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Economic Development Planning Models: A Comparative Assessment

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Abstract

Development economics contain a number of theories, but little research has been conducted on economic planning models. The developing countries' preoccupation with economic planning provides a rationale for this paper. In this paper, the conceptual affinity among the three models is examined. Markov-Chain (Markov 1914) has been applied to short term market forecasting and business decisions on the firm's future market share, given a consumer transition from one firm to the next. Leontief's model shows the short term inter-industry interdependence of production functions, (Leontief 1965, 1985). Kooros' model transcends the former two models by providing an optimum resource allocation planning model and the decision criteria, (Kooros, 1995, 1998). This paper provides a comparative analysis of the three models' structures, similarities, and respective advantages.

Introduction

Economic development, distinguished from economic growth, results from an assessment of the economic development objectives with the available resources, core competencies, and the infusion of greater productivity, technology and innovation, as well as improvement in human capital, resources, and access to large markets. Economic development transforms a traditional dual-system society into a productive framework in which every one contributes and from which receive benefits accordingly. Economic development occurs when all segments of the society benefit from the fruits of economic growth through economic efficiency and equity. Economic efficiency will be present with minimum negative externalities to society, including agency, transaction, secondary, and opportunity costs. At the same time, disintegration of national sovereign states into more fragmented nations along the ethnic lines would not help these newly formed societies to accede to a formidable economic development regardless of their form of government.

Regional economic integration of these fragmented nations seems implausible and may not be even beneficial, since the impetus for their political disintegration has been due to the ethnic conflicts, which cannot be expected to be mitigated for mutual economic benefits, unless such disintegration has been purely exogenous, and thus temporary. It is obvious that a new competitive economic development strategy for any country or region is to facilitate regional survival in the coming century, (Kooros and O'Sullivan 1997). "Economic development is a process by which an economy is transformed from one that is dominantly rural and agricultural to one that is dominantly urban, industrial, and service in composition,"[Manley 1987]. Economic development brings a higher standard of living and welfare to a nation, while attempting to adhere to the Parato Optimality, or a "win-win strategy" without negative externalities. In their economic development pursuits, many ideological transformations are confronting these countries: foreign debt conversion into foreign direct investment, Foreign Direct Investment (FDI) privatization of economic activities; trade regionalization; conversion of import-substitute investments into export- expansion investments; technology transfer; co-production, and many other sound economic decisions, (Kooros, 1997).

Despite its apparent plausibility, markets by themselves cannot provide an accelerated and well-coordinated comprehensive economic plan, and therefore each country must develop a blue print for its own future economic well being. Markets have created benefits over the long run, and only through trial and errors, leaving behind the many scars of failures with negative externalities. For example, the degradation of our environment, (the vanishing of the rain forests at thousands of acres per hour, causing catastrophic climatic changes including extensive forest fires, and heat waves- North east Florida and Texas in July 1998, the rise and decline of cities, plagued with unmanageable problems and crimes, decreasing returns to scale, (with widened and enlarged tax base), the widening of income dispersion, adulteration of food resources with unmanageable long-term negative consequences, (Kooros and Deloizer 1998), and many other socioeconomic and technological problems, with inability to making the needed timely corrections.

Alternatively, as with the creation of an urban center, or formulation of a business strategy, there is a need for comprehensive economic planning. This means determining the country's core competencies, resources, and long-term comparative advantage, and formulating the country's priorities, and the manner by which its objectives can be met. Since the outputs of the market are determined by trail-and error, and over a long period of time, the development of such a comprehensive blue print is extremely crucial. Large urban centers, or even a comprehensive university cannot be designed ex-post facto, after the problems have emerged, nor can such problems be mitigated through ad hoc trial-an-error, or the market system, (in which some economists have developed irrationally infinite confidence), because markets are not coordinated. Some markets are also manipulated by oligopolies. It took two hundred years for the United States to reach its stage of economic maturity; but people in other countries want economic development and democratization to occur over night. Therefore, accelerated and comprehensive planning in the manner proposed by Kooros in this paper is a necessity.

Statement of Purpose

Many countries aspire to formulate economic development strategies to improve their quality of life. However, development economics has lacked viable planning models, and thus the rationale for this paper. This paper describes three complementary approaches to economic development to meet the needs of economists and developmental planners:

- To determine the consequence of changes in consumer preferences affecting a firm demand within an industry, or consumers' behavioral changes or economic performance , (with or without any growth in the total market);
- To estimates the impact of growth or dynamic change of one industry on the entire economy, whether such growth is uniform or skewed due to technology, capital injection, productivity, etc; and
- To predict the need for resources and prescribe the manner by which these resources should be allocated to each economic sector or programs so that the overall economic development objective (social welfare function) can be maximized.

This paper examines the above objectives through three models that seem to have structural similarities, but exhibit unique different performance characteristics and output. The relevance of these models to international economics has also been briefly discussed, although a separate paper seems to more aptly justify the scope of this latter topic.

The remaining portions of this paper include a brief survey of planning theories and models, and expositions on Markov's, Leontief's, and Kooros' models. Final section includes a comparative assessment of the three models.

Economic Planning Theories and Models

Planning models is a term applied to several disciplines, each using certain techniques to achieve the planning objectives. For example, in construction industry "Fast Track," Program Evaluation and Review Technique, PERT; Critical Path Method, CPM; and "CPM/Cost," are various planning tools devised for systematic and accelerated project implementation. However, development economists have concentrated most of their efforts on the analysis of the conditions currently facing various countries, the requisites for economic development, and the consequences and the experience of various countries in their development efforts. There is an absence of extensive economic development models in the literature. A number of theories on economic development have been posed by economists dating back to Adam Smith, (1776), David Richrado, (1830), Karl Marx, (1880), W.W Rostow (1953), Leontief (1965), and others. These theories have been summarized in Appendix A. However, none of these theories, except that of Leontief's, provide a viable functioning structure for a development model.

This paper also introduces the Kooros' Model, (1994, 1998), in order to meet the objectives set forth in the introduction section of this paper. Beyond Leontief's and Kooros' models, (although the latter provide an optimum planning strategy, and the former does not), other so-called economic development models are descriptive or normative. This means that they cannot be quantified, since they merely propose some philosophical paradigms on how development should or would takes place. Both Rostow, (1990) and Kooros, (1996) have described the "stages of economic development." and conditions that would lend to such an aspiration.

