Multisector Models for Planning

A Rudra

It is paradoxical that the development of refined econometric techniques applicable to planning has gone farther in countries which have not accepted the philosophy of planning while there have been few theoretical contributions to the techniques of planning from countries which have adopted planning.

As a result, the development of theory in one part of the world has suffered from being detached from practical application while the tremendous wealth of experience of practical planning acquired in the other part of the world has not enriched theoretical knowledge.

Linear programming used in multisectoral growth models can have practical application to planning only in an economy which is totally planned; yet the development of the techniques of programming as well as of growth models have taken place in countries which either do not have any planning at all or have, at most, some applications of partial planning. This is true even though it is to a Soviet academician that the credit goes for first stating the programming problem in its purely mathematical form.

Indian planning has not benefited much till now from any application of econometric techniques. This raises the question: To what extent do we really have econometric techniques and methods that can usefully be applied to planning but which have been neglected?

[The views expressed here are those of the author and do not in any way, involve the Indian Statistical Institute of which he is an employee. This requires to be emphasised as the two books under review are publications of the Institute.]

IT is a well known fact that our Planning Commission has, during the last five or six years, received technical advice from a large number of experts in the fields of econometrics and model building having from many of the notable universities of the West. Indian universities and institutions have had the privilege of playing host to practically all the leading names of this particular world. Many of them have come here not on brief lecture tours, but have spent several months and worked hard. Despite all this, it cannot be said that the Third Five Year Plan has been prepared in a way fundamentally different from the First Five Year Plan. Are we to lay the blame for this state of affairs only on the insularity of our planners or are there also lacunae in the models and methods that render them inapplicable in actual planning? Rather than attempt a straight forward review of the two publications, it may be more useful to look at them from this particular angle. (In any case, at least insofar as Professor Frisch's work is concerned, it would be somewhat pointless as well as improper to review it as late as this considering that the publication presents only an early fragment of a line of thinking that he has been developing almost continuously during the last six or seven years.)

Utility of Multisector Models

It should, however, be clearly understood at the very outset that it is not the opinion of the reviewer that multisector programming models cannot be of service in the preparation of a plan; he is firmly convinced that they can be. It is, however, his contention that if multisector models have not as yet been used in planning in India, it is to a large extent due to the complexities of the task. A model by its very nature and purpose makes an abstraction of the reality and simplifies the problem. The loss of details is more than compensated by the greater clarity and a more effective tackling of the problem which it permits. But there is a certain point in simplification beyond which a problem ceases altogether to be the same, so that a course of action based on such an over-simplified model will yield a result that is not merely less satisfactory but one that is altogether unsatisfactory. No multisector model has as yet been formulated in India that does not base itself on a degree of simplification lying on the wrong side of this crucial point.

Frisch considers a 22 sector model where the sectors are divided into four broad groups: primary products, large scale manufactures, small scale manufactures, and 'construction, trade transport and services'. He considers two problems differing by the time horizons encompassed, a Coming Year problem relevant to annual planning and an Asymptotic Problem relevant to perspective planning. Sandee deals with only 13 material production sectors and considers a single time horizon, namely ten years.

Assumption of Constant Coefficient

Frisch makes the usual Leontief assumption about the output of a sector being related to an input into the sector by a constant coefficient for all the sectors. This assumption presumes (i) constant technology, (ii) constant industry composition and (iii) constant work organisation and the usual objection raised against it is that such constancies are incompatible with the very idea of development. This objection is generally valid about any sector in any economy, but when it concerns some of the more unorganised sectors of an underdeveloped economy, the assumption amounts to one of those cases of
India gives Technical Know-how...

We have a proud record of leadership in the Light Engineering field.

We are pioneers and the largest exporters of light engineering goods in the country. Usha Sewing Machines and Fans are exported to about 50 countries. Last year we earned valuable foreign exchange amounting to over a crore.

And now we are giving Technical Know-how to other countries. Shortly a group of Usha Engineers and Technicians will be heading for Saigon and Colombo to help them in starting Usha Sewing Machine Assembly Plants.

We look to the future with confidence and in a spirit of dedication to serve the country well.
over-simplification which render an entire analysis quite useless. Of course, on a purely formal plane there is not and cannot be any difference between one sector and another. But for the more organised sectors and especially for of manufacturing industries, it may not be too unrealistic to assume that changes in technology, composition, working method and organisation take place only slowly so that one can expect the use of coefficients estimated on the basis of present data to give results that would be approximations of the true results. In the case of the unorganised industries, however, any assumption of stability of the coefficients is hazardous in an additional way. They are subject, even within a relatively short period of time, to very unsystematic and large fluctuations reflecting the shifting character of technology (understood in the narrow and special sense of the sector of input coefficients for a particular industry) composition and organisation in such a sector.

