forty (40) sub-variables distributed in nine (9) main-variables. These 9 main-variables are: (X₁) policy vision; (X₂) policy approach; (X₃) database sources; (X₄) policy orientation; (X₅) type of policy; (X₆) policy institutional vision; (X₇) applicability of this policy; (X₈) policy geographical coverage; (X₀) policy benefits.

There are three basic steps in the implementation of the PIE-Index. These steps are: (i) the use of multi-input-output table; (ii) classification of variables and identification of parameters; (iii) measurement of the PIE-Index.

8.6. Steps to Implement PIE-index

8.6(i) Use of Multi-Input-Output Table

The multi-input-output table (see Table 1) 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 PIE-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 in measuring a single value, which is the PIE-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” and “1”) helps to maintain a balance among all variables.
### Classification of Variables and Identification of Parameters

The construction of the PIE-Index involves 9 main-variables and 40 sub-variables. The 9 main-variables are: (X₁) policy vision; (X₂) policy approach; (X₃) database sources; (X₄) policy orientation; (X₅) type of policy; (X₆) policy institutional vision; (X₇) applicability of this policy; (X₈) policy geographical coverage; (X₉) policy benefits.

**I. The first main-variable (X₁) (‘policy vision’) is formed by three sub-variables: (X₁:1) short run; (X₁:2) medium run; (X₁:3) long run.**

**II. The second main-variable (X₂) (‘policy approach’) is formed by five sub-variables: (X₂:1) microeconomic level; (X₂:2) macroeconomic level; (X₂:3) global level; (X₂:4) micro-level; (X₂:5) macro-level.**

---

**Table 1: Multi-Input-Output Table**

<table>
<thead>
<tr>
<th>X₁</th>
<th>X₂</th>
<th>X₃</th>
<th>X₄</th>
<th>X₅</th>
<th>X₆</th>
<th>X₇</th>
<th>X₈</th>
<th>X₉</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: PIE-Index Calculation**

<table>
<thead>
<tr>
<th>X₁</th>
<th>X₂</th>
<th>X₃</th>
<th>X₄</th>
<th>X₅</th>
<th>X₆</th>
<th>X₇</th>
<th>X₈</th>
<th>X₉</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Variables:**

- **Policy Vision**
  - (X₁:1) Short run
  - (X₁:2) Medium run
  - (X₁:3) Long run

- **Policy Approach**
  - (X₂:1) Microeconomic level
  - (X₂:2) Macroeconomic Level
  - (X₂:3) Global level
  - (X₂:4) Theoretical approach
  - (X₂:5) Technical approach

- **Database Sources**
  - (X₃:1) Primary data
  - (X₃:2) Secondary data
  - (X₃:3) Mix data
  - (X₃:4) International data sources
  - (X₃:5) Domestic data sources

- **Policy Orientation**
  - (X₄:1) Fiscal policy
  - (X₄:2) Monetary policy
  - (X₄:3) International trade policy
  - (X₄:4) Economic growth policy
  - (X₄:5) Social welfare policy

- **Policy Institutional Vision**
  - (X₆:1) Private sector
  - (X₆:2) Public sector
  - (X₆:3) Public/private sectors

- **Applicability of this Policy**
  - (X₇:1) Adaptability to the real making decisions level
  - (X₇:2) Benefit: high + benefit and low cost: 0 + low benefit and high cost
  - (X₇:3) The existence of financial and human resources
  - (X₇:4) Easy implementation of this policy

- **Policy Geographical Coverage**
  - (X₈:1) Domestic
  - (X₈:2) Regional
  - (X₈:3) Global

- **Policy Benefits**
  - (X₉:1) Large part of population
  - (X₉:2) Minorities
  - (X₉:3) Integral projection

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8.6(ii) Classification of Variables and Identification of Parameters

The construction of the PIE-Index involves 9 main-variables and 40 sub-variables. The 9 main-variables are: (X₁) policy vision; (X₂) policy approach; (X₃) database sources; (X₄) policy orientation; (X₅) type of policy; (X₆) policy institutional vision; (X₇) applicability of this policy; (X₈) policy geographical coverage; (X₉) policy benefits.

I. The first main-variable (X₁) (‘policy vision’) is formed by three sub-variables: (X₁:1) short run; (X₁:2) medium run; (X₁:3) long run. II. The second main-variable (X₂) (‘policy approach’) is formed by five sub-variables: (X₂:1) microeconomic level; (X₂:2) macroeconomic level; (X₂:3) global level; (X₂:4)
theoretical approach; \(X_{2.5}\) technical approach. III. The third main-variable \((X_3)\) (‘database sources’) consists of five sub-variables: \((X_{3.1})\) primary data; \((X_{3.2})\) secondary data; \((X_{3.3})\) mix data; \((X_{3.4})\) supranational institution data source; \((X_{3.5})\) domestic data source. IV. The fourth main-variable \((X_4)\) (‘policy orientation’) is made up of \((X_{4.1})\) fiscal policy; \((X_{4.2})\) monetary policy; \((X_{4.3})\) international trade policy; \((X_{4.4})\) economic growth policy; \((X_{4.5})\) social welfare policy; integral policy \((X_{4.6})\). V. The fifth main-variable \((X_5)\) (‘type of policy’) 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 \((X_6)\) (‘policy institutional vision’) comprises three sub-variables: \((X_{6.1})\) private sector; \((X_{6.2})\) public sector; \((X_{6.3})\) public/private sectors. VII. The seventh main-variable \((X_7)\) (‘applicability of this policy’) is made up of three sub-variables: \((X_{7.1})\) adaptability to the real making decisions level; \((X_{7.2})\) benefit/cost; \((X_{7.3})\) the existence of financial and human resources; \((X_{7.4})\) easy implementation of this policy. VIII. The eighth main-variable \((X_8)\) (‘policy geographical coverage’) comprises the following three sub-variables: \((X_{8.1})\) domestic level; \((X_{8.2})\) regional level; \((X_{8.3})\) global level. IX. The nine main-variable \((X_9)\) (‘policy benefits’) is made up of three sub-variables: \((X_{9.1})\) large part of population; \((X_{9.2})\) minorities; \((X_{9.3})\) integral projection (see Table 2). Besides variables and sub-variables, two (2) parameters are used in the construction of the PIE-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>
<thead>
<tr>
<th>(X_1) Policy Vision</th>
<th>1</th>
<th>Excellent performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(X_2) Policy Approach</td>
<td>1</td>
<td>Excellent performance</td>
</tr>
<tr>
<td>(X_3) Database Sources</td>
<td>0.36</td>
<td>Non-satisfactory performance</td>
</tr>
<tr>
<td>(X_4) Policy orientation</td>
<td>0.75</td>
<td>Good performance</td>
</tr>
<tr>
<td>(X_5) Type of Policy</td>
<td>0.50</td>
<td>Acceptable performance</td>
</tr>
<tr>
<td>(X_6) Policy institutional vision</td>
<td>0.36</td>
<td>Non-satisfactory performance</td>
</tr>
<tr>
<td>(X_7) Applicability of this Policy</td>
<td>0.58</td>
<td>Acceptable performance</td>
</tr>
<tr>
<td>(X_8) Policy Geographical Coverage</td>
<td>0.67</td>
<td>Acceptable performance</td>
</tr>
<tr>
<td>(X_9) Policy benefits</td>
<td>0.22</td>
<td>Poor performance</td>
</tr>
</tbody>
</table>

8.6(iii) Measurement of PIE-Index

The measurement of the PIE-Index involves three steps. (i) The first step is to put the 9 main-variables and 40 sub-variables into the multi-input-output table. (ii) The second step is to evaluate sub-variable by sub-variable according to the parameters mentioned above. (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 1). The last step is the actual measurement of the PIE-Index. The PIE-Index is equal to the sum of all main-variables (see Expression 2).
\[ EPI = \sum_{i=1}^{\infty} \sum_{j=1}^{\infty} X_i (\sum X_i j) / t \times K \quad < i, j, t > = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, \ldots, \infty \] (1)

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

8.6(iii) **Evaluation of Consistency of PIE-Index**

The PIE-Index can be used to evaluate the level of consistency of any policy modeling. The PIE-Index is classified according to one of these four levels of research consistency: ‘perfect policy consistency’; ‘good policy consistency’; ‘acceptable policy consistency’; ‘low policy consistency’. If the PIE-Index is between 1 and 0.90 points, then the research is of ‘perfect policy consistency’. If the PIE-Index is between 0.89 and 0.70 points, then there is ‘good policy consistency’ in the research. A PIE-Index that is between 0.69 and 0.50 points shows ‘acceptable policy consistency’ in the research. If the PIE-Index is between 0.49 and 0 points, then we are referring to a ‘low policy consistency’ research.

8.6(iii) **Construction of Policy Implementation Effectiveness Surface (PIE-Surface)**

The full implementation of the PIE-Index requires one-fourth step, that is, the construction of the PIE-Surface. The purpose of constructing the PIE-Surface is to graphically represent all results in the PIE-Matrix. The PIE-Surface shows the strengths and weaknesses within any policy modeling on a multi-dimensional coordinate space (Ruiz Estrada, 2007) (see Figure 1). It is presented as Table 3. The construction of the PIE-Surface is based on the PIE-Matrix results (see Expression 3). The PIE-Matrix is a three by three matrix that contains the individual results of all nine main-variables (taken from Table 2). The idea here is to use the results of strictly nine main-variables in the PIE-Matrix to build a symmetric surface. When the PIE-Matrix keeps the number of rows strictly the same as the number of columns, then the PIE-Surface can always show a perfect symmetric view (see Table 3).

\[ \text{PIE-Surface} = \begin{pmatrix} X_1 & X_4 & X_7 \\ X_2 & X_5 & X_8 \\ X_3 & X_6 & X_9 \end{pmatrix} \] (3)

8.6(iii) **Evaluation of Strengths and Weaknesses of Main-Variables in Policy Modeling**

The result of each main-variable in the PIE-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’.
8.7. Application of PIE-Index and PIE-Surface: An Example

For demonstration purposes in this chapter, the PIE-Index and PIE-Surface was applied to a single paper that was featured in Journal of Policy Modeling respectively. This paper is entitled “The Crisis of European Monetary Union – Lessons to be Drawn” by Otmar Issing (2011). This paper was analyzed by six experts: one single analysts specialized on finance and economics issues (R1), one single journalist specialized on finance and economics issues (R2), one single academic (R3), one single government adviser (R4), one single supranational institution researcher (R5), and one single think tank analyst (R6). The paper has a PIE-Index of 0.6 points in accordance with our parameters. This paper is located on ‘acceptable policy consistency’ (see Table 2). Hence, the result of each main-variable in the PIE-Matrix shows three weak main-variables: main-variable X3 ‘data sources’ (0.36 = non-satisfactory performance); main-variable X6 ‘policy institutional vision’ (0.36 = non-satisfactory performance); main-variable X9 ‘policy benefits’ (0.22 = poor performance) (see Table 3). According to our results, three main variables have ‘acceptable performance’. These variables are type of policy (X5 = 0.50), applicability of this policy (X7 = 0.58), policy geographical coverage (X8 = 0.67). Additionally, only one main-variable has good performance, this variable is the policy orientation (X4 = 0.75). Finally, only two main-variables received the top rating of ‘excellent performance’. These two variables are ‘policy vision’ (X1 = 1) and ‘policy approach’ (X2 = 1). All results of the above nine main-variables in this can be seen on the PIE-Surface (see Figure 1). Here, the PIE-Surface shows the weaknesses within a specific case of the effectiveness of policy implementation through a multi-dimensional graphical representation. The first recommendation in this paper is to include non-economic variables in its modeling to improve the main-variable (X5). Secondly, this paper should identify the adaptability to the real making decisions level, benefit/cost, evaluation of financial and human resources, and possible implementation of this policy that is relevant to improve the main-variable (X7) in the model. Finally, the recommendation is for main-variable (X9) by proposing more integral projection policies to solve problems in different social groups in different levels (see Table 3 and Figure 1).
8.8. Discussion and Conclusion
In this chapter, we have demonstrated the need to have a policy implementation section in policy modeling papers, where clear, practical, suitable, realistic, and effective policies could be proposed to solve fully or partially real socio-economic problems that affect society on different levels. Moreover, we have added quite a significant degree of credibility to the applicability of policy modeling papers to analyzing and solving real socio-economic problems by introducing a new index called ‘Policy Implementation Effectiveness’ (PIE-index), which could be used at any given time to evaluate the effectiveness of any policy modeling paper in light of its strengths to analyzing and solving real socio-economic problems that affect society. The new policy implementation should be strategically positioned between the conclusions and the references section in any policy modeling paper. The section should be unique and organized with a maximum of one page, and it should be easy and fast to read by any reader as it outlines applicable recommendations and clear strategic steps to implement any policy under management and institutional levels respectively.

In conclusion, our propositions in this article are indeed highly significant. This is so given the fact that the chapter complements the cycle of numerous policy modeling papers by extending their relevance beyond mere theory, but practical instruments that could be used to analyze and solve real socio-economic problems affecting society.
8.9. References

9.1. The National Production Function (NP-Function)

9.1.1. Introduction

It is well understood from the study of the Cobb Douglas production function that the use and combination of labor (L) and capital (K) are not enough variables to quantify and analyze the final output (Y). In fact, the NP-Function includes land (L) and capital (K) plus “n” number of variables together in its analysis. The NP-Function is basically formed by four sub-production functions where each sub-production function stands for the production of various sectors of the economy such as agriculture, industry, manufacturing and services (Schlicht, 1985). The same NP-Function is based on the use of economic real time modeling framework which is based on the application of dynamic growth rates. It should be noted that all variables included in each sub-production function are in growth rate. We assume that the sub-production functions in the NP-Function keep on a constant dynamic imbalance state (Ruiz Estrada, 2008). It is to explain and analyze the behavior of complex dynamic changes of each sub-production function until the final national output is achieved. We propose however, the construction of NP-Function under the application of Econographicology (Ruiz Estrada, 2007) and economic real time modeling framework. The NP-Function can facilitate the analysis and visualization of the sub-production functions of production sector such as the agriculture, industry, manufacturing and services that keep a constant movement in real time at the same physical space; it is to observe the fast and abrupt changes of the four sub-production functions by production sector develop in real time. Finally, the NP-Function is available to offer an alternative economic modeling to measure the final national output.

9.2. The National Production Function (NP-Function)

The section explains the construction of the national production function. Initially, the NP-Function is builds of four sub-production functions where each sub-production function has its quadrant. Each quadrant shows a single dependent variable represented by a vertical line in the central part of its quadrant by $Y_{ij}$ and “n” number of independent variables $X_{ij}$ on the bottom part of the quadrant by horizontal lines. Finally, we join all $X_{ji}$ to the dependent variable $Y_{ij}$ under the application of “$\Box$” linkage of axes. All axes in each quadrant are running on real time under the application of dynamic growth rates (see expression 5). Therefore, we have four quadrants or four sub-production functions where each quadrant has its dependent variable “$Y_{ij}$ “and “n” number of independent variables “$X_{ij}$” respectively. Similarly, we have four outputs from agriculture sector ($Y_0$), industrial sector ($Y_1$), manufacturing sector ($Y_2$) and services sector ($Y_3$) from each sub-production function. Finally, we can observe that among the four quadrants there exist a single axis that we call the final national output “Y”. It is obtained by joining the four outputs from each sub-production sector by the application of the “$\Box$” linkage of quadrants by strait lines (see Figure 1). The idea is to build a single surface based on the links of four outputs together in the same physical space. In the NP-Function, our objective is to build a large and single surface that is moving in
real time in the same physical space. In fact, the application of the Omnia Mobilis assumption (Ruiz Estrada, 2011) is the basic condition to generate the real time effect of the NP-Function. Hence, the final national output “Y∗” always keeps in dynamic and multi-dimensional behavior according to the economic modeling in real time into its multi-dimensional space (Ruiz Estrada, 2013). Finally, the analysis of the result of the NP-Function depends on the position of the surface which can help to determine the situation of any economy. Additionally, the NP-Function result is going to be determined by the position of the surface. If the surface is located into the positive level, then we can observe economic stability (see Expression 7). If the surface keeps zero level, then we can observe economic stagnation (see Expression 8). If the surface keeps negative or positive levels, then it is possible to observe economic recession (see Expression 9). Finally, if the surface is located on the negative level then we find an economic crisis (see Expression 10).