On the other hand, North (1993) incredulously and without empirical evidence has asserted that democratic institutions are responsible for economic development. Contrary to North (1993) the growth and development of industrialized economies was not merely the result of democratic institutions, but due to many other conditions including technology, resources, productivity, and economic policies. North's naive conclusion on the causes of development leaves little hope for South's (i.e., developing countries') economic development, although according to Gillis et al, " Given the great diversity in the developing country experience, it would be a counsel of despair to suggest that the way to begin development is first to recreate the kinds of political, social, and economic conditions that existed in Western Europe and North America when those regions entered into the modern economic growth", (Gillis, et al, 1996, p. 22). Furthermore, the economic development of the West heavily relied on colonialization, neo-colonialization, slavery, sovereign disintegration, imposed long-term commodity concessions through either puppet governments or military interventions, and many other activities which are impermissible and intolerable to-day. Some of the richest Caribbean islands are still colonies. Apparently, Professor North has never been involved in economic development planning, nor do his studies bear any relevance to what has occurred in both the theoretical and experiential worlds.

Beyond the models and theories referred to in the above, a collective self-reliance model for the Caribbean economic development has also been proposed by the Caribbean Economic Community, CARICOM, which merely describes the attainment of economic development through inter-purchases among the CARICOM countries. The validity of the model has also been questioned by Kooros and O' Sullivan. (1997), on grounds for the need of Western technology, FDI, and markets. There are also related issues that pertain to the competitive advantage of the nations that help economic development. A number of descriptive models have been introduced on this topic which are more pertinent to corporate strategic planning.

Almost all-economic planning models deal with causal forecasting or economic growth determination, including Harrod-Domar Model. These models include: a simple Keynesian macroeconomic growth model, Leontief's Input/Output model, the social accounting matrix, general equilibrium models, and cost benefit analysis approach, [Gills, et. Al 1996]. For example Horrod-Domor Model simply states the following:

$$g = s/k \tag{1}$$

where g = GNP or GDP
s = saving rate
k = capital/output

Horrod Domar model can be rewritten as

$$\Delta Y_t = Y_t - Y_{t-1} = (Y_k)\, \Delta\, k_{t-1} = (Y_k)\, (I_{t-10} - dk_{t-1}) \quad (2)$$

Where y = GDP or GNP; I = gross investment; k = capital stock; and d = depreciation rate.

This model states that economic growth, as measured by GNP, is dependent on the stock of capital or net capital investment, (excluding depreciation).

In general, forecasting models can be subsumed into three branches: causal forecasting, econometrics/ regression/correlation, trend analysis, and qualitative forecasting, such as the Delphi-technique or opinion survey, the latter utilized in Kooros' model. The appropriateness of these models depends on the specific configuration of the problem under consideration. However, the perspective of this paper is to present an analysis of a unique set of forecasting models which have been developed independently over fifty years and which do not fall within the categories just mentioned. The purpose of this paper is not to repeat what has been already published about these models but to provide a detailed exposition of each model, with their respective applications and structural similarities. As stated in the introduction, the Markov-Chain model determines the consequence of changes in consumer preferences affecting a firm within an industry, or the consumers' behavioral changes or their economic performance, (with or without any growth in the total market).

Leontief's Model estimates the impact of growth or dynamic change of one industry on the entire economy, whether such growth is uniform or skewed due to technology, differential capital injection, productivity, etc; and Kooros' model determines the need for resources, and prescribes the manner by which these resources should be allocated to each economic sector or programs so that the overall economic development objective (social welfare function) is maximized. After briefly describing each model in some details, Table VIII in the conclusion section shows the comparative structure, input and output of these models.

Model A: A Markovian Model for Income Forecasting

An economy's income distribution has been of interest to development economists, social scientists, and economic planners. The most common index for measuring income dispersion has been the Gini coefficient, attributed to the Italian economist Gini. Gini coefficient, G, measures the amount of inequality present in an economy divided by the amount of equality. G has also been utilized for income dispersion forecasting. Various authors, relating the impact of economic development to income distribution have introduced a number of models. For example, utilizing G as a measure of income inequity, (Gillis, et al, 1996, p. 85) have introduced two models, one in which:

$$G = -0.116 + 0.183 \log Y - 0.14 \log Y^2 \quad (3)$$

This model had been developed through the study of 61 countries, (excluding the Eastern European countries, which have markedly less inequity), where Y=per capita GNP. The Kuznets' inverted-U income inequity is discernible from this model. Equation (3) can be utilized as a good forecast for future determination of G, given the estimateability of the growth in per capita GNP in the future periods. Furthermore, the authors believe that "Logically, if income of the poor rises with growth, their absolute income must also rises, since they are getting an increasing share of an increasing total", (Gillis, et al, 1996, p. 85). The authors have introduced a second model in relation (4):

$$\text{Log } Y_p = -1.687 + 1.088 \log Y \quad (4)$$

where, Y_p is the mean income of the poorest 40 percent of the families, Y is the per capita GNP, and where Y_p and Y have an association of R-squared, R^2=0.95. Adopting the 1990 World Development Report, and assuming a global poverty level of \$ 370 per capita, the authors have introduced the following alternative Model:

$$P = 477.992 - 103.656 \log Y + 5.589 \log Y^2 \quad (5)$$

where P=% of facilities with less than $ 370 per capita, and Y as defined before.

Nissan and Shahmood (1993) have treated the concept of income equity determination through a stochastic model. Other authors have traced the subject from a qualitative perspective. Kooros and Coats (1997) also developed polynomial models for low income, high income, and cross country income comparison and concluded certain limitations to the Kuznets Inverted-U Hypothesis. Kuznets (1955, 1965) has hypothesized that the relationship between economic growth and income inequity follows an inverted U, that is, with economic growth the income distribution widens and then reverses. Kuznets' hypothesis has been tested by others and questioned by [Ram 1985 Kooros and Coats 1997]. Papanek and Kyn (1986) also concluded "rapid growth in a mixed economy is consistent with unchanged or even improved income distribution, at early stages of development." Cross-sectional data by the World Bank (1990) indicates that with the growth of GNP, the income distribution of poor countries has widened. Other studies corroborate that further growth will usually lead to a reduction in income disparity, (Frank and Webb, 1977). The assumption that the income variance in poor countries would be smaller than the rich countries has no validity. A study by Adelman and Morris, (1973) found that income inequality is typically equal in very poor and well-developed countries. However, all these studies infer correlation with the Gini coefficient, which has been refuted by Kooros (1994).

