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A Note on Input-Output Model with Reference to Under Developed Countries

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INTRODUCTION

With the pace of economic development and transformation of the mode of production, classical economic theory has remained as a theory that does not meet the requirements of the changing economic behaviour. Some economists of the pre-classical period attempted to focus on the problem of economic aggregation. The theoretical construction of the Tableau Economique explored by Francois Quency was a meaningful attempt. In 1874 Walras attempted to bring the general equilibrium theory which constitutes the economy as a whole. But these theories remain only the show pieces of economic theories almost up to the 1930's. At the same period the partial economic analysis failed to manipulate the economic variables. The complexity of the economic problems of 1930's made the classical theory a failure. Since then many theories have been investigated by different economists to overcome the everexisting problems. The search for economic aggregation was the then present need. As a result, focuses have been to study the production relationship in the economy. Working in these lines W.W. Leontief has propounded the input-output analysis with a view to study the inter-relationship between the various industries within the economy. It has attempted to study the inter-dependence between the industries with empirical analysis of production. This method of the studying relationship between various sector of an economy is purely a mathematical orientation. The input-output analysis focuses its attention in the general equilibrium of Walrasian type. It seeks to take account of the interdependence of the many industries/sectors which constitutes the economy.

(i) W.W. Leonfief has specified a number of assumptions to make the input-ouput analysis simple. The simplifying assumptions are the homogeneity of production, which requires perfect equilibrium and the production of any industry is subject to constant returns to scale. The basis of the input-output analysis is that every sector of an economy should use a fixed amount of input-output ration one hand and the mathematical relationship can be specified in money terms on the other.

(ii) The input-output analysis has a great achievement in production planning. A planner can use input-output model to formulate short period plans. It shows the interdependence of the industries or sectors on one hand and it predicts the quantities of production to meet the input requirement of the system and

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consumer requirements on the other. In a transaction table of an economy, if the household sector is simply treated as a consumption unit only, the analysis is called a static one but in contrast to this if the household sector is treated as a production unit as well as consumption unit, the analysis is termed as closed one. This article evaluates the static open model only.

(iii) The Model

From the above assumptions it is clear that to produce one unit of jth commodity the required ith input is constant and let us call it aij. The first subscript shows the input and second output.

Thus, the production of each unit of the ith commodity would need say aij, aij and anj of the first, second third and nth input. Let us suppose that there are n° industries in the economy. Concerning to n industries, the input-output table is in the form of the matrix A=/aij/ where aij would state the input coefficients. Such a table shows the inter-industry dependence of flows within the economy. Each column of the table shows the necessary input for producing one unit of the output of the certain industry. If any element in the matrix is zero, it shows that the input demand by that industry is zero.

From the above discussion the input coefficients can be written as

$$aij = \frac{Xij}{Xj} \quad (i \ \& \ j = 1.2.3 \ ... \ n)$$

where, Xj = total output of jth industry.

Xij = number of units of ith good used as input by the jth industry.

aij = input coefficients.

The input-output table usually can be given as

Input-output Table

output

Input	I	II	III	n	Final demand
I	a_{11}	a_{12}	a_{13}	a_{1n}	d_1
II	a_{21}	a_{22}	a_{23}	a_{2n}	d_2
III	a_{31}	a_{32}	a_{33}	a_{3n}	d_3
.	....	....	....	....	
.	....	....	....	....	
n	a_{n1}	a_{n2}	a_{n3}	a_{nn}	d_n

The above table shows the inter-industry dependence. Each column of this table specifies the input requirement for the production of one unit of a particular commodity. The second column states that to produce a unit of commodity 2 the inputs needed is a_{12} units of commodity,[1] a_{22} units of commodity 2 and so on.[2] Average input-output coefficients are computed by dividing the produced and factor inputs of each industry by its output level. The sum of the column entries for an industry equals the output level of industry, and the column sums of the coefficients equal 1. Therefore the column sums of coefficients for produced will be less than one.[3]

Symbolically, it can be shown as,

$$\sum_{j=1}^{n} aij < 1. \quad (j = 1, 2 \,.....\, n)$$

It follows that the value of primary input required to produce a unit of jth good is given by

$$1 - \sum_{j=1}^{n} aij$$

From the input-output table above we can easily derive the following equation:

$$X_1 = a_{11} x 1 + a_{12} x 2 + a_{13} x 3 \,.....\, + a_{1n} x n + d_1$$

$$X_2 = a_{21} x 1 + a_{22} x 2 + a_{23} x 3 \,.....\, + a_{2n} x n + d_2$$

$$X_3 = a_{31} x 1 + a_{32} x 2 + a_{33} x 3 \,.....\, + a_{3n} x n + d_3$$

....