9.3. Model

The NP-Function offers an alternative graphical and mathematical modeling approach to analyze the final national output from a multi-dimensional perspective. This new multi-dimensional graphical modeling can show the final national output. The NP-Function provides to policy makers an alternative methodological approach to measure the final output of any country from the national production function. The NP-Function is follow by four sub-production functions, there are:

Sub-Production Function 0:
\[ \Box Y_0 = f (\Box \Delta X_{00}, \Box \Delta X_{01}, ... , \Box \Delta X_{0\infty}) \] (1)

Sub-Production Function 1:
\[ \Box Y_1 = f (\Box \Delta X_{10}, \Box \Delta X_{11}, ... , \Box \Delta X_{1\infty}) \] (2)

Sub-Production Function 2:
\[ \Box Y_2 = f (\Box \Delta X_{20}, \Box \Delta X_{21}, ... , \Box \Delta X_{2\infty}) \] (3)

Sub-Production Function 3:
\[ \Box Y_3 = f (\Box \Delta X_{30}, \Box \Delta X_{31}, ... , \Box \Delta X_{3\infty}) \] (4)

\[ \Box = \text{Real Time } Y_i = \text{Output } \Delta = \text{Dynamic Growth Rate} \]

All variables in each sub-production function request the application of the dynamic growth rate follow by:
\[ \Box \Delta X_{ij} = \Delta X_{ij_{<t+1>}} - \Delta X_{ij_{<t0>}} \times 100\% \Rightarrow \Delta X_{ij_{<t0>}} \] (5)

\[ i = \{1,2,...,\infty\} \text{ and } j = \{1,2,...,\infty\} \text{ } <t_{t+1}> = \text{Future period of time } <t_o> = \text{Initial period of time.} \]

Therefore, the final mathematic structure to build the NP-Function is equal to expression (6).

\[ \Box Y* = \Box Y_0 || Y_1 || ... || Y_{\infty} \ldots (6) \text{ } || = \text{linkage of quadrants.} \]

The NP-function result is going to depend on the location of the surface (see Figure 1). Hence, we have four possible results that can be classified by Economic Stability (see Expression 7), Economic Stagnation (see Expression 8), Economic Recession (see Expression 9) and Economic Crisis (see Expression 10) (Barro, 1976 and Hansen, 1938):
\( \bigodot Y^* \equiv \bigodot +Y_o + \bigodot + Y_1 + \bigodot + Y_2 + \bigodot + Y_3 \quad (7) \)

\{ if \( \Delta + Y^* \cap R^+ \) then the surface \( \equiv \text{Economic Stability} \} \)

\( \bigodot Y^* \equiv \bigodot + Y_o + \bigodot + Y_1 + \bigodot + Y_2 + \bigodot + Y_3 \quad (8) \)

\{ if \( \Delta Y^* \cap 0 \) then the surface \( \equiv \text{Economic Stagnation} \} \)

\( \bigodot Y^* \equiv \bigodot \pm Y_o \pm \bigodot \pm Y_1 \pm \bigodot \pm Y_2 \pm \bigodot \pm Y_3 \quad (9) \)

\{ if \( \Delta Y^* \cap R_{+/-} \) then the surface \( \equiv \text{Economic Recession Alert} \} \)

\( \bigodot - Y^* \equiv \bigodot - Y_o - \bigodot - Y_1 - \bigodot - Y_2 - \bigodot - Y_3 \quad (10) \)

\{ if \( \Delta Y^* \cap R \) then the surface \( \equiv \text{Economic Crisis} \} \)

**Figure 1**: The National Production Function (NP-Function)

9.4. The Multi-level Trade Creation and Trade Diversion Analysis

9.4.1. Introduction

Over the decades, economists and policy makers have been using a variety of analytical tools to study the behavior of external sector in different countries and regions since Smith (1776) and Ricardo (1817) until our days. The most common analytical tools applied in such studies so far are the terms of trade (ToT) used by Balassa (1985) and the openness index (O) included by Edwards (1998) in his paper titled "Openness, Productivity and Growth: What Do We Really Know?" We introduce in this chapter a complementary set of indicators to evaluate trade creation and trade diversion from different perspective. We name these indices as the trade mass (T), the intra-regional trade trend ratio (R₁), the extra-regional and trade trends ratio (R₂) and the trade expansion coefficient (TEC).
9.4.2. Introduction to the Trade Mass (T)
The main idea behind building the trade mass (T) index is to study the trade volume behavior of any country by the application of sphere volume. The inspiration idea for using the sphere volume is that it can help to make the process of visualization of the trade volume behavior graphically easier. Hence, the trade mass (T) is can be observed graphically from a single sphere. This single sphere would take different sizes across different periods of time and spaces. In fact, the trade mass (T) follows the application of the classic formula of the volume of a sphere denoted by expression 1 as mentioned in the research of Russell (1996). Hence, the volume of a sphere can be obtained by multiplying $4/3$ and $\pi$ and the radius to exponential square. The $\pi$ is a well-known mathematical constant whose value is equal to 3.1416.

$$V = \frac{4}{3} \pi r^2 \quad (1)$$

In expression 3, the trade mass (T) is constructed keeping $\pi$ as constant and the radius is fixed by the growth rate of the trade volume ($\Delta T$). The growth of trade volume is calculated from the trade volume growth rate between the last year ($t-1$) and the current year ($t$) as described in expression 2.

$$\Delta T = \frac{(X + M)_t - (X + M)_{t-1}}{(X + M)_{t-1}} \quad (2)$$

$$T = \frac{4}{3}\pi(\Delta T)^2 \quad (3)$$

Finally, the analysis of the trade mass (T) depends on the size of the volume in different spheres across different periods of time and spaces. The key variable which establishes the size of the sphere volume is the growth rate of trade volume as shown by ($\Delta T$). We find that differences in size of spheres are helpful in observing if exist expansion, contraction or stagnation of the trade volume of any country across different periods of time and space. We would like however, to recommend the use of different colors for different spheres. It could help to visualize easily the behavior of the trade mass (T) into the same graphical space. The difference between the trade volume histogram in 2-dimensions and the trade mass (T) is that we are able to observe the size of any country from a different graphical perspective (Inselberg and Dimsdale, 1994). Additionally, the advantage to use the trade mass (T) is also to observe the process of accumulation from a long historical data of the trade volumes in different periods of time under the visualization of a longer structure formed by joining a large number of spheres together into the same graphical space (see Figure 2). This large structure is entitled “The Trade Accumulation Structure –TES-”. Therefore, we can observe clearly the expansion, contraction or stagnation of each trade mass (T) into the large string of spheres across different periods of time and spaces. It can give us a multidimensional effect to observe the behavior of the international trade in any country.
The multi-level trade creation and trade diversion analysis starts with the building of the trade mass by intra-regional level (Tir) and extra-regional level (Ter). The building of the trade mass using intra-regional level (Tir) and extra-regional level (Ter) is dependent on the measurement of the growth rate of trade volume with the help of intra-regional level (ΔTir) and extra-regional level (ΔTer) as denoted by expression 4 and 5. Lastly, we proceed to measure the trade mass by intra-regional level (Tir) and extra-regional level (Ter) under the application of the expression 5 and 7.

\[
\Delta \text{Tir} = (X_{ir} + M_{ir})_t - (X_{ir} + M_{ir})_{t-1} / (X_{ir} + M_{ir})_{t-1}
\]

\[
\text{Tir} = (4/3) \pi (\Delta \text{Tir})^2
\]

\[
\Delta \text{Ter} = (X_{er} + M_{er})_t - (X_{er} + M_{er})_{t-1} / (X_{er} + M_{er})_{t-1}
\]

\[
\text{Ter} = (4/3) \pi (\Delta \text{Ter})^2
\]

The next task is to find the intra-regional (R₁) and extra-regional (R₂) trade trend ratios respectively with the help of expression 8 and 9. We are interested to remind that the trade mass (T), extra-regional and intra-regional play an important role in measuring the trade trend and trade creation and diversion effect of any economy. This is possible through the comparison of intra-regional (R₁) and extra-regional (R₂) trade trend ratios. There are two possible scenarios. If Tir is larger than the Ter then we can observe that...
there exists trade creation under intraregional level but trade diversion in the extra-regional level. On the other hand, if Ter is greater than the Tir then we can witness evidence supporting the trade creation under extra-regional level and trade diversion in the intra-regional level.

\[ R_1 = \frac{\text{Tir}}{\text{Ter}} \]  
\[ R_2 = \frac{\text{Ter}}{\text{Tir}} \]

Finally, we want to find the trade expansion coefficient (TEC) which can be constructed by multiplying the intra-regional (R_1) and extra-regional (R_2) trade trend ratios as can be seen from expression 10. As a consequence, we are able to find the trend of the behavior of international trade. The final outputs of the trade expansion coefficients (TEC) have two possible results. If the TEC is higher there existing, the possibility of a fast trade volumes expansion. Similarly, if the TEC is lower there exists the possibility of a slow expansion of trade volume.

\[ \text{TEC} = R_1 \times R_2 \]  

Graphically the multi-level trade creation and trade diversion is based on the use of 3-dimensional Cartesian plane. The plotting into the 3-dimensional Cartesian plane (Brouwer, 1913) is divided using three axes followed by X-axis which keep the intra-regional trade trend ratio (R_1), the Y-Axis represents the extra-regional trade trend ratio (R_2) and the trade expansion coefficient (TEC) is fixed into the Z-axis respectively. Figure 3 summarizes the whole process. After, we proceed to join these three variables with the help of straight lines until we build a Figure represented by a single pyramid (see the blue area into each 3-D coordinate system). Lastly, the graphical analysis of the multi-level trade creation and trade diversion depend on the behavior of the Figure (pyramid) which can experience an expansion, contraction or stagnation anytime.

**Figure 3:** The Graphical Analysis of the Multi-Level Trade Creation and Diversion
9.5. The Mega-Economics Structures Vulnerability Analysis (MSV-Analysis)

9.5.1. Introduction
The macroeconomics structures vulnerability analysis (MSV-Analysis) has two general objectives. The first objective is to evaluate the weakness and strength points of different macroeconomic structures (or scenarios) in the same graphical space simultaneously. The second general objective is to simultaneously forecast different macroeconomic structures. The MSV-Analysis is based on the application of the Cubes Cartesian Physical Space as documented in the novel work of Ruiz Estrada (2007). The Cubes-Cartesian physical space opens the possibility to generate a multi-dimensional visual effect to show the vulnerability of many macroeconomic structures in the same graph and time. Each macroeconomic structure is formed by a large number of general structures, sub-structures and mini-structures on different axes, levels, and cubes by sizes and colors (see Figure 2). However, the detail analysis of each structure by axes, levels, perimeters and cubes by sizes and colors depends on the parameters established by our research. Finally, all these general structures, sub-structures and mini-structures are using the global structural imbalance principle under the application of the Omnia Mobilis assumption (Ruiz Estrada, 2011).

9.5.2. Introduction to the Cubes Cartesian Space (Cubes-Cartesian Space)
The cubes Cartesian space (Cubes-Cartesian Space) is formed from infinity number of general axes ($A_0, A_1, \ldots, A_\infty$), where each axis shows different levels ($L_0, L_1, \ldots, L_\infty$), perimeters ($P_0, P_1, \ldots, P_\infty$), and cubes with different sizes and colors ($C_0/\beta, C_1/\beta, \ldots, C_\infty/\beta$). Therefore, the coordinate system of the Cubes-Cartesian space is represented by $S_{A,L,P,C} = (A_i, L_j, P_k, C_s/\beta)$ respectively (see for example Poincaré, 1913). Similarly, the subscripts such as $i, j, k$ and $s$ stands for different values between 0 and $\infty$ and $\beta$ represent different colors of each cube in different levels ($L_0, L_1, \ldots, L_\infty$). All these cubes ($C_{\nu/\beta}$) with different sizes and colors in the same axis under the same level ($L_0, L_1, \ldots, L_\infty$) and different perimeters ($P_0, P_1, P_2, \ldots, P_\infty$) would be joined together based on the application of a concept called the links structures that is represented by the symbol “@.” Moreover, the Cubes-Cartesian space coordinate system is shown by the following expression 1 and Figure 2:
Finally, the Cubes-Cartesian space shows a general function \( Y_g \) that is obtained from the interconnection of all macroeconomic structures \( (S_0, S_1, ..., S_n) \) under different axes \( (A_1, A_2, ..., A_n) \), levels \( (L_1, L_2, ..., L_n) \), perimeters \( (P_0, P_1, P_2, ..., P_n) \) and Cubes with different sizes and colors \((C_0/\beta, C_1/\beta, ..., C_n/\beta)\) respectively as highlighted in the Expression 2.

\[
Y_g = f(A_{1\times\Sigma S_0 \times S_1 \times ... \times A_{n\times\Sigma S_0 \times S_1 \times ...}) 
\]

\( \Box \quad (2) \)

**Note:** \( Y_g = \) The General Variable, \( \Box = \) Interconnection, \( A_i = \) Axis and \( S_i = \) General Structures.

However, the size of all cubes in terms of level is under the use of parameters that we establish in our research. The parameters we fix in this model directly depend on the quantity of money or number of units. The changes of all cubes size depend on the constant changes in the volume of money or the number of units between \( n \)-periods of time. On the other hand, if we assume that all the cubes in different levels are changing constantly in real time, then all the cubes can experience an expansion, contraction or stagnation. We propose that all the cubes in the level cero (mini-structures) are smaller than the cubes in the level one (sub-structures) and finally the cubes in the level one (sub-structures) are smaller than the cubes in level two (general structure) as depicted in Figure 4 and Figure 5.
9.5.3. The Process of Forecasting into the Macroeconomics Structures Vulnerability Analysis (MSV-Analysis)

The process of forecasting in the Macroeconomics Structures Vulnerability Analysis (MSV-Analysis), assumes n-number of vectors. In order to forecast Yg, we suggest in our model the predicted value of the Yg to be equal to the interconnection of n-number of Sub-Y...Ys. We assume therefore, two types of time in the process of forecasting Macroeconomics Structures Vulnerability Analysis (MSV Analysis). It is followed by the general time speed (☉gt) running in Yg and the partial times speed (☉pt) which is running in each sub-Y. Hence, the general time speed (☉gt) is equal to the synchronization of all partial time
speeds (☼ pt) into the macroeconomics structures vulnerability analysis (MSV-Analysis). Different partial time speeds (☼ pt) are running in different magnitude of time in each level of analysis. In our case we work on three different levels of analysis from level 0 to level 2. The partial times speeds (☼ pt) also depend on different axes and perimeters levels into the macroeconomics structures vulnerability analysis (MSV-Analysis). The first stage of forecasting condition in the macroeconomics structures vulnerability analysis (MSV-Analysis) is simplified with the help of Expression 2. Lastly, we reach to the general function shown is by Expression 1:

\[
Y_g = \cup S(n+1, \theta+1, \lambda+1, \alpha+1/\beta) \cup pt C_i > \cap (A(n+1, L\theta+1, P\lambda+1, C\alpha+1/\beta) \cup pt C_i)
\]

(1)

Note: GF = General forecast point; \( \cap \) = Interconnection; \( C_i \) = confidence interval; \( \cup pt \) = Partial Times Speed and \( \cup gt \) = General Time Speed

The confidence interval for the different predicted values of \( C_i \) (see Expression 5) depend on the general time speed (\( \cup gt \)) for a level of significance of \( \cup gt / n \) degrees of freedom, and the expression multiply by \( \cup gt / n \) is the standard error of prediction using the estimated standard deviation of the stochastic term \( \hat{S}_i \). Nevertheless, the forecast interval (Bertrand et al., 2004) became open according to each axis, perimeter and level into the macroeconomics structures vulnerability analysis (MSV-Analysis) that is predicting the \( Y_g \). It is based on the interconnection of large number of sub-\( Y \)’s, because we assume that the space (or world) is Multi-Dimensional (Fedorchuk et al., 1999) and different sub-spaces in the same space are moving with different speeds of time. Hence, we assume that there exists a general time speed (\( \cup gt \)) under the synchronization of infinity partial times speed (\( \cup pt \)). Finally, the forecasting process in the macroeconomics structures vulnerability analysis (MSV-Analysis) shows a different perspective to understand the future behavior of complex economic scenarios from a multi-dimensional perspective, the idea about short, medium and long run is totally different from the classical conception of time in this research.

\[
Y_g = \pm \cup_{\cup pt} \hat{S}_i \pm \frac{\hat{S}_i}{n} + \frac{1}{n} \left\{ \frac{1}{n} \left( A_{n+1} L_{\theta+1} P_{\lambda+1} C_{\alpha+1/\beta} \cup pt_0 \right) - \frac{1}{n} \left( A_{n+1} L_{\theta+1} P_{\lambda+1} C_{\alpha+1/\beta} \cup pt \right) \right\}^2
\]

(2)

9.6. The Mega-Economic Surface Interactive System

9.6.1. Introduction

The literature shows that in the study of any economy from a microeconomic or macroeconomic perspective is common to observe the use of static or dynamic economic models under the application of partial (Cournot, 1838) and general equilibrium (Hicks, 1939). These models explain and analyze the behavior of complex structural economic problems of any economy under ex ante or ex post results (McClelland, 1975). Results are calculated using sophisticated and complex econometrics models together with use of advance software and computer solutions. More to the point, all these results have always been plotted on the 2-dimensional Cartesian plane (X, Y). We came to the conclusion from the brief survey of
the literature that until today any multi-dimensional graphical modeling is not available which can permit the observation of a large number of variables fixed in the same graphical space and interacting simultaneously in real time. Therefore, we propose a multi-dimensional graphical modeling under the application of the MEI-Surface. The MEI-Surface can facilitate the visualization of a large number of macroeconomics variables in constant movement under the same physical space; it is to observe the fast and abrupt changes of all macroeconomics variables of any economy in real time. The MIE-Surface is available to alert policy makers, central banks, government agencies, private sector and investors about the possible economic boom or recession in early stage. Early warnings would help policy makers across the globe to prevent their economies from the unwanted situations by implementing and executing appropriate policies in a timely manner.