Since poverty alleviation is an important sociopolitical concern, human development can therefore be viewed in a variety of ways, one of that is economic well-being, as measured by per capita gross domestic product, (GDP). This measure alone, however, does not adequately account for sociopolitical policy considerations, such as health, education, environment, and political freedom; nor does it fully explain income distribution other social and economic benefits produced in society, Mcgilliver, (1991).

For the first time, Kooros, (1994) applied the Markov-Chain (whose theoretical framework appear in Appendix A) to forecast the entire income distribution. This approach is logical, since any single index such as the Gini coefficient,(G) that attempts to represent the entire income distribution was believed to be limited and thus flawed, (Kooros 1994; Gillis, et al, 1996). Forecasting income distribution, as an a' priori, is of public policy importance for resource allocation decisions. Thus, data on the future behavior of income distribution, given the extant intergroup income dynamics, can serve public policy, (Kooros 1994).

Income Equity and Economic Development:

Since the days of the French Revolution, great disparities in income have been considered destabilizing. Public policy considerations must be based on factors that affect not only economic growth but also income differences, while aiming at ameliorating economic inequities. Otherwise, the increasing masses of the impoverished and unemployed, especially when instigated by exogenous conspiratorial forces, can impart major political upheavals. However, poverty alleviation should precede democratization because political information is costly and wealth concentration in the hands of a few means not only market control but also political control by a few. Yet, history has taught us that accelerated democratization can often be futile for a sovereign nation without any subsequent commensurate economic reward for the masses.

The developing nations' preoccupation merely with economic growth has produced varying degrees of environmental degradation and insensitivity to the quality of life. The notion of improving the well being of the impoverished is important, not only on Rawlsian grounds, but also to avert any political risk associated with widening income gaps. The developing countries have also been criticized for the phenomenon confronting almost all countries, since their economic development efforts have seemed to enhance the conditions of the wealthy, while leaving the poor behind. Such criticism has ignored the fact that few countries succeed in reducing income disparity. Significant poverty alleviation has seemingly failed for two main reasons: First, the lack of comprehensive planning on socioeconomic policies; and second, the over-emphasis on GNP growth rather than on increasing the quality of life. Even the classic Herrod-Dommar model, (Relations 1 and 2), is not excluded from this view.

Also puzzling is that in newly industrialized countries all of life's troubles are attributed to the heads of state, which leads to the de-thronging of their leaders and the be-heading of political elites. In industrialized democracies, with diffused political power, accountability is somewhat dissipated, explaining the political stability in the North relative to the South, and thus a viable pretext for neo-Colonialism. To overcome the apparent problems of utilizing a single index as the G, Kooros (1994) introduced the Markov-Chain Model to measure the entire income dispersion.

Although Markov-Chain can be utilized for a variety of stage-wise forecasting purposes, examination of the literature thus far indicates the absence of such an application for estimating income distribution. To estimate future income distributions, this paper advances the use of a Markov-Chain. Markov-Chain models have been successfully applied to specific cases in business and industry [McQueen 1991, McMillan et al, 1991] and others. The objective here is to demonstrate the applicability of Markov-Chain to forecasting income distribution configuration.

Configuration of the Markov-Chain Model:

Markov systems deal with stochastic environments in which possible "outcomes occur at the end of a well-defined, usually first period"(Turbin 1996). This situation further involves a multi-period time frame, during which the occurring consumer's transient behavior, for example, affects the stability of the firm's performance. This transient behavior, whose future outcome is unknown but needs to be predicated, creates inter-period transitional probabilities. Such a stochastic process, known as the Markov process, contains a special case, where the transitional probabilities from one time period to another remains stationary, in which case the process is referred to as the Markov-Chain. A number of assumptions have been developed by Turbin, et al (1996), Chung, (1991), and others pertaining to Markov-Chain that appear on page 23, below. The most frequently used income equity statistics, the Gini concentration ratio, derived from the Lorenz curve, shows that the larger the share of the area between the 45-degree line (referred to as line of perfect equality) and the Lorenz curve, the higher the value of the Gini concentration ratio, (Baumol, et al, 1991).

However, Gills, et al (1996) has stated that " Estimating income equity through a simple index such as Gini coefficient has its own problems: Lorenz curves can intersect, causing different shapes with the same Gini ratio and perfect equality makes the measure insensitive to changes in distribution, especially in the incomes of low-income groups. Any measure that attempts to encompass the entire Lorenz curve in a single statistic must contain an element of arbitrariness." Thus, any single measure that attempts to encompass the entire distribution can be considered very arbitrary.

Application of Markov-Chain to Income Distribution:

Since a single index such as the Gini coefficient does not give a true picture of the income distribution, income distribution can be estimated in the following manner, although for convenience of exposition, Appendix A provides supplementary information.

Let (q_i) represent a vector of income distribution in a specific year, and [P_{ij}] designate a matrix of income mobility, transition, or dynamics since the previous period. Then,

(Income distribution @ t_{n+1}= (Income distribution @ t)[Income transition](t_{n+1}-t_n).

i.e. (q1, q2, q3, q4, q5)t_{n+1}= (q1,q2, q3, q4, q5,)t [P_{ij}] (6)

where q1, q2,.... q5 are the income received by the first, second,.., fifth population quintals, and P_{ij} are changes of income during t and t_{n+1} time period from an income group to the next.

Hence, in general, Q (t_n) = Q (t_{n-1}) [P_{ij}] (7)

In many developing countries, the unavailability of accurate information for a variety of cultural and structural reasons, and due to the dynamic economic behavior of these countries, render drastic changes in the data base over a short period of time. Therefore, the most recent economic performance data, vis-a-vis income equity, are more relevant for forecasting than historical data. In accordance with Markov-Chain methodolo¬gy, only the income distribution of the previous period and income dynamics between the two periods are needed to forecast income distribution for successive period(s). Under the conditions of Markov-Chain, the transient behavior of economic variables can be estimated by utilizing expression (7). This approach is also relevant to economic environments characterized by exponential growth, when GNP growth has no impact on income equity, such as in the case of the United States.

Experimental Results of Markov-Chain:

The annual income distribution is analogous to an instantaneous snapshot picture at a point in time, without revealing the extent of income flow or mobility across the intergroup's income. Income mobility, on the other hand, shows income group movements during a time period from one income group to another either up or down, as in Table 2. Each ij cell shows the movement from one income class, e.g. q5 to another group q3. C_{ii} represents movement within the income class, i e., no income improvement or deterioration. Without income mobility, each diagonal value is equal to 100 percent (meaning no change in income is experienced by the individual/family within that quintal.) [G¬wartney, et al, 1992].