....

$$X_n = a_{n1} x 1 + a_{n2} x 2 + a_{n3} x 3 + \,.....\, + a_{nn} x n + a_n.$$

The above system of equation can be written in the matrix from as,

$$(I-A)\,X = d \begin{bmatrix} 1 - a_{11} & a_{12} & - a_{13} & ..... & - a_{1n} \\ - a_{21} & 1 - a_{22} & - a_{23} & ..... & - a_{2n} \\ - a_{31} & - a_{32} & 1 - a_{33} & ..... & - a_{3n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ a_{n1} & - a_{n2} & - a_{n3} & ..... & 1- a_{nn} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ . \\ . \\ X_n \end{bmatrix} \begin{bmatrix} d_1 \\ d_2 \\ d_3 \\ . \\ . \\ d_n \end{bmatrix}$$

where, I = identity matrix of order n.

A = input coefficient matrix of order n.

X = unknown variables to be determined.

d = final demand vector.

Now, solving for X we have,

$$Xi = (I - A)^{-1}d.$$

(iv) Underdeveloped Countries and Input-output Model

Most of the UDC's are characterised by many technological and economic problems. Market imperfections in such countries led to the dualistic pattern of the economy. The dualistic pattern of development divides the country into two main sectors. Some of the urban centers of the country are well developed where as the rural sectors are fully guided by the primitive pattern of development. In such economies, the modern as well as traditional method of production are operating side by side. The urban sector of the economy uses the modern method, and in the rural sector the case is reverse. The primitive method of production in UDC's leads to low productivity and income. So, in these economies, the co-existence of technologies have made the complications to develop the system. The inclusion of these features within a meaningful theoretical framework has raised many methodological issue. To sum up the problem most of the developing countries are characterised by rigidities of various kinds, which render the price mechanism ineffective as an allocative device, with the economy being divided into segregated regions having a vast nonmonetized sector and limping price system.[4] The inter connections of various sector in fact has not well developed. The interdependence of various industries can be evaluated either by consumption or through technology. The investment pattern in such economies has made complications to classify the input from the final consumption. Diversifications of the pattern of development have made more obstacles to find out the interdependence of the industries.

As in the calculation of national income the double counting of goods are possible within the system. The input-output model as stated above is the empirical calculation of production activities. So, it is necessary to avoid the possibilities of double counting of goods of each and every sector of an economy. Similarly, in these societies, the more difficult and challenging task is to distinguish final, intermediate and primary goods. Because, "Input-output analysis traces the flow of production in order to study the effects of a change in the demand for final goods on production of primary, intermediate and final goods."

The underdeveloped countries are characterised by such problems. Due to the dualistic pattern of production system, it is one of the vivid complication to distinguish the primary, intermediate and final goods in UDC's. So, it is necessary to distinguish between the primary, intermediate and final goods within the economic system.

In UDC's the economy is segregated into many sectors. These sectors are operated, to some extent, independently. Micro level study is possible in such a society. To transfer the particular sector into aggregation in such societies is a challenging problem. From the above point of view, it becomes more difficult to study empirical the general equilibrium analysis. So, "the practical difficulties of efficient utilization and interpretation of large amounts of detailed qualitative information constituted the principal obstacle in the path of the development of empirical general analysis. The only possible way of overcoming the resulting impass seemed to point toward the detour via aggregative analysis."[5] So, one has to give the detail attention to concentrate the economic system from micro level to macro level. For such works in UDC's, the number of simplifying assumption has to be made in order to get the general equilibrium.

As stated above, the economy of UDC's is fully operated by the dualistic pattern. In these economies, the pace of monetization is low. It will counter the system as a whole. So, due to lack of monetization, it is very difficult to distinguish between the input that is used by industry itself and when sells it as an input to other industries. How much produced has been used to meet the requirement of consumers is another aspect to be faced in such societies. Without the monetary measurement, one cannot forecast the situation as to how much is produced in the economy and where the produced goods are distributed among the industries and consumers and what is the quantity. To solve these questions the economy as a whole should be monetized on one hand and all the input-output used and produced by each sector should be counted in money terms on the other. So, monetization and market perfection of the economy become the primary function for the study of the general empirical equilibrium analysis.

Another major problem in constructing the input-output table of UDC's is the lack of statistical informations. It is very difficult to obtain the sufficient informations about the economic activities in such societies. Due to the dual system of production pattern, different technologies have been used to produce the goods. The large and small scale of production in urban and rural sector of an economy do not provide the clear picture as required by the system. In this situation, it is very difficult to classify the goods that are for final consumption and for the use of final requirement. For instance, it can be said that the collected information will not provide sufficient material to such model. So, one has to develop the new technique and methodology to collect the information in UDC's. The purposewise production information is regarded as the main source of data.

Finally, even though there are so many problems in the path of the construction of input-output table in UDC's, it has become one of the main tool of planning. Many UDC's of the world have been preparing input-output tables to study the production activities within the economy. Now a days, this technique has the main application in the field of production planning. So, in order to formulate the economic planning in UDC's, one can use the input-output table easily.

FOOTNOTES

1. William J. Baumol, Economic Theory and Operations Analysis, Fourth edition, Prentice Hall of India Pvt. Ltd., New Delhi, 1978, p. 538.

