Economic Planning Models for Development: The Relevance for a Developing Economy

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Abstract

This paper examines the relevance of selected planning models in the attempt to reduce poverty and achieve economic growth and development in Nigeria through national economic development plans. A synopsis of the linear programming and input-output models asserts a preference for the linear programming (optimizing) model due to the heterogeneous development pattern in the country coupled with gaps between the achievements vis-a-vis the objectives and strategies of the plans.

Key words: Development planning, Linear programming, Input-Output, Growth, Nigeria

1. Introduction

Economic planning has been the bedrock of achieving development objectives in many successful developing countries. At the heart of such planning is effective coordination and integration of development policies, whether fiscal, monetary or social, across government. However, despite good intentions that always underpin development strategies, the development plans of many developing economies either fail outright or produce disappointingly average returns (Gumede, 2009). Most especially when the type of economy is a developing one like Nigeria. Over the years, in an attempt to reduce the level of poverty and increase the rate of economic development, Nigeria has embarked on several National Development Plans with feasible objectives: from the first plan (1962-1968) to the fifth (1988-1992) and then the rolling plans (1990-1992). Strategies like National Poverty Eradication Programme (NAPEP), National Economic Empowerment and Development Strategy (NEEDS), VISION 2010, and the newly introduced Financial System Strategy (FSS) 20:2020 and Subsidy Re-investment Programme (Sure-P) were also introduced and implemented.

Proponents of economic planning for developing countries argue that the uncontrolled market economy can, and often does, subject these nations to economic dualism, unstable markets, low investment in key sectors, and low levels of employment. In particular, the proponents claim that the market economy is not geared to the principal operational task of poor countries: mobilizing limited resources in a way that will bring about the structural change necessary to stimulate a sustained and balanced growth of the entire economy. Planning came to be accepted, therefore, as an essential and pivotal means of guiding and accelerating economic growth in almost all developing countries (Todaro and Smith, 2011).

If going by the words of Todaro and Smith (2003) that traditionally, economic development connotes the capacity of a national economy, whose initial condition has been more or less static for a long time, to generate and sustain an annual increase in its gross national product (GNP) at rates of perhaps 5 per cent to 7 per cent or more. Then following Iwayemi (2012), Nigeria is one of the fastest-growing economies in the world in the past decade. The remarkable growth narrative is evident in an average annual real growth rate of GDP of over 6 per cent between 2004 and 2012. In 2011, the economy grew robustly at 7.45 per cent. Real per capita income which grew at over 3 per cent per annum in the last five years is also one of the fastest in the world.

However, if going by Sen (1985, 1999), "Economic growth cannot be sensibly treated as an end in itself. Development has to be more concerned with embracing the lives we lead and the freedom we enjoy." In the recent time in Nigeria, the robust and sustained economic growth has failed to translate into any net gain in productive employment for the majority of the labour force, especially for the millions of youth joining the labour market each year. The massive joblessness among the youth is increasingly swelling a social underclass which has often fuelled criminality, social tension and insecurity in the country. Also, there is declining well being and rising poverty level as the impressive and sustained growth has failed to translate into poverty reduction, inclusive growth and development. This observation is substantiated by the significant deterioration in economic prosperity for much of the population based on poverty level and other human development indicators (Iwayemi, 2012).

The significance of this research stems from the necessity of Nigeria as a country to embrace the ideology of economic planning models in the formulation and implementation of its development plans so as to achieve meaningful growth and desired development. Also, due to the fact, as far as we know, that there is hardly a recognised study on planning models in Nigeria, the present work finds relevance in filling this gap by using historical method and quantitative techniques of analysis to examine the rationale for economic development planning model for the country.

Essentially, this study is also premised on the desire of Nigeria to effectively combat poverty with a view to attaining the Millenium Development Goals (MDG) by 2015. Thus, despite the various development strategies that have been introduced and implemented, the country needs a policy measure that will aim at improving the growth rate of per capita income necessary for poverty reduction. Also, since it is imperative that economic planning models are relevant in promoting economic growth and development along the thought of Todaro and Smith (2011), it is worthwhile to explore how planning models are relevant to economic development in Nigeria.
The rest of the paper is structured thus: section two treats the overview of national development planning in Nigeria as the third section discusses some selected models of economic planning. Conclusion is drawn in the fourth section while recommendation wraps the paper in section five.