Utilizing the U.S. historical data on income distribution (Table 1) and the Institute of Social Research (Table 2), showing income dynamics between 1980-1984, income distribution for 1985-1988 can be estimated through the aforementioned Markov-Chain formulation.

Table 1: Inequality of money income of unites states families (selected years) (% of before tax aggregate money income received by each quintal:)

	1st	2nd	3rd	4th	5th
1935-1936	4.6	10.6	16.5	23.7	44.6
1950	4.5	12.0	17.4	23.4	42.7
1960	4.8	12.2	17.8	24.0	41.3
1970	5.4	12.2	17.6	23.8	40.9
1980	5.2	11.5	17.5	24.3	41.5
1985	4.7	10.9	16.8	24.1	43.5
1989	4.6	10.6	16.5	23.7	44.6

[Source: Bureau of the Census, Current Population Reports , Series P. 60, NO.167].

Table 2: Income mobility-family ranking in 1984, (compared with ranking in 1980.)
Family Income Quintal, 1980/Family Income quintal 1984

From/to	q5	q4	q3	q2	q1	Total
q5	[62]	23.6	8.4	3.7	2.3	100%
q4	26.5	[36.9]	23.6	8.9	4.	100%
q3	6.0	26.5	[35.8]	23.4	8.3	100%
q2	4.0	9.3	23.9	[41.9]	20.8	100%
q1	1.4	4.0	8.2	22.1	[64.5]	100%

[Source: Institute of Social Research, University of Michigan. Greg J. Duncan, et al " Years of Poverty, Years of Plenty" An Arbor, Michigan, 1984.]
[Note: our research for a more updated data in this respect was not fruitful, due to unavailability of information.]

In the following matrix multiplication, the first vector is the 1980 annual income distribution; the matrix is the income transition between 1980-1984; and the second vector is the forecasted annual income distribution for 1985-1988. It can readily be verified that the interval of transitional income dynamics matrix determines the interval of future forecasts.

5.2%		62	23.6	8.4	3.7	2.3		9.26%
11.5		26.5	36.9	23.6	8.9	4		13.57%
17.5	X	6.0	26.5	35.8	23.4	8.3	=	18.75%
24.3		4.0	9.3	23.9	41.9	20.8		24.27%
41.5		1.4	4.0	8.2	22.1	64.5		34.10%

The above calculations show that application of Markov-Chain to income distribution determination can provide, not a single index as the Gini coefficient, but the future period income distribution forecast, (the last vector) based on the current income distribution, (the initial vector) based on income group dynamics matrix as determined by the Institute of Social Research. Accordingly, the new percentages of the income group would be 9.26, 13.57,.... and 34.10, rather than a meaningless single index of 36.7 %, e.g., especially if the latter index does not change over time, which in the case of the United States, has not changed since 1936, (Kooros, 1995).

Model B: Leontief's Input-Output Model:

The Leontief's Input-output analysis accounts for general equilibrium phenomenon in the empirical analysis of inter-industry production. It forecasts the dynamics in both the final and intermediate goods. Accordingly, demand plays no role in this theory, unless demand for a product increases, which will impact the derived demand for other factors of production, and intermediate products. Even with its simplicity of assumptions, the input-output model will need massive amount of data on the economy's production interdependence. This model is particularly useful in predicating future production requirements given the availability of demand information.

> "Several assumptions restrict the use of the model, among which are: homogeneity of the product by each industry and the fixity of proportions of input used in the production of any good. The second assumption momentarily dispels the idea of technological progress" (Henderson 1971).

This latter assumption is addressed later on in the conclusion section.

The input-output model consists of n simultaneous linear equations, with n variables to be determined. However, the ingenuity of Leontief to provide an eloquent predictive system pertaining to the real-world behavior through the formulation of this mathematical model that won him the Noble prize. Whereas to many it was initially considered pure abstraction, it is now a well-recognized model.

To illustrate the model, the following simple example shows the structure of this general equilibrium for a three-industry structure, (steel, coal, and railroad), where each industry utilizes the input from others:

		Output		
		Steel	**Coal**	**R.R.**
Producer of Input:	Steel	0.2	0.2	0.1
	Coal	0.4	0.1	0.3
	R.R.	0.2	0.5	0.1
	Labor	0.2	0.2	0.5
	Total	1	1	1

The utility functions are omitted and consumer demands are treated as exogenous. Such a system has been introduced to determine the intermediate goods needed to produce a final product. The above matrix shows that a dollar's worth of steel produced, e. g., 20 cents in steel, (indigenous), 40 cents in coal, 20 cents in transportation, and 20 cents in labor. To produce \$ 100 million in steel, \$20 million in coal and \$ 40 million in railroad transformation, then three simultaneous equations can be written in general term:

$S=0.2\,S + 0.20\,C+0.1\,R+ 100$

$C=0.4S + 0.1C + 0.3\,R+ 20$

$R=0.2\,S + 0.5C+ 0.1R+ 40$

Transactions for the base year 200X for a hypothetical economy with two industries and two factors are presented in Table 3.

An industry's output distribution is described by its row and its input purchases by its column. Industry 1 in the first row used 4,000 million dollars of its output as an intra-industry input, delivered 12,800 million to industry 2 for use as an input, and delivered 3200 million to the two final consumption sectors. Reading vertically, the inputs of industry 1 consisted of 4,000 million dollars of its own output, 12,000 million of industry 2, and 2,000 million of each factor, i.e., each value-added category, which include profits. The value of the output of each industry equals the sum of its column entries as well as the sum of its row entries. Two final consumption sectors in Table 3 are governments and foreign countries. Although the entries are in dollar terms, they may be physical output, if each industry produces a homogeneous output. The input-output coefficients are computed by dividing the outputs and inputs of each industry by its output level. The average coefficients are interpreted as the constant aij and bij of the general input-output model. (See Appendix B).

Table 3: Interindustry Transactions 200x

Final consumption					
Industry	**1**	**2**	**House-holds**	**Other**	**Totals**
1	4,000	12,800	2,000	1,200	20,000
2	12,000	9,600	8,000	2,400	32,000
Value added:					
Labor	2,000	6,400			8,400
Other	2,000	3,200			5,200
Totals	20,000	32,000	10,000	3,600	65,600

Table 4 contains coefficients computed from Table 3. Since the sum of the column entries for an industry in Table 3 equals the industry's output level, the column sums, (i. e. the proportion) of the coefficients in Table 4 equal one.