The point may be illustrated by the agriculture sector. The Leontief assumption of constant coefficients here would imply constant proportions between the input items in agriculture, e.g. seed, chemical fertilisers organic manures irrigation water, etc. These proportions observed during any period are purely functions of that particular period and are liable to quick and erratic changes. This gives rise to difficulties of estimation. Estimates based on the input-output table of any one year will be merely fortuitous; which particular proportions are to be adopted as representing present technology?

Additivity Assumption

The modification introduced by Sandee in his model is a definite improvement. He removes the assumption of constant coefficients as far as agriculture is concerned, treats the inputs into agriculture as independent variables, introduces fresh coefficients that measure increase in production in agriculture due to unit quantity of each type of input and treats these effects of the different inputs in an additive fashion. One will recognise that this is nothing but the “yardstick” technique used by the Planning Commission.

The additivity assumption is in itself a highly questionable one, but Sandee is right in deciding that it is preferable to the assumption of constant coefficients.

Frisch extends his table consisting of 22 rows and columns by 4 rows and 4 columns to achieve a symmetry in the sense of each row total equaling each column total. It is not quite clear why he insists on this formal symmetry, for he introduces one row for factor income and another for gross savings and correspondingly one column for household current outlays including savings and another for investment; he then introduces special symbols to denote addition over rows and columns leaving out the savings row and investment column. Frisch applies the principle of constant coefficients to all the columns and for all the cells, excepting the column for investment. That is to say the break-downs of household outlay, export, and Government outlay are each conceived in terms of rigid proportions; import, tax incidence, savings and factor income for each sector are also rigidly related to the output of each sector. Sandee's model is free of such rigidities; he only subjects the individual cell entries in the household outlay, export and stock building columns to upper am) lower bounds.

On the other hand, Sandee's model does violence to reality by completely leaving out of account all the non-material production sector and the Government sector. This introduces serious errors in all the balance equations (for the non-material production sectors are connected with the material production sectors by input-output relations) and neglects entirely the problem of relating individual targets with overall macro-economic measures and balances. Thus the problem of achieving balance between income, consumption and savings, between Government outlay and tax receipts, and bringing these balances to bear upon the individual targets is completely by-passed.

Breakdown of Capital Formation

The treatment of the breakdown of capital formation in the plan period presents a serious logical difficulty in the use of any multi-sector model for overall planning purposes; it is a difficulty that cannot be quite surmounted and can at best be evaded with varying degrees of success. The current period's output in the different sectors does not have any logical relation either with capital formation taking place in the sector during the same period, or with the part of output of the sector going to capital formation (on account of the time lag of maturity of investment). A logical relation exists between the flow of output of a period with the average stock of capital during the same period; that is to say, between the output of the current period and the investments of the preceding periods. The capital formation of the current period therefore is logically related only with the outputs of future years. No extension of the time horizon can quite eliminate the problem, for there will always be a future.

Frisch in his Coming Year problem connects the entries in the investment column (representing flow of goods from the different sectors to capital formation) to investment in the different sectors with the help of a matrix of coefficients representing the component breakdown of investment in each sector. There is an unwarranted rigidity in the assumption of constant coefficients here, for it implies investment in a sector to have a given component breakdown holding separately for every individual time period. The investments in the different sectors are, however, not linked to the output through the intermediary of any capital output ratios. As a matter of fact investments in the different sectors are the base variables in his model.

In the Asymptotic Problem, Frisch introduces variable time lags of investment for the different sectors but eliminates all complications and does away with (rather than solves!) all difficulties presented by the column for capital formation. He gives the problem a time setting where the economy has reached what he calls an "asymptotic condition" of strict proportionality between all the measures of the economy, where the passage of time changes each quantitative aspect of the economy in the same direction and by the same proportion. With this extremely simplifying assumption, Frisch can collapse a multiple
period problem into a single period one. The results cannot but be of doubtful practical value. Probably no economy in the world is any where near reaching the "asympto tic condition"; but insofar as an underdeveloped economy like ours is concerned, the reality is so far from the assumption that once again, results derived from it cannot, but be bereft of all utility. Sandee also avoids the problem but does so in a way that is more acceptable. He first works out an equ ation connecting the expansion of production in each sector to capital formation in the sector (with three breakdowns) and then relates to it the final year's investment in the sector by assuming that investment in each sector increases during the ten year period along a straight line path.

**Consumption and Investment**

Sandee uses aggregate material consumption as the preference function. He claims that "due to the peculiar structure of the model, this simple target is wider than it seems. As investment and welfare (in the sense of consumption) go together maximising one means maximising the other". It is not clear in what sense the statement is to be taken. It is one thing to say that the results obtained by maximising consumption and maximising income would approach each other asymptotically as the time horizon is extended indefinitely. But that is not what Sandee says and his statement as it stands is incorrect and somewhat misleading. Maximisation of consumption would also maximise investment only if the two are functionally related, an assumption which Sandee does not make. Maximisation of consumption would, of course, maximise investment in the consumer goods industries (given constant technology) in the intervening years, and therefore in the final year (thanks to his assumption of linear growth of investment). It would not maximise investment in the investment goods industries, and therefore not over all investment.