9.6.2. The Mega-Economic Surface Interactive System
The section is aimed to explain in detail the construction of the Mega-Economic Interactive Surface (MIE-Surface). In the first instance, the MIE-Surface is builds by infinity number of axes. Each axis is represented by a vertical line and the vertical line shows a positive and negative real numbers (see Figure 1). The first axis starts from X11 until we jump to X∞∞... (see Figure 6). Hence, each axis in the MIE-Surface represents an independent variable. At the same time, the MIE-Surface requests to plot only one point on each axis. We are considering the growth rates of variables to generate the real time effect on each axis. The MIE-Surface needs to join each growth rate result of each axis to its neighbor growth rate results using a straight line. But it does not mean that they are dependent. The bottom line is to build a single surface based on the linking of all axes together in the same physical space. The MIE-Surface is fixed in the infinity box coordinate system (see Figure 6). The infinity box coordinate system is a huge cube formed by infinity vertical axes together. The infinity vertical axes show positive and negative coordinates. All positive and negative values are located on the top and bottom of the cube respectively. We assume that geometrically the number zero “0“is not a single value or number located in the center of the 2-dimensional and 3-dimensional Cartesian plane. Our point of view is that the number zero “0“is a large and infinity surface that is fixed into the middle part of the infinity box coordinate system (see Figure 6). The MIE-Surface is not a single dependent variable. The single dependent variable is represented through a large and single surface that is moving in real time in the same physical space. In fact, the application of the Omnia Mobilis assumption (Ruiz Estrada, 2011) is a basic condition to generate the real time effect on the MIE-Surface. Hence, the study of any economy according to this research needs to be in real time, because the economy of any country is does not own a static behavior. Every economy has a dynamic and multi-dimensional behavior. We need to assume that the economy of any country always keep in permanent transformation. The assumption about the behavior of an economy (dynamic and multi-dimensional) can be represented with the help of a large surface that is moving in real time into a multi-dimensional graphical space. Similarly, the analysis of the MEI-Surface depends on the position of the surface and is displayed into the infinity box coordinate system (see Figure 6). The position of the surface into the infinity box coordinate system can help to determinate the situation of any economy. Additionally, the position of MIE-Surface into the infinity box coordinates system can allocate a specific color to the surface (see Figure 6). For example, the economic stability surface shows a green color (See Expression 4), the economic stagnation surface shows a black color (see Expression 5), the economic recession alert
surface shows a yellow color (see Expression 6), and finally the economic crisis surface shows a red color (see Expression 7). An animation of the MEI-Surface needs the application of “global balance” and “real time “conditions basically.

9.7. Model
The MEI-Surface presents an alternative graphical and mathematical approach to analyze any economy from a multi-dimensional perspective. This new multi-dimensional graphical modeling can alert about the real situation of any economy immediately. The MIE-Surface is an alternative economic graphical modeling which could help policy makers, central banks, private & public sectors and investors in no time to take appropriate decisions on time to build suitable macroeconomic policies (Keynes, 1936) and at the same time, to reduce the risk of portfolios, stock markets and foreign direct investment (FDI) (Issing, 2011). The Mega-economic interactive surface function is follow by:

\[
\otimes Y_{sf} = f(\otimes \Delta X_{11}, \otimes \Delta X_{12},...,\otimes \Delta X_{\infty \infty})
\]

\(\otimes\) = Real Time \(Y_{sf}\) = Surface \(\Delta\) = Growth rate 3

Each value in each axis is based on measure a growth rate follows by:

\[
\otimes \Delta X_{11} = \Delta X_{11} <t+1> - \Delta X_{11} <t0> \times 100\%
\]

\(\Delta X_{11} <t0> <t+1>\) = Future period of time \(<t0>\) = Initial period of time

Therefore, the final mathematical structure to build the Mega-economic interactive Surface is based on expression (3)

\[
\otimes Y_{sf} \equiv \otimes \Delta X_{11} \parallel \otimes \Delta X_{12} \parallel \ldots \parallel \otimes \Delta X_{1\infty} \parallel \ldots \parallel \otimes \Delta X_{\infty 1} \parallel \ldots \parallel \otimes \Delta X_{\infty \infty}...
\]

\(\parallel\) = linkage of axes.

The MEI-Surface depends on the location of the surface into the infinity box coordinate system (see Figure 6). Hence, we have four possible results that can be classified by economic stability (see Expression 4), economic stagnation (see Expression 5), economic recession alert (see Expression 6), and economic crisis (see Expression 7):

\[
\otimes + Y \equiv \otimes + \Delta X_{11} \parallel \otimes + \Delta X_{12} \parallel \ldots \parallel \otimes + \Delta X_{1\infty} \parallel \ldots \parallel \otimes + \Delta X_{\infty 1} \parallel \ldots \parallel \otimes + \Delta X_{\infty \infty}...
\]

{if \(\Delta X_{ij} \cap R^+\) then the surface became green color \(\equiv\) Economic Stability}

\[
\otimes Y0 \equiv \otimes \Delta X_{11} = 0 \parallel \otimes \Delta X_{12} = 0 \parallel \ldots \parallel \otimes \Delta X_{1\infty} = 0 \parallel \ldots \parallel \otimes \Delta X_{\infty 1} = 0 \parallel \ldots \parallel \otimes \Delta X_{\infty \infty} = 0...
\]

{if \(\Delta X_{ij} \cap 0\) then the surface became black color \(\equiv\) Economic Stagnation}
\[ \mathbb{Y} \equiv \mathbb{Y} + \Delta X_{11} \parallel \mathbb{Y} + \Delta X_{12} \parallel \ldots \parallel \mathbb{Y} + \Delta X_{1\infty} \parallel \ldots \parallel \mathbb{Y} + \Delta X_{\infty1} \parallel \ldots \parallel \mathbb{Y} + \Delta X_{\infty\infty} \ldots \]

(6)
{if \( \Delta X_{ij} \cap R^+ \) then the surface became yellow color \( \equiv \text{Economic Recession Alert} \)}

\[ \mathbb{Y} \equiv \mathbb{Y} - \Delta X_{11} \parallel \mathbb{Y} - \Delta X_{12} \parallel \ldots \parallel \mathbb{Y} - \Delta X_{1\infty} \parallel \ldots \parallel \mathbb{Y} - \Delta X_{\infty1} \parallel \ldots \parallel \mathbb{Y} - \Delta X_{\infty\infty} \ldots \]

(7)
{if \( \Delta X_{ij} \cap R^- \) then the surface became red color \( \equiv \text{Economic Crisis} \)}

\textbf{Figure 6:} The Infinity Box Coordinate System

9.8. Conclusions
This chapter introduced four alternative experimental economic models to the macroeconomic literature in order to help researchers and policy makers to analyze and visualize macroeconomic scenarios from a multidimensional perspective. We have tried to promote the uses of alternative analytical models by using a new mathematical framework and multidimensional graphs that based on the application of Econographicology. Further, this chapter shed some light to study various possibilities to have better understanding about macroeconomic scenarios to reduce the damage of possible economic failures (financial or economic crisis) to the new generation of economists around the world. Policy makers and researchers however, have to learn that economics failures cannot be avoided in any circumstances but we can alert and reduce their damage with the help of real time economic modeling.
9.9. References
CHAPTER X
AN INTRODUCTION TO THE MULTIDIMENSIONAL REAL TIME ECONOMIC MODELING

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10.1. Introduction

This chapter aims to illustrate an alternative economic modeling framework to study market behavior as a whole. It is based on the use of a new multidimensional graphical modeling technique coupled with the application of a real-time effect. The proposed modeling framework builds a computer algorithm that can facilitate the input, storage, classification, analysis and visualization of a large number of endogenous variables that can simultaneously affect market behavior. For a long time, academics and scholars depended on the application of 2-dimensional graphical modeling, and now it is time to transition to multidimensional graphical methods given the advancement in computer technology. The simple graphical format of 2-dimensional modeling can show only the visualization of historical and forecasting data in the same graphical space within a limited space of time. However, multidimensional real-time graphical modeling can help researchers observe all possible changes in a large number of variables. The changes in all these variables allow learners to clearly observe the cause and effect of different economic phenomena through the visualization of multidimensional graphs that permit the observation of a large number of variables in real time. Basically, the transition from 2-dimensional graphical modeling to multidimensional real-time graphical modeling requires researchers to learn how to plot and draw multidimensional graphs using different multidimensional coordinate spaces. Nevertheless, the adaptability to transition from static 2-dimensional graphical modeling to multidimensional real-time graphical modeling takes time. In economic analysis, real economic problems can be identified and incorporated into a multidimensional graph to visualize the movements of variables as simulations of economic variables. Multidimensional graphs can also be used to describe dynamic and multi-functional analyses that represent changes within the total function. Furthermore, multidimensional graphs can also help researchers visualize the changes in all exogenous variables simultaneously.

We suggest the application of Econographication, pioneered by Ruiz Estrada (2007), to learn and understand multidimensional graphs under the application of multidimensional coordinate spaces. Ruiz Estrada contended that the teaching and learning of multidimensional graphs require basic knowledge about the 2-dimensional Cartesian coordinate system, which serves as the foundation in plotting multidimensional graphs in economics. Multidimensional graphs can be constructed in five basic steps: first, the acquisition of basic knowledge of plotting and drawing 2-dimensional graphs in the Cartesian coordinate system; second, the acquisition of basic knowledge of Euler’s geometry; third, the attainment of a basic idea of time and space in the graphical space; fourth, the construction of solid prototype(s) using basic materials such as wood, papers, plastics and others; and fifth, the adaptation to learn and understand
different dimensions that exist in multidimensional graphs. Before proceeding further, it should be noted that the Omnia Mobilis assumption of Ruiz Estrada (2011a) must be applied to multidimensional graphs to generate the environment of freedom in different dimensions needed for the graphs to work without any restriction or condition. The Omnia Mobilis assumption suggests applying economic modeling in real time to observe the changes in all variables simultaneously. The Omnia Mobilis assumption opens a new era in economic theory by applying multidimensional graphs and real-time multidimensional graphical modeling. We can say that the contribution of the Ceteris Paribus assumption was great in its time, but in the present time, it is not sufficient to simply explain complex and dynamic economic phenomena. The difference between the Ceteris paribus and Omnia Mobilis assumptions is that the Ceteris Paribus assumption takes only a snapshot of the historical moments of some economic phenomena at one time, whereas the Omnia Mobilis assumption shows video running in real time. The Omnia Mobilis assumption (everything is moving) was introduced to reduce dependency in the use of the ceteris paribus assumption to explain an economic phenomenon. We propose the openness of substantive isolation through the application of the Omnia Mobilis assumption. Hence, the use of the ceteris paribus assumption is minimal and even relaxed in the application of multidimensional graphical modeling. The Omnia Mobilis is in contrast to the process of building economic models to explain a complex economic phenomenon in 2 dimensions that begins with the ceteris paribus assumption. Marshall (1890) clearly articulated the use of the ceteris paribus assumption in economic models. According to Marshall (1890),

“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 (1890) approach allows the analyses of complex economic phenomena in parts such that each part of the economic model can be joined to generate an approximation of the real world. This approach can be termed as the Isolation Approach, and according to Marshall (1890) and Schlicht (1985), it originates from two possible isolation clauses. First, the ceteris paribus assumption allows some variables to be considered unimportant. This clause is called substantive isolation. Substantive isolation considers that some unimportant variables cannot significantly influence the final result of the economic model. Second, the ceteris paribus assumption allows the impact of some important factors to be disregarded. In this case, the application of the ceteris paribus assumption is purely hypothetical; therefore, the second clause is called hypothetical isolation. It allows parts of the model to be managed more easily and efficiently. The goal is, therefore, to achieve a parsimonious model that is able to explain the complex real world. The idea is to draw multidimensional graphs that can aid in the visualization of a large number of variables in different spaces on the same graphical space. However, beyond that, multidimensional graphs provide an alternative to Marshall's view of a step-by-step cumulative partial
approach to modeling a complex economic phenomenon. To apply the multidimensional real-time economic modeling framework, we generate an effect of movement live or in real time. Hence, the basic premise of the multidimensional real-time graphical modeling framework assumes that markets are in a constant dynamic imbalanced state that experiences constant chaos and high vulnerability. Furthermore, the concept of equilibrium in the multidimensional real-time economic modeling framework is applied to the analysis of market failures. Equilibrium is considered as a leak in the momentum of balance among all variables that can appear at any time. However, we cannot predict exactly when this synchronized balance is going to appear. In the multidimensional real-time economic modeling framework, there is not even a single endogenous variable or single exogenous variable available. Multidimensional real-time economic modeling allows for the observation of a multidimensional graph that is moving different variables in real time in the same graphical space. This multidimensional graph is also capable of showing the regular and irregular behaviors of market failures in the short run. Lastly, multidimensional real-time economic modeling is based on the use of multidimensional partial differentiation.

10.2. Law of Demand and Supply from a Multidimensional Poerspective

Typically, the study of market behavior under the demand and supply law is graphically represented by the traditional demand and supply curves embodied in two-dimensional graphs. In the case of the demand and supply curves in multidimensional form, the Dynamic Imbalanced State (DIS) (Ruiz and Yap, 2013) must be used under the Omnia Mobilis assumption. The DIS permits the demand and supply analysis, which includes internalities and externalities such as economic factors, social factors, political factors, technological factors, environmental factors, institutional factors and other different economic agents and institutional behaviors (e.g., public sector-government, private sector-firms, consumers–households) to explain the real behavior of the market in its whole context. Regarding the application of the analytical graphical method in economics, it is necessary to mention the major contribution of Cournot (1838). Cournot derived the first formula for the rule of supply and demand as a function of price. He was also the first economist to draw supply and demand curves on a graph. This author believed that economists should utilize graphs only to establish probable limits and express less stable facts in more absolute terms. He further held the view that the practical use of mathematics in economics involves not only strict numerical precision but also graphical visualization. In fact, Cournot suggested the application of the first quadrant of the 2-dimensional Cartesian co-ordinate system by drawing two linear functions to represent demand and supply curves in the same graphical space. In addition to Cournot, other innovative economists who contributed to the analytical graph systems in economics over time include Leon Walras, Vilfredo Pareto, Alfred Marshall and Francis Ysidro Edgeworth (see McClelland, 1975).

The reason behind applying the demand and supply law to the study of market behavior is to find market equilibrium among a large number of possible combinations between two specific variables followed by the price of the commodity (exogenous variable) and quantity (endogenous variable) in 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 effect of the unexpected behavior of price commodity on the quantity demanded and supplied.
The main reason to visualize demand and supply through the implementation of multidimensional real-time graphical modeling is to explore unknown dimensions of market behavior from a multidimensional perspective. The basic premise is that the market undergoes constant evolution across time and space. This means that markets in each period of history can show different structures, internalities, externalities, institutions, and economic agents can show different behaviors. Hence, the study of market behavior requires alternative economic assumptions and economic models based on each specific period of history. Additionally, we shed some light on the unexpected, irrational and trends that market behavior can experience at any time from a multidimensional perspective. Therefore, the study of market behavior becomes more complicated, demonstrating with low levels of accuracy across the time dimension. In terms of classification, market equilibrium can be either partial or general. Furthermore, partial market equilibrium can be divided into linear and non-linear modeling from the mathematical and graphical perspectives. Basically, partial market equilibrium using the linear modeling approach is based on the analysis of a single commodity and three variables such as the quantity demanded \( Q_d \), quantity supplied \( Q_s \) and the price of the commodity \( P \). This specific model is represented by two linear equations. The main characteristic of the demand linear equation (see expression 1) is that its slope is always negative (downward) because price and quantity demanded move in opposite directions. The slope of the supply linear equation (see expression 2) is positive (upward) because the price and quantity move in the same direction. Furthermore, the price commodity equilibrium \( P^* \) is a result of the elimination of variables from the identity \( Q_d = Q_s \) (see expression 3). Additionally, the quantity equilibrium \( Q^* \) is a result of replacing the price equilibrium \( P^* \) with the quantity demanded equation \( Q_d \) (see expression 4).

Finally, market equilibrium \( (\varepsilon) \) is represented by expression 5.

\[
\begin{align*}
Q_d & = \alpha - \beta P \\
Q_s & = -\pi + \lambda P \\
Q_d & = Q_s \implies P^* \\
Q^* & = Q_d = \alpha - \beta P^* \\
\varepsilon & = (P^*, Q^*)
\end{align*}
\]

Partial market equilibrium by non-linear modeling is represented by the application of a linear equation (see expression 7) and a non-linear equation (see expression 6). In the first example, we need to identify the price equation by constructing a single equation (see expression 8). Subsequently, we proceed to find the price commodity equilibrium \( P^* \). It is based on the application of the quadratic formula (see expression 9) to 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 incorporate the price commodity equilibrium \( P^* \) into the quantity demanded function \( Q_d \) to find the obtained equilibrium quantity \( Q^* \), as shown in expression 10. The final equilibrium is presented in equation 11.

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

The analysis between static, dynamic and real time plays an important role in the current era of economic modeling. Initially, we can say that economic modeling in real time does not represent a simple relationship between two variables such as a dependent variable and independent variable(s) that are fixed in a specific period of time. In our case, economic modeling in real time suggests that it is not sufficient to use only static and dynamic economic modeling.