Table 4: Direct Requirements Per Dollar Of Output, 1998

Industry	**1**	**2**
1	0.2	0.4
2	0.6	0.3
Labor	0.1	0.2
Other	0.1	0.1
Totals	1.0	1.0

These column sums satisfy existent conditions with $d_j = 1$ ($j = 1 \ldots,m$). Thus, an empirical system always has a general solution with $\beta_{ij} \geq 0$ ($i, j = 1, \ldots,m$) and $\gamma_{ij} \geq 0$ ($i = 1, \ldots,n; j = 1,\ldots,m$). The β_{ij} and γ_{ij} for the hypothetical economy are given in Table 5. Explanation of Table 5 is given on pages 16-17. Successful application of the Leontief's model to the American economy won Professor Leontief the Nobel Prize in Economics.

Table 5: Direct and Indirect Requirements Per Dollar of Final Consumption, 1998

Industry	**1**	**2**
1	2.18750	1.25000
2	1.87500	2.50000
Labor	0.59375	0.62500
Other	0.40625	0.37500

The column sums of coefficients for produced inputs will be less than one.

$$\sum_{i=1}^{m} a_{ij} < 1 \quad j=1,\ldots,m \tag{3}$$

Model C. Kooros' Model for Optimizing Economic Development:

Planners in Newly Industrialized Countries, (NIC's), are concerned with deciding on a paradigm to accelerate development programs, without experiencing socioeconomic or political problems. Yet, not all the projects can be or need to be implemented simultaneously, as they would otherwise overtax the limited productive resources, and hence lead to inflation. Many NIC's are occupied with improving their economic well being through accelerated multi-billion dollar industrialization programs. These programs are to be achieved within an intermediate time frame.

This model utilizes a consensus-oriented approach to identify a set of economic and industrial development objectives and their relative importance as the model's objective function. A plausible modeling approach to this decision environment suggested the need for:

(1) Identifying the economic and industrial objectives, i. e. the criteria on the basis of which economic development is planned;
(2) Determining the relative importance of these objectives, whose aggregate sum constitutes the decision preference, or the model's objective function;
(3) Identifying the conditions under which these factors were affected, (time being an important common denominator); and
(4) Structuring an appropriate model, capable of maximizing the economic and industrial development performance.

Based on Appendix C, such an information generated a matrix, which through a multi-attribute objective function it will maximize the overall economic performance, (Kooros 1994, and Kooros and McManis, 1998).

Due to its successful results, utilization of a consensus-oriented multi-objective decision making framework, MODM, where the overall perspective of the decision objectives was inculcated within a non-dominating group process, helped to quantify the aforementioned decision variables because of its inherent reliability and efficiency. In particular, the use of this technique in technological forecasting, project planning, accelerated development strategies, and in strategic product planning has gained significant success, (Kooros, 1994).

Experimental Results: A set of 12 projects, which were to be implemented within a three-year period, was selected. A 12 by 12 matrix was constructed in which each year was subsumed into four quarters. The original desired schedules, prior to the application of this modeling approach, were considered as the "reference objective" or the "datum." For any project delayed by a cycle from this datum, its weighted objectives were rated on a Likart scale of 1-5, where 5 is being the most desirable. For simplicity, it was further assumed that the objective function for all projects was the same. (See Appendix C).

Subsequently, based on the modeling approach in Appendix C, Table 6 was constructed. The ij values in this table are the composite weighted economic and industrial objectives due to program i at time j. Optimum solution is indicated in the bracketed cells, meaning that if the projects in the bracketed cells are implemented at the time indicated under the relevant columns, the overall economic and industrial objectives are maximized.

This solution signifies the extent by which the model maximized the over-all economic performance, in providing optimum inter-temporal programming decisions. Optimality was achieved without overtaxing market resources, which would have otherwise aggravated the inflationary trends, and thus impacted the project's costs. This feature was ensured by the inclusion in the consensus process of industrial experts, whose input on project timing was incorporated into the model. From this optimum solution, an optimum inter-temporal investment schedule was developed, (Table 7). This Table shows the magnitude of monetary resources needed at the designated time schedules.

Table 6: The Model's Optimum Solution of Weighted Eido's Proj.

Proj	Name	Year 1/quarters				Year 2/quarters				Year 3/quarters			
No.		1	2	3	4	1	2	3	4	1	2	3	4
1	PetroChem.	620	640	710	600	640	400	630	300	600	360	[600]	520
2	Auto Ind.	630	390	[850]	660	840	350	600	430	640	400	600	520
3	Tire/Rub.	640	350	850	640	[840]	640	700	380	630	420	630	600
4	Steel/Plt.	540	[640]	840	450	640	380	620	320	600	340	520	450
5	Alum/Plt.	[700]	380	630	510	610	580	380	620	300	580	380	450
6	Cement	500	380	630	530	600	460	640	350	[750]	470	640	480
7	Constr.	450	410	700	750	840	670	[800]	450	600	480	600	500
8	Agrind.	450	500	600	[780]	800	640	530	490	580	430	500	450
9	Textiles	600	450	630	750	810	500	750	470	570	[500]	540	500
10	Pharmaceud	650	600	700	750	630	[750]	630	300	600	400	550	450
11	Chemicals	540	550	680	450	800	650	380	[600]	310	620	450	500
12	Mining	700	400	700	830	830	750	600	320	550	400	530	[600]

Note: 1, 2, 3, and 4 designate the quarters in a year.

The monetary resources are homogeneous units reflecting an array of heterogeneous resources needed for each program at the designated optimum time schedule.

Analysis and Conclusions

Although these models have been introduced fifty years apart and independent of each other, there seems to be an apparent conceptual/structural affinity among them.

First, Markov-Chain shows the consequence of capturing new consumers or markets by a firm within an industry under the condition of so called “brand switching”, “ behavioral changes”, or economic performance (with or without any growth in the total market) and determining the firms’ relative market shares or changes in the outcome as the result of such behavioral modifications. Alternatively; this model has been employed by Kooros, (1994) to determine the economy’s future income distribution, given the income group dynamics. Since any economic development causes a change in income distribution, development economists and planners are interested in determining whether economic growth has or has not improved the society’s income distribution. In the absence of any improvement, these economists and planners should decide on the economic policy corrections that might be considered.