However, it is better to use a simple macro-economic measure like aggregate consumption as the preference function, than construct functions of more than one variable with subjective assignment of weights as Frisch does. This has always appeared to the reviewer as the weakest point in Frisch's method. Frisch considers a linear function of three variables, $$u$$, millions of new jobs created annually, $$v$$, annual rate of investment; and we net annual increase in India's net foreign assets. The following quotations from Frisch's text illustrate the type of arguments used to decide upon the numerical values of the weights he attaches to them: "Since 2.5 million annually would be a satisfactory achievement in $$u$$ and 10 per cent a satisfactory achievement in $$v$$, one may say that a given increase in 0.25 would be considered roughly equivalent to an equally large increase in $$v$".

"My guess is that the co-efficient of equivalence is somewhere in the neighbourhood of 1.3. That is to say, one would be equally satisfied with a progress report telling of a million ton steel plant built entirely by Indian means and a progress report telling of a 1.3 million ton steel plant built entirely by means of foreign loans, everything else being the same."

**Subjective Judgment**

With due respect to Prof Frisch, the reviewer cannot but express his doubt whether the introduction of this type of purely personal and subjective judgment does not knock the very bottom out of the objectivity and rationality which is supposed to be the strong points of the programming approach. After all, every point within the solution space would give a satisfactory plan in the sense of meeting all the balance and boundary condition. The next step of searching for the "optimal plan" can be of interest only if the criterion of optimality is objective in the sense of being something that could generally be accepted as one (though not the only one) measure of satisfaction of the performance of the economy. Opinions may differ as to whether the greatest importance should be given to employment, or standard of living or the rate of growth of the economy or the acquisition of foreign exchange reserves, but each of them could form the basis of an optimality. If however an attempt is made to combine all of them in a single function with the help of weights, the "optimum" would become a function of purely personal judgment and preferences and cease to be meaningful. Apart from that, if personal judgments have to be entertained it is not clear why and on what basis they should be limited to only a few of the measures. There is scope for personal subjective judgment in relation to most of the more important plan targets and such judgment does indeed play an important role in a plan as it is now prepared by the Planning Commission. One would have thought that the programming approach is adopted to avoid such personal subjective judgments.

The shortcomings pointed out in Frisco's model are such that by themselves they make it quite unsuitable for direct application in India. Sandee's model must be admitted to be more amenable to adaptation. It fails not by having too many untenable assumptions and unacceptable rigidities but by being rather incomplete. A planning model to be accepted for practical application cannot afford to have as many gaps as it contains. Sandee is remarkably fresh and imaginative in the way he treats inputs into agriculture and in the way he avoids capital-output ratios in agriculture and introduces a variable standing for Extension works.

This, however, is not enough: much more care has to be taken of the agriculture, sector before any model can be accepted for application to Indian planning. It seems that a satisfactory solution will only be had if agriculture is related to investment and the various inputs through empirical curves drawn on the basis of actual projects of various types for extending irrigation, fertiliser input and other Extension services.

Only a concluding remark need be made about the difficulties that would be faced by the planners in making use of such models. The state of our economic statistics is such that most of the coefficients needed in the use of such models cannot be calculated with any accuracy; but that need not be stressed at a time when we are discussing the inadequacies of the models; for that at least the model builders cannot be held responsible.
IFCO-HERMIC
Oil Fired Salt Bath Furnaces

MODELS OCP 4 & OCP 8A

These furnaces are General Purpose Heat-treatment Equipments. Pot sizes being 12" dia. x 18" deep and 15" dia. x 18" deep (304.8 mms. x 457.2 mms. and 381.0 mms. x 457.2 mms.) respectively. Temperature range between 600 to 950 deg. C. Normal temperature, 920 deg. C.

MODEL OCP 8A

This furnace is a General Purpose H.T. equipment, pot size 18" dia. x 24" deep (457.2 mms. x 609.6 mms.) Temperature range between 600 to 950 deg. C. Normal temperature 920 deg. C.

Ideally suited for:

- Cyaniding
- Liquid carbonising
- Hardening in neutral salts

Quick delivery! No import licence required.

Indian Furnace Co. Pvt. Ltd.

(Formerly Indian Vidal-Barfield Co. Pvt. Ltd.)
Phone: 74687, Gram: "ELECFURN"
Calcutta office: "NARAYANI", 27/29, Irbourne Road, Calcutta-1 Phone: 22-2441.
People from every walk of life need and use

MAFATLAL products

SHORROCK
AHMEDABAD

NEW SHORROCK
NADIAD

SURAT COTTON
SURAT

STANDARD
BOMBAY

GAGALBHAI JUTE
CALCUTTA

NEW CHINA
BOMBAY

MAFATLAL FINE
NAVSARI

SASSOON & NEW UNION
BOMBAY

INDIAN DYESTUFF
BOMBAY