2. Overview of National Development Planning in Nigeria

The Nigerian experience as regards development planning can be discussed in the light of Long-, Medium-, and Short-term plan in the version of perspective, fixed and budgetary plans. Essentially, the recent epoch of national development plan in the country dates back to the period after the Structural Adjustment Programme (SAP). As an opportunity for revaluating the planning system, the government introduced a new planning proposal which consisted of a fifteen to twenty-year perspective or Long-term Plan, a three-year Rolling Plan, and an Annual Budget that was to draw from the Rolling Plan (Okojie, 2002). As a significant innovation, following from the criticism in the form of lack of administrative utility for the implementation of plans (Marcellus, 2009), vagueness (Okojie, 2002), and no constitutional significance (Abasili, 2004) in the previous plans, the Perspective Plan was conceived to be more specific and elaborate. Though scheduled to take effect from 1990 along with the Rolling Plan, the ideology of a perspective plan was actually implemented in 1996 as a result of the setting up of a committee for Vision 2010. The Vision was to provide, as a recommendation, the focus for all plans, including the rolling and annual plans.

The country's First national Rolling Plan (1990-1992) came into force in 1990 with the objective to afford the country the opportunity to revision in the midst of increasing socio-political and economic uncertainties. This supposedly medium-term plan, however, turned out to be an annual event which became almost undistinguishable from the annual budget. According to Okojie (2002), Rolling Plans have been prepared yearly at all levels of government including the local government level. Such that, at the end of about ten Rolling Plans from 1990 to 1999, Nigerians are no better off than they were during the years of fixed medium-term planning.

The fixed medium-term planning in Nigeria commenced with the First National Development Plan (1962-1968). It was followed, after the civil war, by the Second National Development Plan (1970-1974), the Third National Development Plan (1975-1980) and the Fourth National Development Plan (1981-1985). After a three-year brake which resulted from the Coup D'état that overthrew the country's second civilian administration in 1983 and a military government in 1985, the Fifth National Development Plan was rescheduled for the period 1988-1992. However, in late 1989, the then military government, headed by General Ibrahim Babangida abandoned the concept of a fixed five-year plan with the introduction of a three-year rolling plan in the context of more comprehensive fifteen to twenty-year plans.

In fact, national planning experience in Nigeria predates the 1960s. It was the period when planning activities were purely a function of the colonial administrators. Although not comprehensive in scope and depth, the foremost national plans in the country include the Ten-year Plan of Development and Welfare for the period 1946-1955, and the 1955-1960 Plan which, however, was extended to 1962. Nevertheless, as observed by the authors of the First National Development Plan (1962-1968), the pre-1960 plans were not plans in the true sense of the word. They were rather a series of projects which had been coordinated or related to any overall economic target. In essence, probably it was as a result of oversight or a deliberate action that all the planning documents thus far released in Nigeria have been silent on the Planning models employed or adopted. Thus, it has always been a difficult exercise to quantitatively assess the performance of any economic plan in Nigeria vis-à-vis the goals and objectives.

3. Selected Planning Models

Basically, economic models are frequently used to construct economic planning and for the fact that such models should have the dual characteristics of clarity and consistency aside the property of being selective so that only the behaviour of the major variables is analysed, and quantified, two models are, therefore, selected for the main reasons of analysis of inter-industry relationship and efficient allocation of resources. The models are described as follows.

3.1 The Input-Output Model

The use of input-output technique in development planning has become quite noticeable as it delineates the general equilibrium analysis and the empirical side of the economic system of production of any country. It was developed by the work of Leontief (1951 & 1986). The assumption of the model requires that to produce one unit of the *j*th good the required *i*th input would be constant as, say, a_{ij}. That is, the production of each unit of the *j*th good would need a_{ij} of the first commodity, a_{2j} of the second commodity and a_{ni} of the *nth* input. The model is a short term predictive model which estimates the impact of growth or dynamic change in a particular industry on the entire economy. It follows the process whereby if there is uniform or balanced growth pattern across industries, then technological innovation is not infused and changes are not expected in each industry's input and output coefficients. On the other hand, if technological or structural changes occur in one or more industries, there would be changes in the entire economy which can necessarily be estimated using the input-output model. The changes predicted by the model are, however, purely speculative such that without resource availability, the changes are not guaranteed.