Table 7: The model's optimum inter-temporal investment requirements, (in $ millions)

Project	Name	Year 1				Year 2				Year 3				Project Cost
No.		1	2	3	4	1	2	3	4	1	2	3	4	(Millions)
1	Petro Chem.	0				0	0	0	0	0	0	800	0	800
2	Auto Ind.	0		4000	0	0	0	0	0	0	0	0	0	4000
3	Tire/Rub.	0			0	150	0	0	0	0	0	0	0	150
4	Steel/Plt.	0	200	0	0	0	0	0	0	0	0	0	0	200
5	Alum/Plt	400	0	0	0	0	0	0	0	0	0	0	0	400
6	Cement	0	0	0	0	0	0	0	0	300	0	0	0	300
7	Constr.	0	0	0	0	0	0	200	0	0	0	0	0	200
8	Agrind.	0	0	0	800	0	0	0	0	0	0	0	0	800
9	Textiles	0	0	0	0	0	0	0	0	0	250	0	0	250
10	Pharmacud.	0	0	0	0	0	100	0	0	0	0	0	0	100
11	Chemicals	0	0	0	0	0	0	0	50	0	0	0	0	50
12	Mining	0	0	`0	0	0	0	0	0	0	2000	0	0	2000

Note: 1, 2, 3, and 4 designate the quarters in a year.

Second, Leontief’s Model estimates the impact of growth or dynamic change of one industry on the entire economy. If this growth is uniform, or no technological innovation is infused, no changes can be expected in each industry's input and output coefficients. If structural or technological changes occur in one or more industries, changes in the entire economy can also be estimated. However, in Leontief's Model nothing has been said about the availability of resources. The changes predicated by the Leontief Model are purely speculative, i.e. without resource availability such changes are not guaranteed.

Third, Kooros' Model predicts the need for resources and prescribes the manner by which these resources should be allocated to each economic sector or program in a specific/different time horizons in order to maximize the overall economic development objectives (social welfare function). Neither Markov-Chain, nor Leontief's models have the dual qualities of objective function maximization over time. Kooros' Model is useful, not only for economic development purposes, but for strategic financial decisions, (Kooros and McManus, 1998), product planning, (Kooros, 1993), corporate training, (Kooros, 2004; Kooros, 2006), as well as closing of military bases, various government subsidies, or reconstruction of the school system. Kooros' model is therefore a dynamic decision making framework evolving time and allocation of scarce resources in multi-program, multi-time horizon, and multi-criteria settings. Markov- Chain and Leontief's models are both short-term predictive models, while Kooros' Model attempts to be both multi-period predictive and optimally prescriptive.

Finally, the relevance of these models to the international economics is discussed. Markov-Chain provides predictions on the relative share of a specific economic sector in the international domain as the result of the several competitive firms capturing each other's market. This behavior provides for planned investment, production, and marketing activities in the global economy. Although Leontief's Model is developed for a closed economy, in the opinion of the authors it can be applied to the international domain. Assume that a country wishes to expand trade in the areas where it commands long-term comparative advantage. The need for resource input from interdependent industries (vertically integrated or dependent systems) can be calculated by Leontief's Model. In the event of some insufficiency of the inputs to boost export, either the input resources must be expanded or trade expansion in the desired sectors must be curtailed. As a complement to Leontief's model, Kooros' Model prescribes that in the face of limited resources what should be the optimum time sequence of implementing the projects pertaining to the economic sectors or industries in order to meet the country's national economic and international trade objectives.

Table 8: Summary of the Modeling Attributes of Markov's, Leontief's and Kooros'

Model	Markov's	Leontief's	Kooros'
Input	Vector of state probabilities @ times t, with a unity sum	Inter-industry variations in demand or production vector	Vector of social welfare (objective) function with a unity sum
Throughput	Transitional probability Matrix from t_1 to t_2 (1)	Matrix of inter-industry technological coefficients in a general equilibrium.	Inter-temporal utilities of economic and industrial performance factors for project i at time j
Output	Vector of State probabilities at time t_2	Interindustry impact on production	Vectors/matrix of the impact of objective function on inter-temporal utilities
Goal	Forecasting a stage-wise behavior at t_2 (2)	Forecasting changes in the production due to changes in demand (3)	An optimum solution to economic and industrial objective (4)

Notes:
(1) This matrix is assumed to have reached steady state equilibrium of the consumer or decision maker's transient behavior.
(2) Limited information is necessary to achieve goal.
(3) Massive amount of information is necessary to achieve goal.
(4) Limited judgmental information is necessary to achieve goal. The final product optimizes inter-temporal decisions pertaining to an array of projects.

In addition to the above comparative attributes, the structural framework of each model is discussed below and summarized in Table VIII. Accordingly, all the three models are concerned with forecasting and they utilize a transitional matrix: Markov's matrix deals with the decision maker transient behavior, or changes within an industry; Leontief's matrix deals with inter-industry interdependence; and the Kooros' matrix deals with the impact of time/resources on each program's or economic sector's decision criteria. The latter model further utilizes a goal-programming algorithm to optimize decisions pertaining to the timing of each program implementation and resource allocation. In this respect, as a decision making tool, Kooros' model contains both the predictive and optimization properties, whereas the Markov-Chain and Leontief's models provide forecast information but no optimization of decision making. Each model provides a unique solution to the problem on hand, and therefore they are complimentary, rather than conflicting or competitive. Both Markov and Kooros' models require only a small amount of information and thus involve the least amount of information processing. Leontief's model, on the other hand, requires massive amount of information.

