UNITED ARAB REPUBLIC

THE INSTITUTE OF NATIONAL PLANNING

Memo. No. 436

RESEARCH ON LARGE MATHEMATICAL SYSTEMS FOR ECONOMIC PLANNING OF THE UNITED ARABIC REPUCLIC

by

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May 18, 1964

T.K/A.A.
17.5.1964

Research on Large Mathematical Systems for Economic Planning of the United Arab Republic

Three themes seem to be of immediate importance for the elaboration of an efficient economic planning system for the UAR and the Arab League, which would make use of the most recent results known on the solution of large mathematical programming problems, viz.:

i) a large short run model of foreign trade and production;
ii) a large short run model of international cooperation;
iii) a large dynamic model for the five year plan including foreign trade and international cooperation.

The greatest interest lies, in principle, with the later scheduled theoretically more developed models embracing cooperation between several states and investment planning. As, however, the training of economic planners in various ministries in mathematical planning techniques has to be further developed without unnecessary delay, it seems, that it should be useful to start practical experiments on the first model for which a theoretical framework has already been elaborated at the Operations Research Center, cf. UAR Institute of National Planning, Memo. No.397, Tom Kronsjo, Iterative Price and Quantity Determination for Short-Run Production and Foreign Trade Planning, Cairo, 10 February 1964, 56 pp.

1. A large short-run model of foreign trade and production

The aim of this model is to permit the optimal solution of a very large production and foreign trade system. It attempts to do this by considering the equational structure of the system. The foreign trade part has a specially favourable structure from the point of view of computation, and the

production system may probably fairly well be described as system of blocks. Special computational methods are developed for the computer solution of such a system.

The main economic assumptions of the model are that

i) the balance of payment requirements have directly or indirectly to be taken into account, when decision concerning foreign trade or production have to be made;

ii) a substantial part of the trade is carried out in incompletely convertible currencies (e.g. in rubles, zloties, or in the currencies of other developing countries) and in which (currency blocks) the ratios of obtained or paid prices on various commodities may be different;

iii) upper bounds are usually existent upon the maximal amount that could be sold (or bought) of a particular commodity in a particular foreign market;

iv) available quantities of exports or required quantities of imports have to be allocated to or procured from the various foreign markets in an optimal way;

v) in every branch of production there may exist alternative methods of production or choice between production of different commodities requiring for instance various structure of imports;

vi) a preference function has been formulated specifying that we may be especially interested in maximizing the imports of certain investment commodities or in achieving balance of payment surpluses in certain currencies.

The data which have to be obtained are:

i) the required net balance of payments with the various currency blocks;

ii) the marginal revenue or outlay (price) from exporting or importing some quantity of a commodity in various foreign markets;

iii) the amount which can be sold or bought at this particular marginal revenue or outlay;

iv) the available amount of an export commodity or the the required amount of an import one, or the amounts which can be produced or used at varying marginal costs or revenues, or the technological interrelationships determining the production or utilisation possibilities of various commodities;

v) the structure of investment commodities or of foreign currency surpluses that should be optimized.

Some difficulties may be expected in precising the price and quantity concepts as they may be of a stochastic nature. If this will turn out to be very essential, part of the model may have to be reformulated on a probabilistic basis, as was begun in Tom Kronsjö, Optimization of Foreign Trade Policy for a Planned Economy by Mathematical Programmes, University of Oslo, 1961. Further developments have, however, to be made in these models to permit the consideration of fairly large systems.

Partly based upon the deterministic theoretical framework of the last mentioned work, investigations using real data have recently been completed in the German Democratic Republic under the leadership of Mr. Gerhard Grote, Ministry of Foreign Trade, and Dr. G. Otto, Hochschule fur Ökonomie, Berlin.

The general results were presented in the following table quoted from G. Otto, Probleme der linearen Optimierung in der Aussenhandelspraxis, Der Aussenhandel, Berlin, No. 3, 1964, pp. 20-23:

Improvement of the Planproposition (a feasible basis solution) of the Foreign Trade Enterprise in percent

Foreign Trade Enterprise	In all	Clearing currencies	Convertible currencies
A	0.9	-0.8	+ 17.9
B	2.25	-6.83	+ 15.73
C	0.3	+0	+ 0.4

In judging these results, it has to be beared in mind that i) each model embraced only a small number of commodities; ii) only export commodities were considered, so that favourable relationships between export and import prices could not be utilized; iii) the Foreign Trade Enterprises had been asked to provide their best possible basis solution.