2. B.C. Mehta and G.M.K. Madnani, Mathematics for Economists, Sixth edition, Sultan Chand & Sons, New Delhi, 1988, p. 463.

3. James M. Henderson and Richard E. Quandt, Micro Economic Theory, A Mathematical Approach, Second edition, M.C. Graw Hill Kogakush Ltd., Tokyo, 1971, p. 374.

4. R. Bhardwaj, ... "Arth Vijnana", 1969, Vol. XI, No. I, p. 153.

5. Jean Weber, Mathematical Analysis, Business and Economic Applications, J. MC Press Incorporated, Philippines, 1976, p. 614.

6. W.W. Leontief, The Structure of American Economy, 1919-1939, Vora & Company Publishers Private Ltd., 1971, p. 207.

BOOK REVIEW

Fomby, Thomas B., Hill, R. Carter and Johnson, Stanely R. (1984): Advanced Econometric Methods (New York: Springer-Verlag Publisher), price U.S. $ 58, pp. 624 including Appendix, Index and References.

This book, written by three professors representing three universities (Southern Methodist University, University of Georgia, and University of Missouri), is a modern, comprehensive, graduate-level introduction to econometrics, combining thorough technical discussions with informal and intuitive explanations. However, this book is written for those readers who have had an econometric methods course, using texts like J. Johnston's "Econometric Method" or "An Introduction to the theory and practice of Econometrics" by G. Judge, R. Carter Hill, W. Griffiths, H. Lukepohl, and T. Lee.

The book under review is divided into five parts consisting of twenty-five chapters. Part I deals with basic methods and models, such as properties of ordinary and generalised least squares, maximum likelihood estimation, likelihood ratio test procedures, and a discussion of small and large sample hypothesis tests and properties of statistical estimators. Also, results for models with stochastic regressors and models that incorporate a variety of forms of nonsample information are introduced. The final chapter of this part discusses the consequences of model building schemes that use preliminary tests and develops a nontraditional way of combining sample and nonsample information, namely the stein-rules. Stein-rules estimation methods are shown to provide a means of addressing the inferior risk properties obtained from making estimator choice dependent upon the outcomes of tests of hypotheses.

In Part II the authors treat generalised least squares and violations of the assumptions for the basic model of Part I. Seemingly unrelated regressions are used as the framework for developing the associated results on feasible generalized least squares. According to Aitken's Theorem, the use of ordinary least squares in the presence of nonspherical errors causes a loss of estimation efficiency and provides an inappropriate framework for statistical inference. Two basic characterizations of nonspherical disturbances are heteroscedasticity and autocorrelation. Estimation and tests of hypotheses for errors with these properties are the subjects of Part II. Another violation of the classical linear regression model is that of contemporaneous correlation between the error term and the explanatory variable, which makes the OLS estimators inconsistent and inefficient. Two occasions where the contemporaneous correlation condition arises are when coefficients must be estimated in the lagged dependent variable - serial correlation model and in the unobservable variables models. Consistent and efficient methods of estimation for those models are presented in the last two chapters of Part II.

Part III of the book under review introduces a set of special econometric topics: Multicolinearity, varying and random coefficient models, pooling time-series and cross-sectional data models, models with qualitatives and limited dependent variables (Probit and Logit Models and Censored dependent variable models) distributed lags, and a chapter on model selection and specification (including classical specification analysis, specification error tests, nested and nonnested models, and choice of functional form by Box-Cox transformation and generalised likelihood ratio method).

In Part IV, the authors treat simultaneous equation models. After an introductory chapter follows a discussion of identification, limited and full information estimation, estimation of the reduced form, forecasting, and dynamic properties of simultaneous equations models. Sufficient conditions for the stability of a dynamic simultaneous equations model are described and a test for stability is presented. A discussion of standard errors of simulation forecasts and the technique of optimal control concludes this part.

Part V of the book is titled "Frontiers" and is very useful for those who want to explore the current frontiers of theoretical and applied econometrics. The topic selected illustrate extensions of simultaneous equation models. These subjects are: Simultaneous Equations Tobit Model; Simultaneous Equations generalized Probit Model; Disequilibrium Econometric Models, Vector Antoregressive Error Processes in Simultaneous Equations Models, Rational Expectations in Econometric Models, and Updating Econometric Models.

At the end of the book is an Appendix on nonlinear models. It is to be noted that estimation in nonlinear models is complicated by the fact that whether one adopts the least squares or maximum likelihood principle, the first order conditions of the maximization or minimization problem usually cannot be easily solved analytically. Hence iterative numerical techniques are required. Included in the Appendix among others are, Methods of Newton-Raphson, and Method of Scoring.

From the above discussion it is clear that the book under review is somewhat at an advanced level. But it is gradually gaining popularity among econometricians in the USA and should be included in the collections of books by those who wish to make a career in econometrics, and by those who wish to apply econometric methods in their analyses without falling into many pitfalls of obtaining apparently impressive results which are in fact the consequences of inconsistent and inefficient models and estimators.

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