**10.3. Traditional Economic Modeling vs. Economic Modeling in Real Time**

We find that economic modeling in real time can offer an alternative visual approach to observing the behavior of macroeconomic and microeconomic variables that move through a single screen live. To generate this type of modeling, we need to use advanced information technology and multidimensional graphical modeling. Economic modeling in real time allows us to observe different changes in different variables in the same graphical space. All the variables defined in the abovementioned expressions constantly move through different periods of time (years, months, weeks, days, hours, minutes and seconds) and space (different geographical spaces). It is important to mention that economic modeling in real time is an alternative approach to studying economics from a different perspective. We suggest a major transformation in the economic modeling-oriented framework to detect economic failures in a timely manner. We think that it is very difficult to quantify or predict the behavior of any complex economic phenomenon in the long run because domestic factors and externalities in different economies change at different speeds. It is understood that changes in different factors such as factors in the social, economic, technological and political arenas suffer differently in the different world economies. These fast transformations that economies experience cannot be accurately observed in static and dynamic economic modeling or forecasting. Since Smith’s approach in 1776 until today, different schemes of economic modeling such as static and dynamic schemes have been used, as evidenced in a large number of essays, articles and books in libraries, the internet and journals. All these documents have used different theoretical approaches such as descriptive, theoretical, experimental and mathematical frameworks including econometrics. Furthermore, they have given us a general idea about some economic phenomenon or behavior in a specific historical moment through a frozen picture in 2 dimensions (X, Y). To analyze an economic phenomenon, we typically focus on selecting a few variables whose impact is expected to be more visible and ignoring the less important variables floating under the application of “the ceteris paribus assumption” to support possible unexpected scenarios that cannot be simultaneously included in our analysis. It also seems important to highlight here that partial market equilibrium assumes the use of the ceteris paribus assumption. The doctrine here is to isolate the less important variables from the study of market behavior and focus our attention on two specific variables such as the price of the commodity (P) and the quantity (Q). In fact, the price of the commodity (P) is the only variable that can affect quantity. Nevertheless, general market equilibrium is based on the use of a multi-commodity market. The approach is to include more commodities in our analysis, represented by n-equations in the quantity demanded function (see expression 12) and the quantity supply function (see expression 13). Market
equilibrium is represented by expression 14. Lastly, it is important to state that general market equilibrium also rests on the Ceteris Paribus assumption.

\[ Q_{d_i} = Q_{d_i}(P_1, P_2, \ldots, P_{\infty}) \quad i = 1, 2, \ldots, \infty \]  
(12)

\[ Q_{s_i} = Q_{s_i}(P_1, P_2, \ldots, P_{\infty}) \quad i = 1, 2, \ldots, \infty \]  
(13)

\[ \varepsilon_i = (P_1, P_2, \ldots, P_{\infty}) = 0 \]  
(14)

After a short review of the demand and supply model, the following question arises: can the classic analysis of demand and supply fully capture the behavior of the market as a whole? However, we suggest that market behavior needs to be studied based on the interaction of a large number of sub-markets. At the same time, all sub-markets should be kept in a permanent dynamic imbalanced state under the application of the Omnia Mobilis assumption. In fact, the market can be considered as a multidimensional system that interacts and works in perfect harmony without any restriction or condition. Our idea of equilibrium is quite different from the traditional classic view because we view equilibrium as an imbalanced synchronization state that can appear in unexpected and unlimited time. The imbalanced synchronization state is considered a fleeting momentum as a result of the relaxation (or lesser instability) of all sub-markets. It depends on the economic, social, political, technological, and environmental factors; market structures; institutions; and economic agents’ behavior. In the same context, we suggest the use of the dynamic imbalanced state (DIS), which can help explain possible unexpected market behavior. The dynamic imbalanced state is not a chaotic state; rather, it is the unconditional and unexpected complex sensitive reaction of a large number of sub-markets that is generated by different institutional, economic, political, social, technological, and environmental forces simultaneously under the condition of uncertain non-rational behavior. Therefore, all sub-markets do not necessarily need to be in equilibrium simultaneously because all sub-markets are kept in a dynamic imbalanced state. Moreover, all sub-markets can experience an imbalanced synchronization state at any time. It is a short, fleeting transitional state and is unpredictable and spontaneous. Market equilibrium is not a static and isolated phenomenon; it is a transitional and evolutionary state that cannot be controlled and determined arbitrarily. When studying market equilibrium, we must remember that it is not a natural phenomenon that can be exactly measured or demonstrated by the sciences. In our case, market equilibrium can be considered a dynamic imbalanced state, whereby humans’ interactions with each other to satisfy their needs always change according to the different periods of history. The analysis of market behavior under the application of the dynamic imbalanced state can be shown by constructing 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 \( Q^*_s \) identifies the price commodity equilibrium \( (P^*) \) for any commodity. The measurement of the quantity demanded equilibrium \( (Q^*_d) \) depends on the interaction of a large number of variables without any restriction(s) or classification (see expression 15), while in the case of partial market equilibrium, only the price commodity \( (P) \) can affect the quantity \( (Q) \). Therefore, we attempt to account for a large number of variables that can influence 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. All these sub-axes at the bottom part of each sub-
level are directly connected to the quantity demanded equilibrium \((Q_d^*)\) using straight lines until we can build the demand surface by sub-level, whereby each sub-level represents a specific commodity in the market. A large cylinder can be generated by connecting all sub-levels. It is assumed that each sub-axis in its sub-level shows growth rates \((\Delta)\) in real time (*), as depicted in Figure 1. Additionally, we must apply the Omnia Mobilis assumption to generate the relaxation of all variables affecting the demanded quantity equilibrium \((Q_d)\) because we avoid isolating some of the variables that the Ceteris paribus assumption considers less important. However, if all variables suffer because of relaxation, then the umbrella is open and the price imbalance \((P\approx)\) becomes lower, according to Figure 2. From a graphical perspective, the price imbalance \((P\approx)\) is a vertical axis located between the demand and supply surfaces. Figure 2 shows that each commodity has its own specific sub-level (or commodity) and quantity demanded imbalance \((Q_d\approx)\) and quantity supplied imbalance \((Q_s\approx)\) simultaneously in its specific price imbalance \((P\approx)\).

\[
Q_d\approx = Q_d^* (\bigodot \Delta V_1, \bigodot \Delta V_2, \ldots, \bigodot \Delta V_n) \tag{15}
\]
\[
Q_s\approx = Q_s^* (\bigodot \Delta V_1, \bigodot \Delta V_2, \ldots, \bigodot \Delta V_n) \tag{16}
\]
\[
\bigodot Q_d\approx \approx \bigodot P\approx \approx \bigodot Q_s\approx \tag{17}
\]
Figure 1
Quantity Demanded Equilibrium (Qd*), Quantity Supplied Equilibrium (Qs*) and Price Commodity Equilibrium (P*)

Source: Ruiz Estrada, Yap, Nagaraj (2008)

Figure 2
Demand Surface and Supply Surface

Source: Ruiz Estrada, Yap, Nagaraj (2008)
10.4. Can We Provide an Alert or Forecast of Market Failures?

This section is devoted to the study of market failures from an economic modeling perspective. It seems important to make a clear distinction between economic forecasting modeling and economic alerting modeling. Economic forecasting modeling is based on the classic use of econometrics under the application of different techniques, methods and models using sophisticated software such as SSPS, SAS, STAT, EVIEWS AREMOS, DATADESK and others. The modern econometrics software always adopts a dynamic modeling approach to analyze time-series, cross-sectional and longitudinal data. Forecasting economic modeling attempts to give us some basic and preliminary reasons behind the cause and effect of any economic phenomenon. In addition, we find that econometric models did not precisely predict market failures in the medium and long run with accuracy or a small margin of error until recently.

Furthermore, forecasting economic modeling under the application of econometrics can have low levels of accuracy and be unclear and unstable scenarios in the long run. Hence, the economic forecasting modeling of market failures in the long run becomes impossible and unrealistic. It can originate from the quickly rising challenges of economic, social, political and technological aspects and institutions in the market. Various factors are responsible for the low level of accuracy in forecasting market failures in the long run. Rapid technological changes, the vulnerability of the world economy due to international trade and investment under the umbrella of globalization, and the unpredictability of natural disasters due to a lack of ability can explain why the forecasting economic models are unable to correctly predict economic crisis in the long run.

By contrast, economic alerting modeling is based on mathematical models and computer programming supported by software and dynamic simulators. This type of economic modeling permits us to observe the behavior of the market as a whole in real time without any restrictions or limitations. Hence, the appearance of unexpected market failures because of an oil crisis, a financial crisis, or an international trade crisis become more difficult to predict than in the past, as market failure shows different signs and behaviors in different periods of time in the history of the world economy. Market failures can appear in different periods of time and retain their unique characteristics before the market experiences a substantial full or partial recovery from a deep or superficial crisis. The magnitude of the final impact of market failures can vary across different periods of time and geographical spaces.

More specifically, the negative impact of any market failure can be accounted for by the fast expansion of unemployment, uncontrolled and galloping inflation, constant economic slowdown, rapid and uncontrolled expansion of poverty, low stock market performance, constant currency depreciations, less international trade, high speculation in real estate and consumer uncertainty. Lastly, economic alerting modeling utilizes multidimensional graphical modeling offered by Econographicology and economic modeling in real time.

10.5. The Idea of Time and Space in Economic Analysis

This section demonstrates that the 2-dimensional space (X, Y) and 3-dimensional space (X, Y, Z) can show only a micro-picture in the visualization of complex and dynamic economic phenomena. The hypothesis of this research is that the 2-dimensional and 3-dimensional spaces are micro-slices of the large Mega-space or Universe in a fixed period of time and common space. Therefore, to test the proposed
hypothesis, we suggest the application of an alternative multidimensional graphical modeling approach that is called “the Mega-Space Cartesian Plane”. For a long time, economists attempted to visualize simple (static) or complex (dynamic) economic phenomena in different periods of time using the same graphical space through the application of 2-dimensional spaces (X, Y) or 3-dimensional spaces (X, Y, Z). The most common dimension applied to economic analysis is the 2-dimensional space (X, Y) to visualize historical data and explain economic theories and results from economic models under the application of econometrics. For example, the graphical visualization of the behavior of any country in response to any economic phenomenon (G.D.P. rates, inflation rates, exports/imports, etc.) is based on the application of the 2-dimensional Cartesian plane (X, Y). Typically, economists attempt to interpret a group of points located in different places according to time and space. All these points are connected by lines to visualize the historical trends from the past until today or possible results from economic models or forecasting models. In fact, the main idea of applying 2-dimensional spaces (X, Y) to economic models or forecasting models is to visualize how an economic phenomenon behaves under the impact of internal and external factors. Hence, economists can search for suitable policies to prevent possible economic failures or possible results of decisions made in the short or long term.

10.6. Why Do Economists Use 2-Dimensional and 3-Dimensional Spaces?

Economists use 2-dimensional space (X, Y) or sometimes 3-dimensional space (X, Y, Z) in the graphical representation of complex and dynamic economic problems, and it is important to determine the underlying reasons behind this usage. In our opinion, the following reasons can explain the use of these spaces in the study of economics.

1. These two graphical models were developed and established in Lafleur’s (1960) introduction of the 2-dimensional Cartesian plane. Since then, the application of the 2-dimensional space in economic graphical analysis has been a “tradition”.

2. The 2-dimensional space is “easy to apply” when visualizing basic trends or values in the same graphical space. We randomly selected approximately 5,000 documents (JSTOR and DIRECT SCIENCES -ELSEVIER-, 2013) from different reputable journals and text books in economics, econometrics, business, statistic, mathematic and sciences. Of all these documents 99.50% used 2-dimensional spaces (X, Y) and only 0.05% used 3-dimensional spaces (X, Y, Z).

3. The logical explanation for the frequent use of 2-dimensional spaces is the ease of plotting, drawing and visualizing any economic phenomenon. Therefore, 2-dimensional spaces can generate a clear visual and mental refraction to graphically present complex and dynamic economic phenomena in the same space and time.

4. It is difficult to find “alternative and suitable multidimensional graphical models” to move from 2-dimensional space graphical modeling to graphical modeling of multidimensional spaces. This research chapter encountered some difficulties in generating this crucial visual and mental transition from 2-dimensional spaces to multidimensional spaces. The main consideration of this research chapter is that 2-dimensional and 3-dimensional spaces are not able to capture the behavior of the real economic world as a whole. It is understood that the real world is changing constantly and in different spaces and across time. To test this proposition, we assume
that inside the Mega-Space or Universe, the number of General-Spaces, Sub-Spaces, Micro-Spaces, Nano-Spaces and JI-Spaces is infinite. All these spaces move differently. The logic behind the plotted points on the 2-dimensional or 3-dimensional Cartesian plane in this research is quite different from the traditional view because a single point plotted on the Cartesian plane is considered a rigid body. The first assumption applied in this research is that two rigid bodies cannot occupy the same space simultaneously. Different rigid bodies unfold and contend for different positions in the Mega-Space. The rigid bodies constantly move and generate different graphical reflections. The second assumption is that different rigid bodies in the Mega-Space, General-Spaces, Sub-Spaces, Micro-Spaces, Nano-Spaces and JI-Spaces run at different speeds of time. We assume that there are different types of time and that these times are followed by general times, partial times and constant times. The general time runs in the Mega-Space, but the General-Spaces, Sub-Spaces, Micro-Spaces, Nano-Spaces run under different partial times (see Figure 3). The JI-Spaces runs in constant time. The rigid body hangs on a specific point of the Mega-Space. The rigid body in the economic analysis can be represented by the interaction among fixed values in some specific space through the Cartesian plane. These values can be classified by absolute values (e.g., amounts of money or units of goods) and relative values (e.g., growth rates or percentages). In addition, it is also important to mention the roles of Euclidian geometry and Minkowski’s 4-dimensional spaces (Einstein, 1952) in supporting our proposition. Einstein used both geometrical models to explain his theory of relativity. These two geometrical modeling frameworks are strongly supported by his formal mathematical and theoretical frameworks. However, these two geometrical modeling frameworks are not able to provide any graphical modeling to facilitate the visualization of 4-dimensional spaces. Our proposed new multidimensional graphical modeling framework is missing from studies on Euclidian geometry and Minkowski’s 4-dimensional spaces. The new multidimensional graphical modeling is based on the application of multidimensional physical spaces (Ruiz Estrada, 2011b).

10.7. Introduction to the Mega-Space Coordinate Space

We introduce the Mega-Space coordinate system, as shown in Figure 3. Universe (U) is equivalent to the Mega-Space (S). The Mega-Space Coordinate System is followed by the General-Spaces (GS), Sub-Spaces (SS), Micro-Spaces (MS), Nano-Spaces (NS) and JI-Spaces (see expression 18). The JI-Space applies formula (18) to plot each JI-Space into its Nano-Space. The JI-Space can be a negative or positive number in its Nano-Space coordinate system, but there is also a possibility that the number “0” is located at the center of all Nano-Space coordinate systems. Hence, the number “0” is a large surface located in the central part of all Micro-Spaces that divides the positive and negative numbers of each JI-Space (see expression 19).

\[
U \equiv S = (GS_i, SS_{ij}, MS_{ijk}, NS_{ijkl}, JI_{ijklm}) \quad (18)
\]

\[
L = \frac{\alpha h x \beta z}{2} \quad (19)
\]

\[
M = [(X<i:j:k:\alpha i>),(Y<i:j:k:\beta i>)] \quad (20)
\]

Where \(i = \{1, 2\ldots \infty \}; j = \{1, 2\ldots \infty \}; k = \{1, 2\ldots \infty \}; h = \{1, 2\ldots \infty \} \) and \(z = \{1, 2\ldots \infty \} \)
Therefore, the Mega-Space Coordinate System starts from the General-Space "0", as shown in expression 21.

\[
U = S = GS_0, SS_{0:0}, MS_{0:0:0}, NS_{0:0:0:0}, JI_{0:0:0:0:0} \ldots \quad (21)
\]

Until the General-Space, the infinity Space \( \infty \ldots \) is expressed by expression 22.

\[
GS_{\infty}, SS_{\infty}, MS_{\infty}, NS_{\infty}, JI_{\infty} \ldots \quad (22)
\]

\[
M = f (GS_i, SS_{i:j}, MS_{i:j:k}, NS_{l}, JI_{m}) \quad (23)
\]

The final general function and all partial functions in analyzing the Mega-Space Coordinate System are equal to expressions 24, 25, 26, 27 and 28.

\[
S = f (GS_0, GS_1 \ldots GS_{\infty}) \quad (24)
\]

\[
GS = f (SS_0, SS_1 \ldots SS_{\infty}) \quad (25)
\]

\[
SS = f (MS_0, MS_1 \ldots MS_{\infty}) \quad (26)
\]

\[
MS = f (NS_0, NS_1 \ldots NS_{\infty}) \quad (27)
\]

\[
NS = f (JI_0, JI_1 \ldots JI_{\infty}) \quad (28)
\]

In fact, when we join all JI-Spaces located in different Nano-Spaces at the same Micro-Space, we observe a single surface in vertical position. Each JI-Space represents a single growth rate and constantly experiences different changes in different proportions compared with its neighbor JI-Spaces in the same Micro-Space. Hence, we can observe a large vertical surface constantly moving in its dimensions. We can determine that all Micro-Spaces move in their Sub-Spaces, that all Sub-Spaces move in their General-Spaces and, finally, that all General-Spaces move in the Mega-Spaces with variable speeds of time. It can be further stated that an economic phenomenon cannot be analyzed in isolation because every economic phenomenon is dynamic and complex by nature. Economic phenomena change dramatically and constantly and, therefore, will be studied from a multidimensional perspective. The traditional economic modeling approach is not able to precisely show the imperceptible changes associated with economic phenomena or behavior in the same graphical space. The multidimensional economic modeling framework can analyze any economic phenomenon from a multidimensional perspective to observe the unknown dimensions that cannot be observed with 2-dimensional modeling. Multidimensional economic modeling requires the use of graphical animation to generate real-time or slow motion visual effects to examine a giant graph move with different speeds of time live.