The suggested analysis in no way pretends to replace traditional methods of estimating trade volumes and prices, using information about own and foreign economic fluctuations. Such research is necessary in order to obtain the price and quantity information needed for the model.

The price solution (dual) of these mathematical programmes will probably turn out to be of special importance for the authorities concerned with the elaboration of a rational system of internal prices. As the analysis is based upon probably fairly realistic information of what particular commodities may be bought or sold in the foreign markets and at what prices, the shadow prices which occur will much better than usually, describe the social cost of these commodities.

The importance of being able to elaborate fairly detailed short and long term economic plans together with the encouraging experiences already made abroad seem to stress the importance of practical investigations into the suitability of these planning tools for the UAR with special reference to :

i) economic assumptions;
ii) organisation necessary for obtaining data and revising the model;
iii) the speed of convergence of the computational method;
iv) the possibilities of solving this and similar large mathematical programming systems on the IBM 1620 Computer available at the Operations Research Center.

As earlier mentioned it would also serve as a preliminary training project for various groups in anticipation of a large five year plan model including foreign trade and international cooperation scheduled to be developed by the Operations Research Center.

In order to rapidly proceed to further theoretical development and practical application, it seems suitable to have four kinds of working groups, viz.:

i) a policy group devoted to consideration of general theoretic problems and to the problem of which sectors of the economy should be incorporated in the first studies using real data. In this small working group would be Dr. Salah Hamid, Dr. Salib Roufail and Mr. Tom Kronsjö.

ii) various sectorial data groups for the selection, collection and organisation of practical data. An experience in attempting to apply these methods in the German Democratic Republic is that the practical implementation seems to be swifter if collaborators of various ministries, foreign trade enterprises, big export industries and foreign market research institutes are at an early stage connected with this research work. In this group would be Drs. Said Hafez, Maurice Makramala together with collaborators from outside the Operations Research Center;

iii) a small internal price system group, whose main duty will be to study the applicability of this methodology for the practical realization of a rational internal price system for the UAR.

iv) a computer programming group which has to devote itself to the problem of a computer programme for solving large mathematical programming problems with the aid of a fairly small computer. The flow charts and detailed

Decomposition developed by Pierre Huard and P.Broise together with the brief account of Daniel Pigot on the programming of the Dual decomposition method on IBM 650 may be of immediate interest as well as the ALGOL programmes for Foreign Trade Allocation elaborated by Tom Kronsjö and which will be used by the Polish and East German Ministries of Foreign Trade. Of importance for the efficient solution of this and related large mathematical programming problems is to route the iterations so that a minimum of computational effort is required. This is especially important when the computations have to be done on a fairly small computer. The conclusions gained will probably prove of considerable importance for the efficient formulation of a very large five year plan model including foreign trade and international cooperation. To our knowledge this problem has not been mathematically analysed. Mrs. Lidija Kronsjö has declared herself interested in studying possible ways of its solution. The computational group would consist of Mrs. Mary Naguib Youssef, Mr.Roushdy Amer and Mrs. Lidija Kronsjö.

2. A short run model of international cooperation

Of great political interest seems to be the formulation of a mathematical programming system for the consideration of the short run foreign trade and production activities of a cooperating group of states. The elaboration of a preliminary model for this purpose will be the responsibility of Mr. Tom Kronsjö and it is expected that it will be ready before the 15th of June 1964. After that a new phase of theoretic, practical and computational inquiry on the possibilities of applying such a more general model to the Arab League could commence.

3. A large dynamic model for the five year plan including foreign trade and international cooperation.

The problem of probably the greatest importance is to

enable a synthesis of the preceeding two models and of Professor Ragnar Frisch's Five Year Plan Model. The aim would be to devise a system which included all earlier elements, but permitted their consideration as a very large and, if required, very detailed planning system. A preliminary study of this problem will be a responsibility of Mr. Tom Kronsjö in the time period up to 1st September 1964. Important tasks would thereafter be to move away from the linear and deterministic framework to a more general planning system.

In order to acquaint the research groups with these mathematical programming methods and to discuss their possible improvements a series of seminars and lectures is scheduled to be held beginning from the 24th May 1964.

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