If, on assumption, there are *n* industries in the economy, the input-output table in the form of the matrix $A = [a_{ij}]$ would state the input coefficients. The table, essentially, shows the inter-industry flows where each column shows the necessary input(s) for producing one unit of the output of a certain industry. If, for whatever reason, any element in the matrix is zero, it shows that the input demand is zero. The input coefficients can be stated as

$$a_{ij} = \frac{x_{ij}}{X_j} \qquad \begin{matrix} i = 1, 2, \dots, n \\ j = 1, 2, \dots, n \end{matrix} \qquad (1)$$

where X_j is the total output of the *j*th industry and x_{ij} is the number of units of the *i*th good used by the *j*th industry.

An input-output table is of the form given in the following matrix as

		Output			
	Input	I	II	. . .	N
	I	a_{11}	a_{12}	. . .	a_{1n}
	II	a_{21}	a_{22}	. . .	a_{2n}
A=	.	.	.		.
	.	.	.		.
	.	.	.		.
	N	a_{n1}	a_{n2}		a_{nn}

The above form of the input-output table considers only inter-industry flows and ignores final demand. The table would be an open one when a final demand for the product of each industry is included along the corresponding supply of primary inputs.

Obviously, due to the supply of labour inputs, the sum of the elements in each column of the matrix *A* will be less than one because in the absence of primary input costs the sum of such element in any column will be exactly equal to one. Thus,

$$\sum_{j=1}^{n} a_{ij} < 1 \qquad j = 1, 2, \ldots, n \tag{2}$$

such that

$$1 - \sum_{j=1}^{n} a_{ij} \tag{3}$$

Equation (3) sates the value of primary input required to produce one unit of the *j*th good. Thus, for industry 1 to produce enough output to cater for the final demand plus the input demand of *n* industries, the following relations must hold as

$$x_1 = a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n + D_1 \tag{4}$$

or

$$(1 - a_{11})x_1 - a_{12}x_2 - \ldots - a_{1n}x_n = D_1 \tag{5}$$

where D_1 is the final demand for the output of industry 1.

The system of equations can be stated in the following matrix form as

$$[I - A]x = D \begin{pmatrix} 1 - a_{11} & -a_{12} & -a_{1n} \\ -a_{21} & 1 - a_{22} & -a_{2n} \\ \vdots & & \\ -a_{n1} & -a_{n2} & 1 - a_{nn} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{pmatrix} = \begin{pmatrix} D_1 \\ D_2 \\ \vdots \\ D_n \end{pmatrix} \tag{6}$$

where the identity matrix *I* is of the form

$$I = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \tag{7}$$

and obtaining the value for *x* will take the form

$$x = [1 - A]^{-1}D \tag{8}$$

thus, with the rule for matrix inversion, that is, $[A]^{-1}$, it gives

$$A^{-1} = \frac{1}{|A|} A^{*} \tag{9}$$

If by assumption, table 1 below represents a closed economy inter-industry analysis of some sectors in a developing country, then the actual total output of each sector and the values of the flows of goods and services among different sectors can be obtained. In essence, appendix 1 shows the framework with which 468.4 units, 634.6 units and 721 units of total output of the agricultural sector, industrial sector and the services sector are derived, respectively. Thus, the difference in the total output between the tabulated values and the calculated values in appendix 1 gives the actual values of part of each sector's output that goes to the final demand (final consumption) sector in the economy.

Table 1

Sector	*Agriculture*	*Industry*	*Services*	*Final Demand*	*Total Output*
Agriculture	*50*	*150*	*200*	*100*	*500*
Industry	*100*	*200*	*150*	*200*	*650*
Services	*200*	*100*	*300*	*150*	*750*
Value Added	*150*	*200*	*100*	*0*	*450*
Total Input	*500*	*650*	*750*	*450*	*2350*

3.2 The Linear Programming (Optimizing) Model

The main task of development strategy is to ensure that resources will be forthcoming to meet the goals of a development programme, and that the resources are allocated efficiently subject to certain constraints. The linear programming model can provide a simultaneous solution to the three basic purposes of development planning, which are the optimum allocation of resources, efficiency in the use of resources through the proper valuation of the resources, and the avoidance of social waste, and thirdly, the balance between different branches of the national economy.