It will be useful to understand different scenarios that cannot be visualized using 2-dimensional modeling. Our final aim is to propose a powerful multidimensional economic and graphical modeling framework to observe different stages that any economic phenomenon can be experienced in real time or in slow motion.
10.8. Definition of Time in the Mega-Space Coordinate System

Our basic premise is that the Mega-Space or Universe is multidimensional. The JI-Space is a rigid body (value) that hangs in its Nano-Space. When all JI-Spaces are joined together, a surface in vertical position in the same Micro-Space can be generated. The Mega-space coordinate system applies three different types of time to its graphical modeling including general times (GT), partial times (PT) and constant times (KT), as previously mentioned.

\[ S_{GT} = f(GS_{i/PT}, SS_{i:j/PT}, MS_{i:j:k/PT}, NS_{i:j:k:l/PT}, JI_{i:j:k:l:m/KT}) \]  (29)

The Mega-Space runs on a general time, while General-Spaces, Sub-Spaces, Micro-Spaces and Nano-Spaces (see Figure 4) simultaneously run with partial times. The JI-Space hangs in its Micro-Space. A linear or non-linear curve in one Micro-Space can be obtained by joining the JI-Spaces. Expressions 30 and 31 clearly show that the Mega-Space Cartesian plane is applied in three different types of time, as previously mentioned.

\[ M_{wt} = f(GS_{i/wp}, SS_{i:j/wp}, MS_{i:j:k/wp}, NS_{i/wp}, JI_{m/wk}) \]  \hspace{1cm} (30)

\[ L_{wp} = \frac{a_h/wk \times \beta_{z/wk}}{2} \]  \hspace{1cm} (31)

Where

\[ h = \{1,2,\ldots,\infty \} \] and \[ z = \{1,2,\ldots,\infty \} \]

\[ m_{wk} = [(X<i/wp: j/wp: k/wp: a_h/wk>),(Y<i/wp: j/wp :k/wp :\beta_{z/wk}>)] \]  \hspace{1cm} (32)

Where

\[ i = \{1,2,\ldots,\infty \} \]; \[ j = \{1,2,\ldots,\infty \} \] and \[ k = \{1,2,\ldots,\infty \} \]
Figure 3
Mega-Space, General Space and Sub-Space

Source: Ruiz Estrada (2011b)

Figure 4
General-Space, Sub-Space, Micro-Space, Nano-Space and JI-Space

Source: Ruiz Estrada (2011b)
10.8.1. How to Plot on the Mega-Space Cartesian Plane

This section demonstrates how to plot on the Mega-Space. Initially, we apply the Mega-Space Cartesian plane coordinate system that is shown by the following expression.

\[ U \equiv M = (G_{Si}, SS_{ij}, MS_{i:j:k}, NS_{L}, J_{I[(X<i:j:k:ah>, (Y<i:j:k:βz>)]} (33) \]

\[ L = a_{h} \times b_{z} / 2 \quad (34) \]

The values that should be used during the process of plotting on the Mega-Space Cartesian plane are shown in Figure 5.

- \(G_{S_i} = 3\)
- \(SS_3 = 0\)
- \(MS_{3,0} = 0\)
- \(a_{h} = 3\)
- \(β_z = 3\)
- \(NS_{L} = 4.5\)

\[ J_{I[(X<3:0:0:3>),(Y<3:0:0:3>)]} \]

**Figure 5**
Mega-Space Plotting

Source: Ruiz Estrada (2011b)
10.9. Introduction to the Multidimensional Real-Time Economic Modeling Framework

Economic alerting modeling requires the creation of a data center that is able to save a large amount of information in different databases from different sources such as government agencies, academia, statistical departments and think tanks. The data center can also process a large amount of information in each database and simultaneously plot all the database information in a multidimensional coordinate system such as the mega-surface coordinate system. Similarly, we are also in a position to observe a mega-surface that is moving in real time through a large screen. Lastly, the database can alert us of possible failures in some or all the variables in one mega-surface at the same time. The main idea is to alert and generate special images in real time and slow motion. If we identify exactly which variable(s) is suffering, then we can take action(s) at the appropriate time to prevent more severe damage, for example, a possible major economic crisis in any economy. We assume that the mega-surface does not have a dependent variable; rather, it contains a large surface formed by infinite independent variables moving simultaneously. A mega-surface moving continuously in relation to the different growth rates of independent variables can be generated by adding all these independent variables using straight lines. Furthermore, all these variables are assumed to be independent of each other. The purpose of generating the mega-surface is to study the behavior of several independent variables simultaneously in the same graphical space in real time. We can observe that it is possible to obtain high levels of accuracy and effectiveness to reduce the impact of a possible economic crisis in a timely manner. Our main focus is the ex-present effect in real time instead of the ex-post or ex-ante effect. The objective is to detect failure(s) in some or all independent variables in mega-surface live using the Omnia Mobilis assumption to relax all independent variables in our modeling and, thus, provide an alert of a possible economic crisis at any time.

10.10. Multidimensional Economic Modeling

This chapter proposes a multidimensional economic modeling framework that is able to generate a large number of simulations in the same graphical space in real time or slow motion to study the behavior of complex and dynamic economic phenomena. We suggest that multidimensional economic modeling requires the use of multidimensional physical spaces. The first assumption of multidimensional economic modeling is that all dimensions run under different speeds of time because any economic phenomenon can adopt a multidimensional behavior across time and space. The second assumption of multidimensional economic modeling is that any economic phenomenon always experiences a dynamic imbalanced state under the application of the Omnia Mobilis assumption. Hence, multidimensional economic modeling never needs to be in a state of equilibrium under the application of the Ceteris Paribus assumption.

Moreover, the idea of time in this model is rather different from that in 2-dimensional linear and non-linear graphical modeling because 2-dimensional modeling refers to a single and unique time standard under the use of the traditional calendar (by months or years) to analyze complex and dynamic economic phenomena or behaviors. In our personal view, the 2-dimensional framework can clearly show analytical inconsistency in the short and long runs. Therefore, we assume that any economic phenomenon can be analyzed from different dimensions because each dimension runs following a different speed of time. Furthermore, any economic phenomenon experiences different speeds of time. If we join different
economic phenomena in the same graphical space, then it is possible to observe a series of economic phenomena moving in different directions with variable speeds of time in the same graphical space.

10.11. Economic Modeling in Real Time

Economic modeling in real time can be done with the help of Econographicology (Ruiz Estrada, 2007). Econographicology supplies different multidimensional physical spaces to construct multidimensional graphs. The software required for economic modeling in real time follows various steps. First, there must be a standard format to input information on a line daily. Second, all these pieces of information (I) can be transferred to different databases (DB), which are interconnected to a unique information data center. Third, the same software can work immediately to plot different pieces of information (I) from different databases (DB) on the multidimensional physical space. Every observation from a database depends on different data sources such as the central bank, government agencies, private companies, national statistical departments and public and private research institutes, as demonstrated in Figure 6. Each plotted point in the multidimensional physical space is always changing. We use the concept of data changing in real time (see expression 37). Data changes in real time are due to the comparison of pieces of information (I) between two periods of time (the past and the present period of time). Similarly, the data changes in real time are fixed into their coordinate and variable positions all the time. Additionally, we reiterate that all changes in data in real time plotted in the multidimensional physical space are linked together with straight lines that form a single mega-surface in the same physical space (see Figure 6).

**Figure 6**
Mega-Surface

Source: Ruiz Estrada (2011b)
10.11. Model

Economic modeling in real time routinely starts with the input data function, as shown below:

\[ I_{C,R} = Q_1; Q_2; \ldots; Q_{\infty} \quad (35) \]

\[ I = \text{Input answer} \quad Q = \text{Question(s)} \quad C = \text{Column} \quad R = \text{Row} \]

The next step is the storing the data in the database (DB), which is described with the help of equation 36.

\[ 1.) \quad DB_{C,R} = \bigoplus SI_{C,R} \bigoplus \ldots \bigoplus \bigoplus SI_{C,R} \quad (36) \]

\[ C = \{1, 2, 3\ldots n\} \quad n = \infty \]
\[ R = \{1, 2, 3\ldots n\} \quad n = \infty \]

Where DB = Database, C = Column, R = Row, \( \bigoplus \) = Running information in real time, SI = Save Information, and \( \bigoplus \) = Interlink Database

In the case of data changes in real time (\( \bigoplus \Delta I_{C,R} \)), we compare the information we received on the previous day (\( t-1 \) = past period of time) and the information received on the current day (\( t \) = actual period of time), as presented in expression 37.

\[ \bigoplus \Delta I_{C,R} = \bigoplus SI(t) - \bigoplus SI(t-1)/ \bigoplus SI(t-1) \quad (37) \]

Finally, the plotting of real-time data is illustrated by expression 38, as follows:

\[ Y_{sf} = f (\bigoplus \Delta I_{11} \bigoplus \ldots \bigoplus \Delta I_{\infty\infty}) \quad (38) \]

Next, Figure 7 further clarifies and simplifies the idea discussed above.

**Figure 7**
Economic Modeling in Real Time

Source: Ruiz Estrada (2011b)
The multidimensional graphical signal detection model avoids the use of a single dependent variable. This model suggests replacing a single dependent variable with a single mega-surface. This mega-surface is formed by infinite axes, and each axis is located in a vertical position. An axis shows positive values on the top of the axis and negative values at the bottom of the axis (see Expression 36). Similarly, for each axis, it is possible to observe a point that is pending and moving up and down on its axis constantly. This point represents the behavior of an independent variable on its axis. Furthermore, we need to join each independent variable to its next independent variable neighbor using a straight line. Finally, we can observe that the mega-surface (see expression 37) is formed by joining all independent variables (see Figure 5). The mega-surface is always in constant movement in real time and moving in different directions. The real-time modeling effect generating into the mega-surface depends on the speed of the information reception that directly influences the behavior of each independent variable’s growth rate (see Expression 39). We suggest the application of the Omnia Mobilis assumption to relax all independent variables that are moving on their axis in real time. Multidimensional graphical signal detection modeling starts by building the growth rate function of each independent variable, as shown by the following expression:

\[
\bigcirc \Delta I_{ij} = \bigcirc \Delta I(t) - \bigcirc \Delta I(t-1)/\bigcirc \Delta I(t-1) \quad (39)
\]

Where the row: \(i = \{1, 2, 3…n\} \ n = \infty\); the column: \(j = \{1, 2, 3…n\} \ n = \infty\); \(\Delta = \) Growth rate; \(\bigcirc = \) Running information in real time; \(t-1 = \) past period of time and \(t = \) actual period of time. Each independent variable in the mega-surface in the coordinate system can be represented as below:

\[
\bigcirc \Delta I_{ij} = (X_{ij}, Y_{ij}) \quad (40)
\]

Where \(X = \{-\infty \ldots -3, -2, -1, 0, 1, 2, 3…\infty+\}\) and \(Y = \{-\infty \ldots -3, -2, -1, 0, 1, 2, 3…\infty+\}\)

The next step is to build the final mega-surface given by \((i \times j)\).

\[
\bigcirc M S = \begin{bmatrix}
\bigcirc \Delta I_{11} & \bigcirc \Delta I_{12} & \cdots & \bigcirc \Delta I_{1n} \\
\bigcirc \Delta I_{21} & \bigcirc \Delta I_{22} & \cdots & \bigcirc \Delta I_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
\bigcirc \Delta I_{n1} & \bigcirc \Delta I_{n2} & \cdots & \bigcirc \Delta I_{nn}
\end{bmatrix}
\]

Where \(i = \{1, 2, 3…\infty\}\); \(j = \{1, 2, 3…\infty\}\) and “\(\bigcirc\)” is equal to the interlinking variables. Finally, the analysis of the final mega-surface is based on the location of all independent variables in the mega-surface coordinate system. Hence, we obtain the following three possible results:

(1) If \(\bigcirc \Delta I_{ij} > 0\), then our mega-surface becomes GREEN in color, indicating good economic performance.

(2) If \(\bigcirc \Delta I_{ij} = 0\), then our mega-surface becomes YELLOW, showing that the economy is stagnant.
If $\Delta I_{ij} < 0$, then our mega-surface becomes RED, demonstrating that the economic performance of the economy is poor.

Put simply, the color of the mega-surface can alert us of a possible economic crisis in a timely manner. We would like to state that we cannot stop an economic crisis. Rather, we can only reduce the damage caused by an economic crisis. Therefore, the findings of this chapter have serious implications for both researchers and policy makers.

10.12. Conclusions

This chapter has attempted to develop an alternative modeling approach for researchers to utilize. The traditional 2-dimensional modeling approach is not able to explain complex and dynamic economic problems in real time. We have, therefore, attempted to develop an alternative economic modeling (MRTE-Modeling) framework that is 3-dimensional by construction. Similarly, we believe that alerting economic modeling is more effective than economic forecasting. Now, we are able to observe the behavior of any economic phenomenon as a whole in real time and the timing of possible market failures. However, it should also be noted that we cannot stop market failures; rather, we can only minimize their damage in the short and medium runs. Reducing the damages associated with market failures would certainly help policy makers make their economies more efficient by implementing and executing appropriate policies.

The major contribution of this chapter to the existing literature on macroeconomic modeling is that it provides solutions for various complex and dynamic economic phenomena in the same graphical space under the application of multi-times framework. We posit that any economic phenomenon needs to be studied from a multidimensional perspective and in real time based on the use of high-performing information technology and the application of multidimensional real time graphical modeling under Econographicology. The proposed modeling framework would enable researchers to observe the behavior of any economic phenomenon live through a screen and to find failures in the market in a timely manner. The idea behind applying multi-times framework is to generate a real-time effect or slow motion visual effect and to identify possible failures that any economic phenomenon can experience in different stages across time and space. Market behavior in the real world is always in a dynamic imbalance state. Therefore, the market does not necessarily need to be in a state of equilibrium in which only the price of the commodity ($P$) can influence the quantity demanded ($Q_d$) and quantity supplied ($Q_s$). It follows that the real-world market cannot be analyzed using only two variables to explain dynamic and complex market behaviors. In our opinion, the study of the market needs to include a large number of variables that affect demand and supply simultaneously. We, therefore, suggest the use of the price imbalance ($P \approx$) resulting from the relaxation or stress of all variables running into quantity demanded imbalance ($Q_d \approx$) and the quantity supplied imbalance ($Q_s \approx$) simultaneously.

The proposed modeling framework is sufficiently flexible to include a large number of variables without any restriction or isolation. This is in contrast to the Ceteris Paribus assumption, which imposes restrictions and isolation into partial and general market equilibriums. A market basically consists of a large number of sub-markets in a dynamic imbalanced state. Therefore, if all sub-markets are kept in a dynamic imbalanced state, then the momentum of the imbalanced synchronization state can appear in
different sub–markets simultaneously. The momentum of the imbalanced synchronization state is a result of the relaxation of all sub-markets. In fact, the momentum of the imbalanced synchronization state is a fleeting and unpredictable leak momentum that can appear spontaneously in all sub-markets at any time. Furthermore, the price commodity equilibrium \((P^*)\) depends on the relaxation or stress of all the variables that affect the quantity demanded equilibrium \((Q_d^*)\) and the quantity supplied equilibrium \((Q_s^*)\).

10.13. References


CHAPTER XI
AN ALTERNATIVE MULTIDISPLINARY INDEX TO EVALUATE
THE MARKET PERFORMANCE AND ITS VULNERABILITY:
MPVT-INDEX

Mario Arturo Ruiz Estrada

11.1. Introduction

This chapter is willing to explain the complex and dynamic behavior of the market from a multi-dimensional perspective. Initially, we assume that exist five global forces are interacting together and affect on the market behavior simultaneously. These five global forces are the economic global forces, social global forces, political global forces, technological global forces and natural global forces. Hence, 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 became more vulnerable to suffer anytime a crisis. It is according to the advance stages in the evolution of the market. Usually, the traditional explanation about the market behavior is based on the uses of demand and supply forces. In our case 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 the market behavior was great to explain how the market works and the failures of market. If we analyze the point of view about the market behavior by these four economists then we can find different conceptions and views, this may be caused by different historical timing that each of these economists were lived. This research agrees that all these economists are right at the moment to explain the dynamic and complex behavior of the market into its historical momentum, but they are unavailable to explain the behavior of the market in our days.

In the study of the market, always is common to observe the uses of the Ceteris Paribus assumption. In our case the application of the Ceteris Paribus assumption became unnecessary, it is because we argue that the study of the market you cannot isolate some variables that they are considered less important into the study of the market behavior. For this reason, we suggest the uses of new assumptions and graphical modeling to explain more clearly the dynamicity and chaotic behavior of the market can experience across time and space. Firstly, this research assume that the market always experiences a dynamic imbalance state. It is only possible by the application of the Omnia Mobilis assumption (everything is moving).

The uses of the Omnia Mobilis assumption can help to include more variables without any isolation in the study of the market. Additionally, we suggest the application of multidimensional graphical modeling to facilitate the visualization of the market behavior from a global perspective. On the other hand, the market can be considered as a complex and multidimensional system under the interaction of the private and public sector. In the end both sectors became complementary and inseparables to keep alive the economy of any country. In our opinion the market is not a simple place that we can only exchange goods and services. Hence, the market is a dynamic multidimensional system that is affected by different global forces. And all these global forces always keep in constant quantitative and qualitative transformation(s) all the time. According to this research the study of the market behavior basically
depends on the five global forces volatility and the historical momentum of humanity experience in different phases.

Therefore, in the study of the market at the last past fifty years, we can observe the application of sophisticates and complex econometrics and mathematical models and techniques that try to catch up as a whole the dynamic and complex behavior of the market. But we can observe that all these models and techniques are not available to enclosed a large number of variables and reduce the isolation of some variables that there are considering not important to be accounted into its modeling.

Finally, we like to propose an alternative multidimensional model to analyze and visualize the fast changes of the market behavior. It is based on the uses of five global forces outputs follow by: 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 is running in real time and affect directly on the market behavior simultaneously without any isolation of some variable(s).

11.2. Model

This model attempts to use a multidimensional mathematical and multidimensional graphical approach. We propose the uses of the 6-dimensional coordinate space (vertical position) (Ruiz Estrada, 2016). This specific coordinate space offers six axes to plot five exogenous variables and one endogenous variable, now we are available to observe the changes of each exogenous variable and the endogenous variable into its axis separately at the same graphical space (Ruiz Estrada, 2012). We also suggest the application of the Omnia Mobilis assumption (Ruiz Estrada, 2011) to generate the relaxation of the five global forces of the market. The main objective is to observe in real time the behavior of the market without any isolation. In our case we fix each market force into its axis. These five global forces are follow by the 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 (☼) (see Annex 2). All these factors (i) in our model can be considered such as independent sub-variables. At the same time, we suggest that each global force apply infinity partial derivatives (∂) are running in real time (☼) and affect directly on the final market performance and vulnerability trend index (MPVT-Index) result.