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Appendix A
Theories of Economic Development

THEORY	THEORY
The Classical Theory of Economic Stagnation, David Ricardo	Ricardo's major principle was the law of diminishing returns which states that when increased quantities of a variable factor are added to a fixed factor then each additional output becomes continually lower.
Marx's Historical Materialism, Karl Marx	Marx believed in the ongoing process of change. He shows the transition of the working class society from capitalism, where emergence of monopolies brings about control over the workplace and eventually causing a revolt. This then leads to socialism and then to communism
Walter W. Rostow's **Stages of Economic Growth,**	Rostow's economic stages are: The traditional society The preconditions for takeoff The takeoff The drive to maturity The age of high mass consumption
Balanced vs. Unbalanced Growth Balanced: Ragnar Nurske	The synchronized application of capital to a wide range of different industries is called balanced growth.
Unbalanced: Albert O. Hishman	Deliberately unbalancing the economic, in line with a predesigned strategy, is the best path for economic growth.
Baran's Neo-Marxist Thesis Paul A,O Baran	A homegrown variety of a capitalist revolution in LCD's is unlikely because of western economic and political domination. He theorizes that the only way to make a change for capital accumulation would be a worker and peasant revolution.
Dependency Theo. Celso Furtado	According to Furtado, since the 18th century the world as divided in a new international division of labor were the LCD's specialized in primary products depending on the DC's for any technological progress. His basic thesis is that underdevelopment does not mean traditional or non- modern economic, political and social institutions, but subjection to the colonial rule and imperial domination of foreign powers.
Neoclassical Growth Theory Robert Socon	The neoclassical model predicts that income per capita between rich and poor countries will converge. The theory stressed the importance of savings and capital formation for economic development.
The New Growth Theory Paul Romer	If technology is endogenous new growth economists can elucidate growth were the neoclassical model fails. Variable technology means that the speed of convergence between DC's and LCD's is determined primarily by the rate of diffusion of knowledge.
Vicious Circle Theory	Shows the circle of demand and supply as it relates to poverty. When income is low then there is low productivity per person and we see then in this case that the country is too poor to save. On the demand side when incomes are low there is also low investment.
The Lewis-Fei-Ranis Model	When there is a limitless supply of labor available to the industrial sector this allows for the accumulation of capital and then will lead to economic growth.

Source: Compiled from various sources, August 1998

Appendix B
Theoretical Background of Markov-Chain

The appropriateness of each forecasting model depends on the specific configuration of the problem under consideration. Markov-Chain has been utilized for a variety of stage-wise forecasting purposes. Application of Markov-Chain for forecasting income distribution by Kooros (1995) for the first time has been rationalized in detailed in his publication and under section on Model A. Markov systems deal with stochastic environments in which possible "outcomes occur at the end of a well-defined, usually first period", (Turban, et al 2000). This system further involves a multi-period time frame, during which the occurring consumer's transient behavior, for example, affects the stability of the firm's performance. This transient behavior, whose future outcome is not known and needs to be predicated, creates inter-period transitional probabilities. Such a stochastic process, known as the Markov process, contains a special case, where the transitional probabilities from one time period to another remains stationary, in which case the process is referred to as the Markov-Chain. A number of assumptions have been developed by Turban, et al (2000), Chung, (1991), and others pertaining to Markov-Chain, that include properties with:

- A nonabsorbing finite -discrete state;
- A system's condition or state that depends on the preceding period;
- Constancy of transitional probability over the occurrence of the system's changes in each period; and
- Regularity in the occurrence of the probabilities.

The transitional probabilities of Markov-Chain can be shown by $[P_{ij}]$. Where,

$$\sum_{j=1}^{n} P_{ij} = 1 \qquad \text{(B-1)}$$

Decision makers, faced with explicit limited resources, may alter their preferences over time. However, such preferences in Markov-Chain are assumed to be governed by so called the initial state probabilities, q(k),

where, $q(k)=q_1(k),q_2(k),q_m (k)]$ (B-2)

This initial state probability, usually designated by $q(t_o)$, serves as the basis for determining the state probabilities for the next period, which can then be calculated from

$$q(t_{n+1}) = q(t) \times [P_{ij}] \qquad \text{(B-3)}$$

$$\sum_{i=1}^{n} q(i) = 1 \; q_i = \sum_{i=1}^{n} P_{\text{ijqi}} \qquad \text{(B-4)}$$

Markov-Chain's unique property is that it reaches a steady state (equilibrium) over time, where state probabilities exhibit the property of:

$$q(t_n) = q\,(t_{n-1}) \qquad \text{(B-5)}$$

and where, $q(t_n)$ can be market shares of several competing companies in a specific product, or a financial institution's composition of debt delinquency, whose sum will be equal to 100%. The transient behavior of economic variables, under the conditions of Markov-Chain, can be estimated by utilizing expression (B-6),

Estimate of (t_{n+1}) = (Actual observation @ t) x [Transi¬tional Probabilities]$_{(tn+1-tn)}$.

i.e., $q(t_{n+1}) = q(t) \times [P_{ij}]$ (B-6)

Appendix C
Leontioef's Input_Output Model

In this system of linear equations, the amount of each intermediate input into the final product is determined by technological coefficients. In general terms, Henderson, et al, (1971), Gillis, et al (1996), and Leontief (1986) have provided a straight forward formulation:

Let m = number of goods to be produced in an economy
n = number of intermediate goods
a_{ij} = the technological coefficient between the intermediate and final goods,

where
i = intermediate goods
j = final goods

and i = 1, 2, ... n, j = 1, 2, ... m (C-1)

$a_{ij} \geq 0$
$bij \geq 0$

the output of the industry q_i is absorbed by industry input uses and final consumption uses, y_i:

$$q_i = a_i\, q_i + a_2\, q_2 + \ldots\ldots a_{im}\, q_m + y_i \qquad \text{(C-2)}$$

An open input-output system contains one or more exogenous sectors. All sectors are endogenous n closed system. Then,

$$\begin{aligned} Y_i &= (1-a_{11})\, q_1 - a_{12}\, q_2 \ldots\ldots a_m\, q_m \\ Y_2 &= - a_{21}\, q_1 + (1 - a_{22}) \ldots\ldots a_{2m}\, q_m \\ Y_m &= - a_{m1}\, q_1 - \ldots\ldots + (1 - a_{mm})\, q_m \end{aligned} \qquad \text{(C-3)}$$

The quantity of each good available for final consumption equals total output less intermediating input requirements. Utilizing Cramer's rule, if the determinant of the coefficient array (C-3), Aij is not zero.

$$\begin{aligned} q_1 &= {}_{11}\, Y_1 + {}_{21}\, Y_2 + \ldots\ldots {}_{1m}\, Y_m \\ q_2 &= {}_{21}\, Y_1 + {}_{22}\, Y_2 + \ldots\ldots {}_{2m}\, Y_m \\ q_m &= {}_{m1}\, Y_1 + {}_{m2}\, Y_2 + \ldots\ldots {}_{mm}\, Y_m \\ q_i &= [{}_{ij}]\, [Y_m] \end{aligned} \qquad \text{(C-4)}$$

$$qi = \sum_i^m n \sum_j \beta_{ij}\, y_m \qquad \text{(C-5)}$$

where $\beta_{ij} = A_{ij}/A$ is the co factor of the element within j^{th} row and the column of an array of relation (C-3), A_{ij} divided by the determinant of the array. Relation (C-4) provides an input output system of (C-3) if q_i 0 whenever $Y_i \geq 0$. A necessary and general condition for (C-4) to be a general solution is that $\beta_{ij} \geq 0$, for (i,j = 1,2,3, ...m). The coefficient β_{ij} for i j gives the direct and indirect input requirements for the good necessary to support one unit of final consumption of the j th. The direct requirement is a_{ij}.