Linear programming can be considered as providing an operational method for dealing with economic relationships, which involve discontinuities. It is a specific approach within the general framework of economic theory (see Koutsoyiannis, 1989).

The optimizing model has proved useful in modelling diverse types of problems in planning, routing and design and can be applied to various fields of study. Basically, industries that use linear programming models include transportation, telecommunications, and manufacturing as it helps determine the techniques necessary to optimize output and cost at the plan formulation stage. Essentially, the basic assumptions upon which the model rests include proportionality, additivity, divisibility and certainty.

Thus, if we assume that a country is putting up its national plan for economic development and that there are five sectors X_1, X_2, . . . , X_5 with three main resources R_1, R_2, R_3 in the economy. Let us assume further that the available quantities of the resources are $R_1 = 100$ Units of Labour; $R_2 = 80$ Units of Capital; and $R_3 = 150$ Acres of Land; and that the unit contributions of the five sectors to the national output (Y) in the previous year are: $y_1 = 4$, $y_2 = 6$, $y_3 = 3$, $y_4 = 2$, and $y_5 = 2$. If the known techniques of resources usage by each sector are as follows in table 2

Table 2

	X_1	X_2	X_3	X_4	X_5
R_1	$l_1=1$	$l_2=2$	$l_3=2$	$l_4=2$	$l_5=2$
R_2	$k_1=1$	$k_2=2$	$k_3=0$	$k_4=1$	$k_5=0$
R_3	$S_1=2$	$S_2=2$	$S_3=1$	$S_4=1$	$S_5=1$

then the problem can be formulated in the linear programming form as stated below in order to determine the national output and the contribution of each sector to the national output in current year so as to formulate national plan for the next fiscal year.

Maximise $$Y = 4X_1 + 6X_2 + 3X_3 + 2X_4 + 2X_5$$

Subject to $$X_1 + 2X_2 + 2X_3 + 2X_4 + 2X_5 + S_1 = 100$$
$$X_1 + 2X_2 + 0X_3 + X_4 + 0X_5 + S_2 = 80$$
$$2X_1 + 2X_2 + X_3 + X_4 + X_5 + S_3 = 150$$
$$X_1 \geq 0, X_2 \geq 0, X_3 \geq 0, X_4 \geq 0, X_5 \geq 0$$

where the S_i represent slack variables on the assumption that each resource is underutilised by each sector. That is, the slack variable represents the difference between total quantity of available resource and the quantity of resource utilized by each sector. Thus, the inclusion of a slack variable in any of the constraint relationships automatically changes the inequality sign to equality. As such, given the iterations in appendix 2, the total optimum output in the economy is 330. By implication, only sectors X_1, X_2 and X_3 are viable to be incorporated into the national development plan since these are the 3 sectors that contributed optimally to the national output.

4. Conclusion

This study has analysed the efficacy of the linear programming (optimizing) model and the input-output model for economic planning in a developing economy. In the synopsis of the models, it is established that the input-output model would need massive amount of data on the economy's production interdependence especially where more than three industries are been considered simultaneously in the domestic scene or when the activity in the international arena is required. But then, this model can provide an accurate prediction of future production requirements if information on demand is made available given that the interdependence and interrelationships among industries are unravelled in the whole economy. It would also be effective for the analysis involving specialised industries where each industry produces a single product like the rubber plantation vis-à-vis tire manufacturing industry as available in Nigeria. Also, it is inferred from the study that the linear-optimizing model is relevant when multi-sectoral or multi-regional analysis is involved in the economy. This model could be employed if efficient allocation of resources to sectors or regions is the main objective of the planning authorities in the economy. Prior to allocation, an analysis incorporating all sectors or regional usage of resources based on previous period allocation is carried out such that the contribution or sectoral or regional output to the central output is determined. As earlier explained, any sector or region that contributes to the central output would be incorporated in the national economic plan and resources also would be allocated based on the optimised usage.