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

The measurement of each global force is based on the equation 6, where we are running several partial derivatives (☼) in real time (☼) between different periods of time: the past time <t-1> and the future time <t+1>.

\[
\mathcal{O}X_i = \mathcal{O} [\partial X_{i<\mathcal{O}t+1>} / \partial X_{i<\mathcal{O}t-1>}] \Rightarrow i = \{1, 2, 3, 4, 5\} \quad (6)
\]
Each global force in our model can be measured by expressions 7, 8, 9, 10 and 11. After, these five global forces will be plotted directly on its axis at the 6-dimensional coordinate space respectively:

\[ \bigcirc X_1 = \bigcirc \left[ \frac{\partial X_{1t}}{\partial X_{1t-1}} \right] \quad (7) \]

\[ \bigcirc X_2 = \bigcirc \left[ \frac{\partial X_{2t}}{\partial X_{2t-1}} \right] \quad (8) \]

\[ \bigcirc X_3 = \bigcirc \left[ \frac{\partial X_{3t}}{\partial X_{3t-1}} \right] \quad (9) \]

\[ \bigcirc X_4 = \bigcirc \left[ \frac{\partial X_{4t}}{\partial X_{4t-1}} \right] \quad (10) \]

\[ \bigcirc X_5 = \bigcirc \left[ \frac{\partial X_{5t}}{\partial X_{5t-1}} \right] \quad (11) \]

In the case of the market performance and vulnerability trend index (MPVT-Index) can be calculated by the equation 12. The final result of the market performance vulnerability trend index (MPVT-Index) always is represented by an absolute value.

\[ MPVT\text{-Index} = \bigcirc \left[ \frac{\partial X_i}{\partial X_{i-1}} \right] \Rightarrow i = \{1,2,3,4,5\} \quad (12) \]

However, the final measurement of the market performance and vulnerability trend index (MPVT-Index) (see Expression 13) continue apply infinity partial derivatives (\(\bigcirc\)) are running in real time (\(\bigcirc\)) (see Annex 1). All these global forces were mentioned before; these are interconnected to a common variable that is called “The Market Performance Vulnerability Trend Index (MPVT-Index)”. At the same time this index requests to apply the interconnectivity principle (\(\bigcirc\)) (see Annex 3).

\[ MPVT\text{-Index} = \bigcirc \left[ \frac{\partial X_{1t+1}}{\partial X_{1t-1}} \right] \bigcirc \left[ \frac{\partial X_{2t+1}}{\partial X_{2t-1}} \right] \bigcirc \left[ \frac{\partial X_{3t+1}}{\partial X_{3t-1}} \right] \bigcirc \left[ \frac{\partial X_{4t+1}}{\partial X_{4t-1}} \right] \bigcirc \left[ \frac{\partial X_{5t+1}}{\partial X_{5t-1}} \right] \quad (13) \]

The final analysis of this model depends on the final output from the global economic forces, global social forces, global political forces, global technological forces and global natural forces and the market performance and vulnerability trend index (MPVT-Index). If we find the final output for all global forces and the market vulnerability trend index, then we can start to plot each final output into its axis at the 6-dimensional coordinate space respectively (see Figure 1). Finally, we proceed to join all final outputs was plot into its axis by apply straights lines until we can build a single surface. This surface will be called “the market surface”. Finally, the market surface can show three possible results (see Figure 2):

4. If the market surface is located on high level at the 6-dimensional coordinate space, then we are referring to a “high vulnerability intensity”

5. If the market surface is located between a high and low level at the 6-dimensional coordinate space, then we are referring to a “unstable vulnerability intensity”

6. If the market surface is located under low level at the 6-dimensional coordinate space, then we are referring to a “low vulnerability intensity”
11.3. Analysis of the final results

The study case for this chapter is the U.S. market vulnerability between 20th century and 21th. We are using 1500 variables (exogenous sub-variables) distributed into the five general exogenous variables (five global forces) that fix the 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 performance and vulnerability trend
index (MPVT-Index) (general endogenous variable). It is to compare the vulnerability of the market between these two centuries on the U.S. market. This model applies partial derivatives in real time under the uses 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>MPVT-Index</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 in this model shows that the U.S. market behavior between 20th century and 21st century became more vulnerable according to market performance and vulnerability trend index (MPVT-Index) from 0.61852468 to 0.81025594 (see Table 1). In the case of the economic global forces vulnerability of U.S. market shows a level of vulnerability of 0.8521247 in the 21st century compare to 0.6852114 in the 20th century.

In the case of the global social forces and global political forces vulnerability of U.S. market. Both global forces experience small growth expansion into its rates of vulnerability compare to the economic global forces vulnerability. In the case of the global social vulnerability of U.S. market show a vulnerability rate from 0.425143 to 0.512544 according to the Table 1. Subsequently the political global forces vulnerability rate of U.S. market experiences rates from 0.454813 to 0.885484 (see Table 1).

The technological global forces of U.S. show the largest rate vulnerability among these two centuries that change from 0.468715 to 0.852414. Something similar happens to the natural global forces rate for U.S. market that is possible to be observed by a considerable expansion of its vulnerability rate from 0.558741 to 0.858713 (see Figure 3). Hence, we can probe that the market behavior of the U.S. market became more vulnerable according to the fast advance stages that the U.S. market can experience. If we refer to the figure 3 then we can observe clearly that the market surface of U.S. for the 20th century is lower than the market surface of U.S. in the 21st century.
11.4. Concluding Remarks

This opinion chapter concludes that the performance and vulnerability of the market behavior basically depend on five global forces follow by economic global forces, social global forces, political global forces, technological global forces and natural global forces. All these five global forces interact and keep in constant changes across time and space. We also encourage include all possible general-variables and sub-variables can affect the market behavior without any isolation or restriction. At the same time, we request the application of multidimensional graphical modeling in real time to observe the complex and dynamic behavior of the market as a whole. Finally, we can conclude that the analysis of the U.S. market became more vulnerable according to the advance stages of evolution in the humanity and the fast changes into each global force. It is possible to be observed in the final results of our model in the case of U.S. market performance and its vulnerability.
11.5. Annex

Annex 1: Multidimensional partial differentiation rules

\[
\frac{dy_{ij}}{dx_{ij}} = 0 \quad \text{or} \quad f'(x_{ij}) = 0 \quad \text{(A.1.1)}
\]

\[
\frac{d}{dx_{ij}} = nx^{n-1}_{ij} \quad \text{or} \quad f'(x_{ij}) = nx^{n-1}_{ij} \quad \text{(A.1.2)}
\]

\[
\frac{d}{dcx_{ij}} = cnx^{n-1}_{ij} \quad \text{or} \quad f'(x_{ij}) = cnx^{n-1}_{ij} \quad \text{(A.1.3)}
\]

\[
\frac{d}{dx_{ij}} [\alpha_{ij}(x_{ij}) \pm \theta_{ij}(x_{ij}) \pm \ldots \pm \lambda_{ij}(x_{ij})] = \frac{d}{dx_{ij}} \alpha(x_{ij}) \pm \frac{d}{dx_{ij}} \theta(x_{ij}) \pm \ldots \pm \frac{d}{dx_{ij}} \lambda(x_{ij})
\]

or \( \alpha(x_{ij}) \pm \theta(x_{ij}) \pm \ldots \pm \lambda(x_{ij}) \) \quad \text{(A.1.4)}

\[
\frac{d}{dx_{ij}} [\alpha_{ij}(x_{ij}) \theta_{ij}(x_{ij}) \ldots \lambda_{ij}(x_{ij})] = \alpha(x_{ij}) \frac{d}{dx_{ij}} \theta_{ij}(x_{ij}) \ldots \lambda_{ij}(x_{ij})
\]

\[
\alpha(x_{ij}) + \theta_{ij}(x_{ij}) \frac{d}{dx_{ij}} \lambda_{ij}(x_{ij})
\]

\[
\alpha(x_{ij}) + \theta_{ij}(x_{ij}) + \ldots + \lambda_{ij}(x_{ij}) \frac{d}{dx_{ij}} \ldots 
\]

\[
\frac{d}{dx_{ij}} [\alpha_{ij}(x_{ij})] \frac{d}{dx_{ij}} [\theta_{ij}(x_{ij})] \ldots \lambda_{ij}(x_{ij})] = \alpha(x_{ij}) \frac{d}{dx_{ij}} \theta_{ij}(x_{ij}) \ldots \lambda_{ij}(x_{ij})
\]

\[
\frac{d}{dx_{ij}} \alpha(x_{ij}) \frac{d}{dx_{ij}} \theta_{ij}(x_{ij}) \ldots \lambda_{ij}(x_{ij})
\]

\[
\alpha(x_{ij}) + \theta_{ij}(x_{ij}) + \ldots + \lambda_{ij}(x_{ij}) \frac{d}{dx_{ij}} \ldots 
\]

\[
\frac{d}{dx_{ij}} [\alpha_{ij}(x_{ij})] \frac{d}{dx_{ij}} [\theta_{ij}(x_{ij})] \ldots \lambda_{ij}(x_{ij})] = \alpha(x_{ij}) \frac{d}{dx_{ij}} \theta_{ij}(x_{ij}) \ldots \lambda_{ij}(x_{ij})
\]

\[
\alpha(x_{ij}) + \theta_{ij}(x_{ij}) + \ldots + \lambda_{ij}(x_{ij}) \frac{d}{dx_{ij}} \ldots 
\]

Annex 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. 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 A.2.3). Basically, data changes in real time compare the information (I) between two periods of time (the past period of time and the present period of time), while the data changes in real time are simultaneously fixed into the multi-dimensional coordinate space that is itself changing position all the time. Additionally, all data changes in real time plotted in the multi-dimensional coordinate spaces are linked together by straight lines until they form a single surface in the same physical space (see Figure 4). Initially, economic modeling in real time starts with this input data function:
The next step is storage in the database (DB) equation, represented by

\[ \text{DB}_{C:R} = \mathcal{SI}_{C:R} \parallel \ldots \parallel \mathcal{SI}_{C:R} \ldots \] (A.2.2)

\[ C = \{1, 2, 3\ldots n\} \ n = \infty \]
\[ R = \{1, 2, 3\ldots n\} \ n = \infty \]

DB = Database  C = Column  R = Row  \(\mathcal{SI}\) = Running information in real time  SI = Save Information  \(\parallel\) = Interlink Database

In the case of data changes in real time (\(\mathcal{SI}_{C:R}\)), we compare the information we received a day before (t-1 = past period of time) and the information received today (t = actual period of time) (see Expression A.2.3).

\[ \mathcal{SI}_{C:R} = \mathcal{SI}(t) - \mathcal{SI}(t-1)/ \mathcal{SI}(t-1) \] (A.2.3)

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

\[ Y_{st} = f (\mathcal{SI}_{11} \parallel \ldots \parallel \mathcal{SI}_{c\infty}) \] (A.2.4)
ANNEX 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 5). Each n-dimensional coordinate space (vertical position) can plot an infinite number of sub-exogenous variables into an infinite number of axes ($Y_{\text{L,n}}$) and a single sub-endogenous variable into its single axis ($X_{\text{L;i,n}}$).

After all these variables have been plotted into its respective axes, all sub-endogenous variables ($S_{\text{L;i,n}}$) 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 ($\Box$) (see Expression A.3.1) and the general interconnectivity condition ($\Box$) (see Expression A.3.2).

\[
S_0 = Y_{0;i} = f \left( X_{0;0:i} \Box X_{0;1:i} \Box \ldots \Box X_{0;\infty} \right) \\
S_1 = Y_{1;i} = f \left( X_{0;0:i} \Box X_{0;1:i} \Box \ldots \Box X_{0;\infty} \right) \\
\vdots \\
S_\infty = Y_{\infty;i} = f \left( X_{0;0:i} \Box X_{0;1:i} \Box \ldots \Box X_{0;\infty} \right) \quad (A.3.1) \\
I = S_0 (Y_{\text{L,n}}) \Box S_1 (Y_{\text{L,n}}) \Box \ldots \Box S_\infty (Y_{\text{L,n}}) \ldots \quad (A.3.2)
\]

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 5**

*The Interconnectivity of Multi-Dimensional Physical Spaces*

Source: Ruiz Estrada, 2016
11.6. References

CHAPTER XII
THE PAST, PRESENT, AND FUTURE OF POLICY MODELING

Mario Arturo Ruiz Estrada and Donghyun Park

12.1. The 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.” (Ruiz Estrada, 2011).

Policy modeling can also be classified into different categories. Based on an analysis of all two thousand eight and five (2,085) papers that were published in the Journal of Policy Modeling (JPM) between 1978 and 2018 (40 years) (see Table 1), policy modeling can be classified into the following seventeen (17) categories: (i) domestic and international trade policy modeling; (ii) energy, infrastructure, communications, and transportation policy modeling; (iii) environmental, agriculture, and natural resources management policy modeling; (iv) fiscal, government expenditure, and public debt policy modeling; (v) institutional, regulation and negotiation policy modeling; (vi) labor, employment and population policy modeling; (vii) monetary, stock market, exchange rate, finance, banking, insurance, and investment policy modeling; (viii) production, saving, income, 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) education and human capital development policy modeling; (xiii) military and national security policy modeling; (xiv) gender, culture, discrimination, and racism policy modeling; (xv) natural disasters and food security policy modeling; (xvi) unemployment, inflation, poverty policy modeling; and (xvii) miscellaneous policy modeling (See Table 1).
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Source: Journal of Policy Modeling, ScienceDirect, Elsevier
12.2. The origins of policy modeling

According to Antonio Maria Costa (2011), policy modeling was born at the United Nations (UN) at the end of the 1970s when economists agreed that their profession was not all that useful to people engaged in macroeconomic management. As a result, they searched for a scientific policy modeling research approach that was rooted in empirical validation. Unfortunately, there was none around. Even worse, there was a general feeling that economics had become too mathematical, too abstract, and basically irrelevant. Hence, the economics research field was being dominated by mathematicians who only wanted to impress economists with complicated and sophisticated mathematical models, failing their discipline miserably in the process. Analytically rigorous policy modelling emerged as an alternative to rambling books without focus and application, (Ruiz Estrada and Yap, 2013).

According to Professor Douglas O. Walker (2011), back in the 1950s and 1960s, before Journal of Policy Modeling existed, development policy stressed "Big Push" capital fundamentalist ideas that linked economic growth to investment, which replaced traditional economic practices with more modern technologies and institutions. Policy models reflected this orientation. The 1970s saw a period of turmoil, stagnation, growing concerns about foreign investment and dependency, and the price and income controls. In the 1980s, policy highlighted the pre-eminence of markets and the need for structural adjustment in the face of external imbalances. The decade also witnessed the rise of social development as a key concern in the formulation of long-term strategies for development. With the collapse of central planning in the late 1980s and early 1990s, the transition to market-oriented economies led to major policy reforms and a quest for better economic governance. Along with the prominence of human rights and globalization, the first decade of the 21st century has seen severe financial instability, triggered by the large-scale fiscal and trade imbalances of the major developed countries.

Throughout the years, JPM has seen a change in its policy focus. Initially it published the then-unanimous view that a high rate of economic growth was the secret to achieving social development and political stability. Over time, however, this view was challenged as environmental and poverty issues took center stage in policy discussions. Capital fundamentalism is now dead. This change in policy focus, especially at the international level, was reflected in the different articles and subjects covered by JPM. Similarly, we suspect that the balance between internationally-oriented and nationally-oriented papers as well as the kinds of quantitative techniques used as computers becomes more readily available and easier to use would change systematically over the years. In 1968, the first revision of the systems of national account (SNA) was introduced and it slowly but steadily led to a better, more comprehensive and detailed data series. Other data improvements along a wide range of subjects may be added, notably on income distribution. (Ruiz Estrada and Yap, 2013)

It is pertinent from the comments of the two scholars above that there is consensus on the origin of policy modeling. Both authors observe a deep transformation in the analysis, formulation and orientation of policies across different periods of time and geographical spaces. Moreover, it is obvious that the use of more practical economic approaches could facilitate the explanation of various dynamic and complex economic and social phenomenon. The main idea behind the use of practical economic approaches is to find suitable and applicable policies that can help to reduce the negative impact of any economic and social problem(s) in the society by the most efficient and realistic way.
12.3. The evolution of the economic analysis up to the present

The primary objective of this chapter is to evaluate the evolution of the economic analysis of complex and dynamic economic phenomena. We can observe that economic analysis experiences a number of different qualitative and quantitative transformations during different periods. Therefore, economics analysis is moving faster from a qualitative analysis to a pure quantitative analysis. Recently, it is possible to observe the almost universal uses of mathematical tools such as econometrics, statistical models, and economic mathematics models in the evaluation of different economic phenomena around us.

Hence, at the present, the use of qualitative analysis - i.e. historical and descriptive analysis based on the use of simple observations and experiences – is much less common than the use of quantitative analysis – i.e. mathematical and statistical techniques and methods. Furthermore, more recently, a number of new research fields are incorporated in economic analysis. These include physics, biology, chemistry, education, medicine, military studies, psychology, sociology, history, engineering, and other pure sciences.

However, economic analysis always undergoes a constant transformation to evaluate different dynamic and complex economic phenomena. The main reason behind this constant transformation of the economic analysis is that all economic phenomena constantly undergoes simultaneous economic, social, political, and technological transformations. Those transformations can directly or indirectly affect the economic analysis and its possible solutions i.e. policy modeling - in different societies in different historical periods.