It follows that$\beta_{ij} \geq a_{ij}$

$$\beta_{jj} \geq 1 + a_{ij} \qquad \text{(C-6)}$$

Factor requirements are easily determined from output requirements.

$$X_i = b_{i1}\, q_1 + b_{i2}\, q_2 + \ldots\ldots b_{im}\, q_m$$

i = 1,2,.....m, where x_i is the input, (3). (C-7)

The major task is to construct an input-output matrix for a base year.

Appendix D

Theoritical Backgrounf of Kooros' Model

Let U_{ijk} be the k^{th} utility or benefit derived from a decision type i, made at time j, such that $U_{..k}$, generate benefits as follows:

U_{ij1} = project implementation will enhance profitability
U_{ij2} = project implementation will improve market share
U_{ij3} = project implementation will increase sale (D-1)
Uijt = project implementation will
t = 1……. n

Table D-1 provides a more detailed and concrete listing.

Table D-1: Some Economic and Industrial Development Objectives

U_1 = Import Substitution;	U_{10} = International Competitiveness;
U_2 = Income Equity;	U_{11} = Regional economic integration;
U_3 = Support other industries;	U_{12} = Per capita income;
U_4 = Balance of payment/trade;	U_{13} = Output/capital ratio;
U_5 = Expand Export;	U_{14}=Accelerate economic development;
U_6= Indigenous Technology;	U_{15} = Agricultural productivity;
U_7 = Value Added;	U_{16} = Education;
U_8 = Employment;	U_{17} = Other sectors;
U_9=Productivity, quality & cost;	U_{18}= Stable earnings in recession period

This list immediately suggested that: (a) inherent among these objectives is a hierarchy of importance, and therefore some priority or ranking system should be adopted; and (b) the values of these objectives can change over time, as the result of different program timing and environmental dynamics. That objective goals of any type can be rank-ordered is a central tenet of Economics. The fact that industrial and economic objectives, EIDO's or $U_{..k}$ exhibit a hierarchal property has been previously tested (Kooros, 1993, 1994). Thus, implicit in program planning, as with other multi-objective decisions, the following ranking or weighing system exists:

U_{ij1} has a hierarchy of w_1;
U_{ij2} has a hierarchy of w_2;
....
U_{ijk} has a hierarchy of w_k; (D-2)

meaning that $w_{..k}$'s are the respective weights for each $U_{..k}$, and, where $w_k = 1$, and k= 1,2,3,4 , and where ....m; i = 1,2,3 ......n; and j = 1,2,3 ......n.

Each program timing will alter their expected weighted benefits over time. Optimization of these over-all weighted benefits is therefore of interest. Such a decision process embodies four dimensions: program/ projects i, timing j, the weighted EIDO's, W_{ij}, attained by project i at time j, and a decision group with diverse preferences. Since EIDO values vary with respect to programs and time, a series of U_{ijk} matrices, where i, j, and k are defined as before are constructed.

The impact of the model's objective function on these matrices induce temporal vectors (W_{ij}) for each program. Merging these vectors, results in a final matrix, $[W_{ij}]$, designated by programs i at time j.

$$(w_1\ w_2\ w_3\ ..\ w_k) \times [U_{1jk}] = [W_{1j}] = (W_{11}\ W_{12}\ ....\ W_{1n})$$
$$(w_1\ w_2\ w_3\ ..\ w_k) \times [U_{2jk}] = [W_{2j}] = (W_{21}\ W_{22}\ ....\ W_{2n})$$
$$(w_1\ w_2\ w_3\ ..\ w_k) \times [U_{2jk}] = [W_{2j}] = (W_{31}\ W_{32}\ ....\ W_{3n})$$
$$. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad .... \quad . \quad = \qquad [W_{ij}] \tag{D-3}$$
$$(w_{w1}\ w_2\ w_3\ ..\ w_k) \times [U_{njk}] = [W_{nj}] = (W_{n1}\ W_{n2}\ ....\ W_{nn})$$

And in general, $(w_1\ w_2\ w_3\ ..\ w_k) \times [Ui_{ijk}] = [W_{ij}]$ (D-4)

The ij cell values of this final temporal matrix are the weighted EIDO's, i,e. Wij for each program, as affected by time. Since the timing of program implementation impacts the EIDO's, and vice versa, the appropriate launching of the programs through the proposed model is tantamount to maximizing the over-all economic and industrial development objectives.

Linear programming models have fulfilled their functions rather well, by addressing quantitative single objective functions. However, many planning problems are qualitative in nature, and they comprise an array of conflicting goals that are to be aggregated and optimized. Goal programming provides optimum solutions to such problems. This approach is also more powerful, as it integrates the multiple-objective goals of a large number of decision makers. However, a more appropriate algorithm is a hierarchical Assignment Model of LP, even though the problem could be solved by the simplex method. The proposed model is more efficient, when dealing with large number of variables (Kooros, 1993; Kooros, 1994). Furthermore, in goal programming the deviational variables di can be examined by the extent of their goal achievement. In the following LP model, goals are aggregated, and the optimum solution encompasses the entire aggregated set. The solution contains all the goals in accordance with their respective hierarchy, rather than the extent to which individual goals are achieved.

$$\text{(1) Maximize} = \sum_{i}^{n}\sum_{j}^{n} W_k U_{ij}$$

$$\text{(2) } \sum_{i=1}^{n} U_{ij} = 1 \qquad \text{(D-5)}$$

$$\text{(3) } \sum_{j=1}^{n} U_{ij} = 1$$

By applying the LP assignment algorithm to the final weighted W_{ij} matrix, in Relation (C-5), the desired optimality is achieved. In this problem formulation, the unity constraints designate the assignment of only one project to one time period. This was due to the assumption that not more than one project could have been implemented at a time frame. The quantification methodology has been detailed in by Kooros (1993 and 2006).