Essentially yet, a particular sector may not contribute to the national output based on the optimising analysis, nevertheless the sector may be very important in terms of employment provision and object clause of the plan. Such sector or region may be allocated resources and also incorporated into the national plan provided that the planners constitute a committee of experts who can monitor and give advice on how resources could be utilised effectively and efficiently in order to obtain positive output.

5. Recommendation

As a developing country, the non-availability of long-term data and the unreliability of the sources of the available ones, make the aggregative planning model unsuitable for Nigeria. However, from the foregoing, the optimizing or linear programming model will be ideal and suitable for the country considering the unbalanced or heterogeneous growth pattern of development in the economy. Especially in the recent time when the Nigerian government proposes to incorporate each state's value of GDP in its national planning process, couple with the fact that the nation is structured and governed in a regional and sectoral or multi-sectoral type of political system, the optimizing model would be more relevant as a planning model. As such, it could be useful in the development planning process to project an increase in the availability and widen the distribution of basic life-sustaining goods such as food, shelter, health, and protection. Yet, this does not imply a total condemnation of the input-output model because where inter-industry analyses are required at the micro or plan formulation stage the Leontief model cannot be ruled out.

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Appendix 1

$A = \begin{pmatrix} 0.1 & 0.2 & 0.27 \\ 0.2 & 0.31 & 0.2 \\ 0.4 & 0.15 & 0.4 \end{pmatrix}$, $Y = \begin{pmatrix} 100 \\ 200 \\ 150 \end{pmatrix}$ and $(I-A) = \begin{pmatrix} 0.9 & -0.2 & -0.27 \\ -0.2 & 0.69 & -0.2 \\ -0.4 & -0.15 & 0.6 \end{pmatrix}$

Since $I = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$ such that, $|(I - A)| = 0.22298$.

The total output of the respective sector is, therefore, given as follows:

$|Agriculture| = \begin{pmatrix} 100 & -0.2 & -0.27 \\ 200 & 0.69 & -0.2 \\ 150 & -0.15 & 0.6 \end{pmatrix} = 104.445$

Agricultural output $= \frac{104.445}{0.22298} =$ 468.4052381 units

$|Industry| = \begin{pmatrix} 0.9 & 100 & -0.27 \\ -0.2 & 200 & -0.2 \\ -0.4 & 150 & 0.6 \end{pmatrix} = 141.5$

$Industrial\ output = \frac{141.5}{0.22298} =$ 634. 5860615 units

$|Services| = \begin{pmatrix} 0.9 & -0.2 & 100 \\ -0.2 & 0.69 & 200 \\ -0.4 & -0.15 & 150 \end{pmatrix} = 160.75$

$Services\ output = \frac{160.75}{0.22298} =$ 720.9166741 units

Appendix2

Iteration 1

	Y	X1	X2	X3	X4	X5	S1	S2	S3	Solution	Ratio
Y	1	-4	-6	-3	-2	-2	0	0	0	0	
S1	0	1	2	2	2	2	1	0	0	100	50
S2	0	1	2	0	1	0	0	1	0	80	40
S3	0	2	2	1	1	1	0	0	1	150	75

Iteration 2

	Y	X1	X2	X3	X4	X5	S1	S2	S3	Solution	Ratio
Y	1	-1	0	-3	1	-2	0	3	0	240	
S1	0	0	0	2	1	2	1	-1	0	20	10
X2	0	0.5	1	0	0.5	0	0	0.5	0	40	40
S3	0	1	0	1	0	1	0	-1	1	70	70

Iteration 3

	Y	X1	X2	X3	X4	X5	S1	S2	S3	Solution	Ratio
Y	1	-1	0	0	5/2	1	3/2	3/2	0	270	
X3	0	0	0	1	0.5	1	0.5	-0.5	0	10	∞
X2	0	0.5	1	0	0.5	0	0	0.5	0	40	40
S3	0	1	0	0	-0.5	0	-0.5	-0.5	1	60	60

Iteration 4

	Y	X1	X2	X3	X4	X5	S1	S2	S3	Solution
Y	1	0	0	0	2	1	1	0	1	330
X3	0	0	0	1	0.5	1	0.5	-0.5	0	10
X2	0	0	1	0	3/4	0	1/4	0.5	-0.5	10
X1	0	1	0	0	-0.5	0	-0.5	-0.5	1	60