The first broad transformation in economic analysis is historical economic analysis and political economy (qualitative analysis). Historical economic analysis is relevant from the medieval times until the mercantilist times. Subsequently, the mercantilist times gives rise to the first signs of the underlying economic theories that later give birth to political economy. According to our research, political economy is built by a large number of new significant theoretical frameworks, ideological currents, and formal schools of thought that seek to understand different complex and dynamic economic phenomena from various perspectives. Those schools of thoughts include (i) Physiocrats (Quesnay and Cantillon); (ii) Mercantilism (Mun, Bodin, and Petty); (iii) Classics (Smith Malthus, Mill, Marx, Hume, and Ricardo) (Medema and Samuels, 2000).

Each school of thought shows different approaches and uses a formal theoretical frameworks based on its own concepts, definitions, ideas, principles, assumptions, rules, models, techniques, and theories. The school is supported by a group of followers for a certain time. These different schools try to explain and solve various important economic problems that affect the society during different historical periods with using different approaches and solutions. To keep their validity, relevance, and consistency in the long run, the schools of thought need to always adapt to the rapid economic, social, political, and technological transformations which always occur in any society.

Political economy plays a central role in economic analysis up to the present. Consequently, we can observe a remarkable evolution in economic analysis from the use of political economy to the application economic theory. The evolution is from an underlying historical, narrative, and descriptive analysis to more technical analysis using more formal quantitative analysis based on mathematics, statistics, and econometric modelling.
We find classify economic theories in economic analysis according to how long they last. Level-1 is universal economic theories that are valid for more than hundred years. Examples include Adam Smith (Wealth of Nations), David Ricardo (Comparative Advantage and Theory of Rent), Jean Say (Law of Markets), Malthus (Theory of Population), Stuart and Mill (Utilitarian) (Medema and Samuels, 2000). Level-2 is temporary economic theories that are valid for 25 years or less. The last level, Level-3, consists of fleeting economic theories which are valid for 5 years or less.

The second broad transformation in economic analysis starts with Antoine Augustin Cournot who originates modern economic analysis - i.e. applied economics - in 1838 in his book entitled “Researches on the Mathematical Principles of the Theory of Wealth.” This book shows a series of formulas, equations, functions, and mathematical expressions to explain dynamic and complex economic problems related to market demand, supply, and equilibrium. Therefore, the mathematical approach introduced by Cournot book is static mathematical modeling supported by using a series of basic linear equations, in particular demand and supply, to mathematically understand the cause and effect of market phenomena such as equilibrium point.

The third broad transformation in the economic analysis was originated by Paweł Ciompa (1910), Ragnar Anton Kittil Frisch and his chapter entitled "Propagation problems and impulse problems in dynamic economics" in 1933, and Jan Tinbergen (1952) and his book “On the Theory of Economic Policy.” These three great academics make a remarkable contribution in the creation, introduction, and development of a new research field in economics called econometrics. Econometrics would profoundly revolutionize economic analysis, shifting it from static economic analysis to dynamic economic analysis.

In the 20th century, economic modeling which revolutionized economic analysis among economists was often based on sophisticated mathematical and statistical techniques, methods and models. In particular, calculus, trigonometry, geometry and statistical and forecasting methods were frequently employed by economists in the economic modelling and the policy modeling. The application of sophisticated mathematical and statistical techniques, methods, and models can be seen in the development of the following economic models: The foundations of welfare economics (Hicks, 1939), foundations of economics analysis (Samuelson, 1947), monetary theory and fiscal policy (Hansen, 1949), the bargaining problem (Nash, 1950), econometric models, time-series analysis and a path-breaking project link that remains valid at United Nations to this day (Klein, 1956), the contribution to the theory of economic growth (Solow, 1956), economic policy, and its principles and design (Tinbergen, 1956), the theory of consumption function (Friedman, 1957), the relationship between unemployment and rate of change of money wages in the United Kingdom 1861-1957 (Phillips, 1958), input-output economics (Leontief, 1966), and the rational expectations and the role of monetary policy (Barro, 1976) (Ruiz Estrada, 2013).

We also make a distinction between static and dynamic economic models in economic analysis. The static models show unique features such as the use of indicators, indices, basic arithmetic calculations, and graphs. The main characteristic of static models is the application of partial equilibrium analysis. On the other hand, dynamic models use more advanced quantitative tools such as econometrics, advanced mathematical models, and Econophysics. The defining characteristic of dynamic models is the use of general equilibrium analysis.

Going forward, we look for possible future evolutions of economic analysis. Possible future face three key challenges: (i) economic simulation; (ii) artificial economic intelligence; and (iii) the natural
organic economic intelligence. Economic simulation uses sophisticated software and computers with a high capacity of storage and speed. At the same time, these sophisticated machines are able to simultaneously run a long series of fuzzy stochastic or non-stochastic variables onto infinite equations.

The primary objective of the economic simulation is to generate different calibrated scenarios under varying levels of risk to evaluate possible solutions for any economic problem. The main challenge of economic simulation is moving from dynamic economic models to real-time economic models. The second challenge in economic analysis is the use of artificial intelligence, also known as the neural networks approach. Neural networks provide a potentially significant and valuable tool for economic analysis. The primary objective of neural networks is to choose a large database, as well as the most suitable recommendations and suggestions to solve any economic problem.

These recommendations and suggestions originate from an extensive database of past experiences of successful theoretical or experimental cases. Therefore, the adaptation of artificial intelligence to economic analysis is directly connected to new mathematical methods and techniques, chaos theory, logical mathematics, Econophysics, neural networks, advanced computer programming, virtual reality, robotics, faster software development, and strong hardware support.

The third profound transformation of economic analysis is natural organic economic intelligence. It is based on the interaction of mega-computers, new software, and applications based on the use of sophisticated and advanced computer languages and specialized mathematical algorithms, along with artificial intelligence and robotics tools. In addition, there exists a high probability of applying new multidimensional graphical models together with holograms.

Holograms will be able to show to any researcher complex and dynamic data in real time. It also gives the researcher a new visual perception of economic problems from a multidimensional perspective. The researcher can incorporate into the hologram the variables and equations of any economic problem in the process of observation, analysis, and policy modeling.

Finally, we feel that the absence of non-economic variables can considerably increase the vulnerability of any model or policy. Therefore, it suggests that any economic or policy modeling should take into consideration a wide range of factors, including unforeseen factors. These factors include, among others, natural disaster trends, climate change, terrorism, crime and violence, poverty expansion, religion and beliefs, education system, social events and phenomena, and social norms. However, it must be assumed that all these factors maintain a constant quantitative and qualitative transformation in different historical periods of the society under the application of the Omnia Mobilis assumption (Ruiz Estrada, 2011).

12.4. The pioneers of policy modeling

In this section, we introduce the pioneers who made significant contributions to the field of policy modelling. Three influential early pioneers are Antonio Maria Costa, editor in chief of the Journal of Policy Modeling (JPM) and former executive director of UN Office on Drugs and Crime), Professor Douglas O. Walker (editorial board member of the Journal of Policy Modeling (JPM) and full time Professor at Regent University, Virginia, U.S.), and Professor Dominick Salvatore (co-editor of the Journal of Policy Modeling (JPM) and full time Professor at Fordham University, New York, U.S.).
Dr. Antonio Maria Costa served as senior economist in the United Nations in New York. In 1983-87 he was Under-Secretary-General at the Organization for Economic Cooperation and Development (OECD) in Paris. He concurrently was a Member of the IMF/World Bank Interim Committee and of the G-10 Group. Between 1987 and 1992 Dr. Costa was Director-General for Economics and Finance at the EU Commission, and EU Financial Sherpa for the G7 summits. In 1994 he was appointed Secretary-General of the European Bank (EBRD) in London. In 2002 Kofi Annan named him Director General of the UN Office on Drugs and Crime in Vienna, with the rank of Undersecretary General, for an unprecedented double mandate that ended in September 2010. He is also the author of Checkmate Pendulum (Costa, 2014), a fictional representation of the growing collusion between governments, finance and organized crime – translated into Italian as Scaccomatto all’Occidente. In 2017 the same book was awarded the Cerruglio Literary Prize.

Professor Douglas O. Walker served for three decades as a senior economist at the United Nations Secretariat in New York. While with the Secretariat, Professor Walker was a main contributor to major reports on global economic trends for the United Nations, helped design global modeling and data systems for the Secretariat, assisted in the preparation of short-term forecasts and long-term projections of world economic activity and international trade for United Nations reports, served as Secretary to United Nations System Working Groups which coordinated research on economic and social issues among international agencies, and undertook many missions to governments in Asia, Africa and Latin America as an advisor on economic affairs.

Between 1971 and 1991, Professor Walker was adjunct professor of economics at Baruch College of the City University of New York, where he taught graduate classes in economic development and international economics. From 1992 to 1995 he was adjunct professor of diplomacy and world affairs in the Occidental-at-the-United Nations program of Occidental College, Los Angeles, California, and, later, professor of economics at Monmouth and Old Dominion Universities. From 2003 to 2010 he was professor of economics in the Robertson School of Government at Regent University.

Last but not least, Professor Dominick Salvatore is a distinguished Professor of Economics, Director of the Ph.D. Program in Economics, and Director of the Global Economic Policy Center at Fordham University in New York. In addition, he is Honorary Professor at Shanghai Finance University, Nanjing Finance University, Hunan University, and University of Pretoria. He served as consultant to the International Monetary Fund, World Bank, Economic Policy Institute, several central banks, multinational corporations, and global banks. He is co-editor of the Journal of Policy Modeling, author of more than 100 articles in economic journals, and author or editor of 58 volumes and special issues, which include Where Is the World Economy Headed? (Salvatore, 2017); The Dollarization Debate (Salvatore, Dean, and Willet, 2003), Protectionism and World Welfare (Salvatore, 1993), and The Japanese Competitive Challenge and U.S. Response (Salvatore, 1990). He is also the author of leading textbooks, including International Economics (Salvatore, 2016), Managerial Economics in a Global Economy (Salvatore, 2015), and Microeconomics Theory (Oxford University Press, 6th ed., forthcoming 2018). He was nominated in 2010 for the National Medal of Science conferred by the President of the United States.
12.5. The difference between economic modelling and policy modelling

There are substantial differences between economic modelling and policy modeling. Above all, economic modelling is based to a much greater extent on quantitative analysis than qualitative analysis. The use of mathematics and statics is more intensive than policy modeling. Policy modeling is more flexible because it combines quantitative and qualitative analysis to evaluate different economic problems. We find that policy modeling is more flexible and pragmatic than economic modelling.

We took an in-depth look at journal papers to more clearly establish the differences between economic modelling and policy modeling. The evaluation delved into 3,225 papers from two journals that specialize in these two topics i.e. Journal of Policy Modeling (2085 papers) and Economic Modelling (1180 papers). We find five large differences, namely (i) different levels in the uses of quantitative analysis – i.e. economic modelling is more intensive in the uses of quantitative approaches than policy modeling; (ii) the target audience of economic modelling is more specialized and focuses on academic circles; (iii) for policy modelling, the target audience is broader and includes policy makers and government agencies in addition to academics; (iv) the two research approaches share the same academic rigor and scientific approach; (v) policy modelling is more geared toward policy recommendations and implications than economic modelling, which tends to explain an economic problems that solve them. Finally, we found that economic modelling addresses more specialized research issues compared to policy modelling, which tackles more general research issues.

It is important to note the differences and similarities that exist between economic modelling and policy modeling. The main differences are the research focus and methodological approach applied to the analysis of different economic problems. In terms of similarity, both fields focus on the analysis of different economic problems to evaluate the rationale or chaotic behaviors through time (history) and space (geographical). To systematically study the differences and similarities between economic modeling and policy modelling, we examine the bibliographical references of two prestigious journals viz. the Journal of Policy Modeling (Elsevier, 2017a) and Economic Modeling journal (Elsevier, 2017b) are employed.

12.6. The evolution of policy modeling from 1978 to 2018

Our study of the evolution of policy modeling evolution is based on the study of the different volumes and issues of JPM between 1978 and 2018. We can observe that the application of different research approaches in policy modeling leads to a constant quantitative transformation - i.e. volume of research output and a qualitative transformation – i.e. content and form.

Moreover, we assume that the absence of non-economic variables could considerably increase the vulnerability of any policy. Therefore, any policy modeling should take into consideration a wide range of factors, including unforeseen factors. These factors include inter alia, natural disaster, climate change, terrorism, crime and violence, poverty expansion, religious beliefs, educational system, social events, social norms and behaviour, and so on. We believe that it is necessary to incorporate these factors into policy modeling in order to formulate strong policies of minimal vulnerability. However, it should be noted that these factors maintain a constant quantitative and qualitative transformation(s) in different historical periods.

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Basically, the study of the evolution of policy modeling in this chapter is based on the analysis of 2085 papers (see Table 1) based on different categories of the policy modeling identified earlier. In addition, we will study common modeling approaches used by different papers in the past forty years (1978-2018) in JPM. Hence, the individual categories can be classified into the following seventeen (17) categories (see Table 2).

Based on the same study and the same classification above, the percentages of papers in the different categories of policy modeling were found to be as follows: (i) domestic and international trade policy modeling (280 papers = 13%); (ii) energy, infrastructure, communications, and transportation policy modeling (110 papers = 5%); (iii) environmental, agriculture, and natural resources management policy modeling (95 papers = 5%); (iv) fiscal, government expenditure, and public debt policy modeling (135 papers = 6%); (v) institutional, regulation and negotiation policy modeling (50 papers = 2%); (vi) labor, employment, and population policy modeling (80 papers = 4%); (vii) monetary, stock market, exchange rate, finance, banking, insurance, and investment policy modeling (675 papers = 33%); (viii) production, savings, income, and consumption policy modeling (210 papers = 10%); (ix) technological and R&D policy modeling (40 papers = 2%); (x) welfare and social policy modeling (30 papers = 1%); (xi) economic growth and development policy modeling (225 papers = 11%); (xii) education and human capital development policy modeling (15 papers = 1%); (xiii) military and national security policy modeling (20 papers = 1%); (xiv) gender, culture, discrimination, and racism policy modeling (5 papers = 0%); (xv) natural disasters and food security policy modeling (10 papers = 0%); (xvi) unemployment, inflation, and poverty policy modeling (30 papers = 1%); and (xvii) miscellaneous policy modeling (75 papers = 4%) (see Table 2).

Table 2: Classification and Distribution of JPM Papers by 17 Categories (1978-2018)

<table>
<thead>
<tr>
<th>Category</th>
<th>Papers</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Domestic and International Trade Policy Modeling</td>
<td>280</td>
<td>13%</td>
</tr>
<tr>
<td>The Energy, Infrastructure, Communications, and Transportation Policy Modeling</td>
<td>110</td>
<td>5%</td>
</tr>
<tr>
<td>The Environmental, Agriculture, and Natural Resources Management Policy Modeling</td>
<td>95</td>
<td>5%</td>
</tr>
<tr>
<td>The Fiscal, Government Expenditure, and Public Debt Policy Modeling</td>
<td>135</td>
<td>6%</td>
</tr>
<tr>
<td>The Institutional, regulation, and Negotiation Policy Modeling</td>
<td>50</td>
<td>2%</td>
</tr>
<tr>
<td>The Labor, employment, and Population Policy Modeling</td>
<td>80</td>
<td>4%</td>
</tr>
<tr>
<td>The Monetary, Stock Market, Exchange Rate, Finance, banking, insurance, and Investment Policy Modeling</td>
<td>675</td>
<td>32%</td>
</tr>
<tr>
<td>The Production, Savings, Income and Consumption Policy Modeling</td>
<td>210</td>
<td>10%</td>
</tr>
<tr>
<td>The Technological and R&amp;D Policy Modeling</td>
<td>40</td>
<td>2%</td>
</tr>
<tr>
<td>The Welfare and Social Policy Modeling</td>
<td>30</td>
<td>1%</td>
</tr>
<tr>
<td>The Economic Growth and Development Policy Modeling</td>
<td>225</td>
<td>11%</td>
</tr>
<tr>
<td>The Education and Human Capital Development Policy Modeling</td>
<td>15</td>
<td>1%</td>
</tr>
<tr>
<td>The Military and National Security Policy Modeling</td>
<td>20</td>
<td>1%</td>
</tr>
<tr>
<td>The Gender, Culture, Discrimination, Racism Policy Modeling</td>
<td>5</td>
<td>0%</td>
</tr>
<tr>
<td>The Natural Disasters and Food Security Policy Modeling</td>
<td>10</td>
<td>0%</td>
</tr>
<tr>
<td>The Unemployment, Inflation, Poverty Policy Modeling</td>
<td>30</td>
<td>1%</td>
</tr>
<tr>
<td>The Miscellaneous Policy Modeling</td>
<td>75</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2085</strong></td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: Journal of Policy Modeling, ScienceDirect, Elsevier
In terms of the evolution of policy modelling in the past decades, in the 1970s was oriented above all toward production, savings, income, and consumption policy modeling (11 papers = 28%). Second place is shared by energy, infrastructure, communication, and transportation policy modeling (5 papers = 13%) and institutions, regulation, planning, and negotiation policy modeling (5 papers = 13%). Domestic and international trade policy modeling (4 papers = 10%) occupies third place, while fourth place is shared by welfare and social policy modeling (3 papers = 8%), economic growth and development policy modeling (3 papers = 8%), and unemployment, inflation, poverty policy modeling (3 papers = 8%).

In the 1980s, the focus of policy modeling research changed dramatically. For example, domestic and international trade policy modeling (68 papers = 21%) moved from third place to the second place. Third place now belongs to monetary, stock market, exchange rate, finance, banking, insurance, and investment policy modeling (45 papers = 14%). Production, savings, income and consumption policy modeling (70 papers = 22%) remained in the first place among all categories. Fourth and fifth place belongs to economic growth and development policy modeling (35 papers = 11%) and fiscal, government expenditure, and public debt policy modeling (33 papers = 10%) respectively.

In the 1990s, the focus of policy modeling again shows pronounced changes. First place now belongs to monetary, stock market, exchange rate, finance, banking, insurance and investment policy modeling (97 papers = 27%). Second place is occupied by the domestic and international trade policy modeling (65 papers = 18%). Third place moved from economic growth and development policy modeling to fiscal, government expenditure, and public debt policy modeling (40 papers = 11%). The fourth, fifth, and sixth places are, respectively, production, savings, income, and consumption policy modeling (35 papers = 10%), economic growth and development policy modeling (33 papers = 9%), and labor, employment, and population policy modeling (19 papers = 5%).

Finally, in 2000-2010 the top category is now monetary, stock market, exchange rate, finance, banking, insurance, and investment policy modeling (373 papers = 39%). The second place remains domestic and international trade policy modeling (98 papers = 10%). Third place is taken over once again by economic growth and development policy modeling (85 papers = 9%). The fourth and fifth places belong to the fiscal, government expenditure, and public debt policy modeling (75 papers = 8%) and production, savings, income, and consumption policy modeling (54 paper = 6%). (see Table 3 and 4).

In the period 2011-2018, the first place remains monetary, stock market, exchange rate, finance, banking, insurance, and investment policy modeling (117 papers = 28%). The second place changes from international trade policy modeling (51 papers = 10%) to energy, infrastructure, communications, and transportation policy modeling (66 papers = 16%). The fourth place is occupied by economic growth and development policy modeling (40 papers = 10%). The fifth place goes to fiscal, government expenditure, and public debt policy modeling (30 papers = 7%). Four categories drop to 0% in this period. These categories are education and human capital development policy modeling; military and national security policy modeling; gender, culture, discrimination, racism policy modeling; and finally, natural disasters and food security policy modelling.
Table 3: Classification and Distribution of JPM Papers by 17 Categories by Decade

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The Domestic and International Trade Policy Modeling</td>
<td>4</td>
<td>68</td>
<td>65</td>
<td>98</td>
<td>51</td>
<td>286</td>
</tr>
<tr>
<td>The Energy, Infrastructure, Communications, and Transportation Policy Modeling</td>
<td>5</td>
<td>20</td>
<td>12</td>
<td>44</td>
<td>66</td>
<td>147</td>
</tr>
<tr>
<td>The Environmental, Agriculture, and Natural Resources Management Policy Modeling</td>
<td>0</td>
<td>21</td>
<td>15</td>
<td>34</td>
<td>12</td>
<td>82</td>
</tr>
<tr>
<td>The Fiscal, Government Expenditure, and Public Debt Policy Modeling</td>
<td>1</td>
<td>33</td>
<td>40</td>
<td>75</td>
<td>30</td>
<td>179</td>
</tr>
<tr>
<td>The Institutional, regulation, and Negotiation Policy Modeling</td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>37</td>
<td>6</td>
<td>61</td>
</tr>
<tr>
<td>The Labor, employment, and Population Policy Modeling</td>
<td>1</td>
<td>7</td>
<td>19</td>
<td>46</td>
<td>10</td>
<td>83</td>
</tr>
<tr>
<td>The Monetary, Stock Market, Exchange Rate, Finance, banking, insurance, and Investment Policy Modeling</td>
<td>2</td>
<td>45</td>
<td>97</td>
<td>373</td>
<td>117</td>
<td>634</td>
</tr>
<tr>
<td>The Production, Savings, Income and Consumption Policy Modeling</td>
<td>11</td>
<td>70</td>
<td>35</td>
<td>54</td>
<td>47</td>
<td>217</td>
</tr>
<tr>
<td>The Technological and R&amp;D Policy Modeling</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>35</td>
<td>4</td>
<td>41</td>
</tr>
<tr>
<td>The Welfare and Social Policy Modeling</td>
<td>3</td>
<td>3</td>
<td>10</td>
<td>40</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>The Economic Growth and Development Policy Modeling</td>
<td>3</td>
<td>35</td>
<td>33</td>
<td>85</td>
<td>40</td>
<td>196</td>
</tr>
<tr>
<td>The Education and Human Capital Development Policy Modeling</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>The Military and National Security Policy Modeling</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>The Gender, Culture, Discrimination, Racism Policy Modeling</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>The Natural Disasters and Food Security Policy Modeling</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>The Unemployment, Inflation, Poverty Policy Modeling</td>
<td>3</td>
<td>5</td>
<td>10</td>
<td>17</td>
<td>22</td>
<td>57</td>
</tr>
<tr>
<td>The Miscellaneous Policy Modeling</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>320</td>
<td>354</td>
<td>950</td>
<td>421</td>
<td>2085</td>
</tr>
</tbody>
</table>

Source: Journal of Policy Modeling, ScienceDirect, Elsevier
It is important to note that during all decades’ research by JPM authors highlight monetary, stock market, exchange rate, finance, banking, insurance, and investment policy modeling; domestic and international trade policy modeling; economic growth and development policy modeling; and fiscal, government expenditure, and public debt policy modeling. Based on our evaluation, the only category that grows constantly is monetary, stock market, exchange rate, finance, banking, insurance, and investment policy modelling, which grew by 9% in the 1970s and 1980s. In 1980s and 1990s, the growth rate rose to 13%. Between 1990s and 2000-2010, the growth rate was 12%. On other hand, the period between 2011 and 2018 shows a decline of -11% (see Table 5).

Hence, we can observe that papers relating to the monetary, stock market, exchange rate, finance, banking, insurance, and investment policy modeling grew steadily until 2010, in line with the preferences of JPM researchers and readers. Furthermore, according to our analysis of the four decades-sample, in the 1970s and 1980s JPM’s average research output grew by an impressive 5%, but this dropped to -2% in the 1980s and 1990s. However, the growth rate expansion was favorable in 1990s and 2010s, reaching around 2%. Subsequently, the period between 2010 and 2018 shows a contraction of -4% (see Table 5).
Among the 2,085 papers published in JPM in the past forty years (1978-2018), the following research approaches were the most common: benefit/cost, probabilistic or forecasting analysis through the application of econometric methods, and use of microeconomic and macroeconomic level secondary data. Also, there has been an increasing dependency of policy modeling on economics models, methods, and techniques. 1,980 papers or ninety-five percent (95%) adopted the economics research approach in policy modeling. Only 5% or 105 of the papers adopted a multidisciplinary research approach based on several disciplines such as history, sociology, politics, technology, and so on.

In the case of policy modeling evaluation by research approach, we applied fifty (50) variables to analyze paper by paper all 2,085 papers published in the Journal of Policy Modeling to study different policy modeling approaches.

Based on our analysis, we find that almost all JPM papers focus on monitoring policy modeling (1,400 papers = 67%) and empirical policy modeling (1,885 papers = 90%). At the same time, there was a good balance of papers between quantitative (1,245 papers = 60%) and qualitative policy modeling (1,245 papers = 60%). In the case of data analysis policy modeling, 1,850 papers or 89% of all papers are

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**Table 5: The JPM Papers Growth Expansion Rate by 17 categories per Decade**

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>60s/70s</th>
<th>70s/80s</th>
<th>80s/90s</th>
<th>90s/2010</th>
<th>2010/2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 The Domestic and International Trade Policy Modeling</td>
<td>0%</td>
<td>11%</td>
<td>-3%</td>
<td>-8%</td>
<td>0%</td>
</tr>
<tr>
<td>2 The Energy, Infrastructure, Communications, and Transportation Policy Modeling</td>
<td>0%</td>
<td>-6%</td>
<td>-3%</td>
<td>1%</td>
<td>11%</td>
</tr>
<tr>
<td>3 The Environmental, Agriculture, and Natural Resources Management Policy Modeling</td>
<td>0%</td>
<td>7%</td>
<td>-2%</td>
<td>-1%</td>
<td>-1%</td>
</tr>
<tr>
<td>4 The Fiscal, Government Expenditure, and Public Debt Policy Modeling</td>
<td>0%</td>
<td>8%</td>
<td>1%</td>
<td>-3%</td>
<td>-1%</td>
</tr>
<tr>
<td>5 The Institutional, regulation, and Negotiation Policy Modeling</td>
<td>0%</td>
<td>-11%</td>
<td>1%</td>
<td>2%</td>
<td>-2%</td>
</tr>
<tr>
<td>6 The Labor, employment, and Population Policy Modeling</td>
<td>0%</td>
<td>0%</td>
<td>3%</td>
<td>-1%</td>
<td>-2%</td>
</tr>
<tr>
<td>7 The Monetary, Stock Market, Exchange Rate, Finance, banking, insurance, and Investment Policy Modeling</td>
<td>0%</td>
<td>9%</td>
<td>13%</td>
<td>12%</td>
<td>-11%</td>
</tr>
<tr>
<td>8 The Production, Savings, Income and Consumption Policy Modeling</td>
<td>0%</td>
<td>-6%</td>
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</tr>
<tr>
<td>9 The Technological and R&amp;D Policy Modeling</td>
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</tr>
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<td>15 The Natural Disasters and Food Security Policy Modeling</td>
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<td>16 The Unemployment, Inflation, Poverty Policy Modeling</td>
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<td>-3%</td>
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<tr>
<td>17 The Miscellaneous Policy Modeling</td>
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<td>Total</td>
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<td>2%</td>
<td>-4%</td>
</tr>
</tbody>
</table>

*Source: Journal of Policy Modeling, ScienceDirect, Elsevier*
based on the use of secondary data modeling that originated from existing bibliographical and statistical sources. Similarly, the time horizon of analysis modeling can be grouped into long run policy modeling (1,050 papers = 50%) and short run policy modeling (625 papers = 30%).

The econometric approaches applied by different authors in the JPM include times series data modeling (1,200 papers = 58%), cross-sectional data modeling (320 papers = 15%), and panel data modeling (320 papers = 15%). Furthermore, the research approaches used by papers in the JPM include economic policy modelling (1,300 papers = 62%), social policy modelling (210 papers = 10%), technological policy modeling (300 papers = 14%), and other policy modeling (500 papers = 24%). Another interesting result of our analysis is that 1,900 papers or 91% of all published papers in JPM applied the traditional theoretical framework policy modeling approach, while only 90 papers or 4% applied the extension theoretical framework policy modeling approach.

In addition, 1,900 papers = 91% of the JPM papers are oriented toward public sector policy modeling. Macroeconomic and microeconomic modeling approach accounts 1635 papers or 78% and 450 papers or 22% respectively. We find that JPM papers are supported by general equilibrium modeling (1565 papers = 75%), static modeling (1730 papers = 83%) and imperfect competition modeling (1595 papers = 76%). In terms of geographical coverage, JPM papers can be grouped into national level policy modeling (1040 papers = 50%) and global level policy modeling (825 papers = 40%).

Moreover, the most common theoretical modeling approaches applied in JPM papers are in the following order: Keynesian modeling approach (700 papers = 34%), monetary modeling approach (900 papers = 43%), neo-classic economic modeling approach (180 papers = 9%), and classic economic modeling approach (285 papers = 14%). Finally, we find that a strong majority of JPM papers (1730 papers = 83%) deploy the static modeling approach while only 355 papers or 17% applied the dynamic modeling approach (see Table 6).
<table>
<thead>
<tr>
<th>No.</th>
<th>Modeling Approach</th>
<th>Total</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Predicting modeling approach</td>
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<td>2</td>
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<td>3</td>
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<tr>
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<td><strong>2085</strong></td>
<td><strong>100%</strong></td>
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<tr>
<td>5</td>
<td>Empirical modeling approach</td>
<td>1885</td>
<td>90%</td>
</tr>
<tr>
<td>6</td>
<td>Theoretical modeling approach</td>
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</tr>
<tr>
<td>7</td>
<td>Quantitative modeling approach</td>
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</tr>
<tr>
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<td>Qualitative modeling approach</td>
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</tr>
<tr>
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<td><strong>100%</strong></td>
</tr>
<tr>
<td>9</td>
<td>Primary data modeling approach</td>
<td>115</td>
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<td>10</td>
<td>Secondary data modeling approach</td>
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<td>11</td>
<td>Mix data modeling approach</td>
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<td>57%</td>
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<td><strong>100%</strong></td>
</tr>
<tr>
<td>12</td>
<td>Long term modeling approach</td>
<td>1050</td>
<td>50%</td>
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<tr>
<td>13</td>
<td>Medium term modeling approach</td>
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<td>20%</td>
</tr>
<tr>
<td>14</td>
<td>Short term modeling approach</td>
<td>625</td>
<td>30%</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>2085</strong></td>
<td><strong>100%</strong></td>
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<tr>
<td>15</td>
<td>Linear regression analysis modeling approach</td>
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<td>Multiple regression analysis modeling approach</td>
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<td>17</td>
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<td>18</td>
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<tr>
<td>19</td>
<td>Panel data modeling approach</td>
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</tr>
<tr>
<td>20</td>
<td>Multi-dimensional panel data modeling approach</td>
<td>15</td>
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<td><strong>Total</strong></td>
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<td><strong>100%</strong></td>
</tr>
<tr>
<td>21</td>
<td>Economics modeling approach</td>
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<tr>
<td>22</td>
<td>Social modeling approach</td>
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</tr>
<tr>
<td>23</td>
<td>Technological modeling approach</td>
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<tr>
<td>24</td>
<td>Political modeling approach</td>
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<td>2%</td>
</tr>
<tr>
<td>25</td>
<td>Environment modeling approach</td>
<td>100</td>
<td>5%</td>
</tr>
<tr>
<td>26</td>
<td>Institutional modeling approach</td>
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<td>2%</td>
</tr>
<tr>
<td>27</td>
<td>Sciences modeling approach</td>
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<td>1%</td>
</tr>
<tr>
<td>28</td>
<td>Multi-disciplinary modeling approach</td>
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<td>3%</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>2085</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>29</td>
<td>Original theoretical framework modeling approach</td>
<td>95</td>
<td>5%</td>
</tr>
<tr>
<td>30</td>
<td>Traditional theoretical framework modeling</td>
<td>1900</td>
<td>91%</td>
</tr>
<tr>
<td>31</td>
<td>Extension theoretical framework modeling</td>
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<td>4%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>2085</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>32</td>
<td>Private sector modeling approach</td>
<td>120</td>
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</tr>
<tr>
<td>33</td>
<td>Public sector modeling approach</td>
<td>1900</td>
<td>91%</td>
</tr>
<tr>
<td>34</td>
<td>Public/private sector modeling approach</td>
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<td>3%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>2085</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
It is apparent from our analysis that the future of policy modeling depends on the flexibility and dynamism of the policy modeling research approaches adapted to the real world through the application of practical research techniques, methods, methodologies and research focus, based on the integration of different knowledge fields.

Hence, in the future, policy modeling can evolve into a multi-disciplinary research approach that could facilitate the study of different economic problems with adverse effects on society. We should stress that policy modeling is an important technical-theoretical analytical tool for future academics, economists, policy makers, and international organizations such as World Bank (WB), United Nations (UN) and others.

More importantly, the relative rise in the impact factor of the JPM from 0.763 in 2015 to 0.993 in 2016, based on the Institute for Science Information (ISI), underlines the relevance and significance of policy modeling to a large array of socio-economic and political issues. (Thomson Reuters, 2016).

### 12.7. Conclusions

Our study makes it abundantly clear that policy modeling can open a new research field to academics, policy makers, and social scientists in the study of complex and dynamic economic problems that can affect our society anytime and anywhere without borders. Our conclusion is drawn from an intensive

<table>
<thead>
<tr>
<th>Table 6: Evaluation of the JPM by Modeling Approach (50 Variables)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>35</strong> Macroeconomics analysis modeling approach</td>
</tr>
<tr>
<td><strong>36</strong> Microeconomics analysis modeling approach</td>
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<tr>
<td><strong>Total</strong></td>
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<tr>
<td><strong>37</strong> Partial equilibrium modeling approach</td>
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<td><strong>38</strong> General equilibrium modeling approach</td>
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</tr>
<tr>
<td><strong>39</strong> Dynamic modeling approach</td>
</tr>
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<td><strong>40</strong> Static modeling approach</td>
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<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>41</strong> Perfect competition modeling approach</td>
</tr>
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<td><strong>42</strong> Imperfect competition modeling approach</td>
</tr>
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<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>43</strong> National level modeling approach</td>
</tr>
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<td><strong>44</strong> Regional level modeling approach</td>
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<td><strong>45</strong> Global level modeling approach</td>
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<tr>
<td><strong>46</strong> Keynesian Approach</td>
</tr>
<tr>
<td><strong>47</strong> Monetary Approach</td>
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<tr>
<td><strong>48</strong> Classic Approach</td>
</tr>
<tr>
<td><strong>49</strong> Neo-Classic Approach</td>
</tr>
<tr>
<td><strong>50</strong> Others Approaches</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Source: Journal of Policy Modeling, ScienceDirect, Elsevier
review and analysis of 2,085 articles published during the last 40 years (1978-2018) in the Journal of Policy Modeling, a journal dedicated to the field of policy modeling. Policy modeling is constantly evolving and changing, at remarkable speed, in line with the rapidly changing social, economic, and political realities of the world. Policy modelling is continuously enriched and enhanced by uses of new research approaches and exploration of new research areas. Finally, the policy modeling is a powerful analytical tool that adapts any technique, methodology, method, and research approach from a wide range of disciplines – e.g. economics, finances, sociology, political sciences, technology, environment, econometrics, and sciences - to rigorously explain the complex socio-political and economic problems that affects different social groups in different geographical areas during different historical episodes. Journal of Policy Modeling will be sure to make a central contribution to this vital endeavor.

12.8. References

Costa, A.M. (2011). Interview by E-mail service from Dr. Antonio Maria Costa. Accessed 5.05.2011. 