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SMEE 1: A SIMULATION MODEL OF THE EGYPTIAN ECONOMY WITH SPECIAL EMPHASIS ON ECONOMIC-DEMOGRAPHIC INTERACTIONS

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* The labour required for producing this paper was divided between the two authors as follows: El-Issawy was in charge of elaborating the theoretical framework, data preparation, parameter estimation, and designing the empirical work on model validation and policy simulation. El-Shafei was in charge of computer programming and execution of the simulation runs. The preparation of this document was the special responsibility of I. El-Issawy.

Contents

I. INTRODUCTION

1.1. Background and Objectives. 1
1.2. Methodology: Simulation. 3

II. THE MODEL

2.1. Sectoral Breakdown. 8
2.2. Components of SMEE1. 10
2.3. Variables and Parameters. 11
2.4. The Equations. 27
2.5. Model Mechanism and Interactions. 56

III. MODEL VALIDATION

3.1. Simplifying the Model. 64
3.2. Data Collection and Parameter Estimation. 65
3.3. Criteria of Model Validity. 73
3.4. Model Performance. 79

IV. POLICY EXPERIMENTS

4.1. The Development Alternatives. 91
4.2. Impact of Reduced Rates of Population Growth. 98
4.3. Consequences of Alternative Development Strategies. 100
4.4. Impact of Terminating the War Situation. 103
4.5. Policy Implications. 105

V. FURTHER WORK

5.1. Data Problems. 107
5.2. Model Structure. 108
5.3. Simulation "Technology". 113

Appendices

1. Sources of Data Used in this Research. 1
2. Projections for the Validation Period 1969/70-1975. 5
3. Projections for the Period 1976-1985. 17

I

INTRODUCTION

1.1 Background and Objectives:

The Food and Agriculture Organization of the United Nations(FAO) has embarked on a series of methodological studies, under the auspicies of the United Nations Fund for Population Activities(UNFPA), focussing on the interactions between population, employment and productivity with special emphasis on the agricultural sector in a multisectoral, long-term perspective study. A major objective of these studies is to assist underdeveloped countries in integrating more fully the population component and agricultural development programs into their development planning. Given this objective, the Policy Analysis Division of FAO has developed a simulation model, henceforth referred to as the Martos Model, under certain specific assumptions[1]. The model is essentially a prototype and its application in specific country case studies may therefore require a certain

1) Bela Martos, Long-term Employment Simulation Model, First Report, The Model, FAO long-term Employment Simulation Project PA 4/1 INT/73/P02 Working Paper Series No. 1, Rome: Policy Analysis Division, FAO, May 1974.

amount of adaptation and modification. It has been used in two experimental studies: one for Egypt[1], the other for Pakistan[2].

Given this background, and following a number of previous studies which were sponsored by FAO and carried out at the Institute of National Planning(INP), Cairo,[3] it appeared appropriate to choose Egypt for further adaptation and testing of the Martos Model. This document describes the modified version of the Martos model and presents the results of its use in an experimental study based on available data on the Egyptian economy[4]. The modifications were aimed at enabling the model to depict more accurately the

1) Wuu-Long Lin and M.C. Ottaviani-Carra, A systems Simulation Approach to integrated Population and Economic planning, FAO long-term Employment Simulation Project PA 4/1 INT/73/P62 Working Paper Series No. 7, Rome: Policy Analysis Division, FAO, Aug. 1975.

2) A Systems Simulation Approach to Integrated Population and Economic Planning with Special Emphasis on Agricultural Development and Employment: An Experiemental Study of Pakistan, FAO/Pakistan Project on System Simulation Approach to Economic-Demogrophic Interaction, PA 4/1 INT/73/P02 Working Paper Series No. 11, Rome: Policy Analysis Division, FAO, March 1976.

3) See, for instance: INP, "Population, Employment and Productivity in Egyptian Agriculture, A Final Report on the FAO/INP research Project, Cairo, INP, Dec. 1974, and Perspective Study of Agricultural Development for the Arab Republic of Egypt, Central Policy Paper, ESP/P/73/2/CPS, FAO, Rome, 1973.

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specific features of the Egyptian economy, and to incorporate those policy choices which appear more relavant to the Egyptian situation. The general objective of the model is to provide planners and policy-makers with an effective tool for evaluating the economic-demographic implications of alternative development strategies. The model does not lead to an optimum solution, nor does it provide the policy-maker with an elaborate program of action. It is simply intended to serve as a useful basis or starting point for discussing relevant policy issues and exploring the consequences of alternative long-term policy options. The results of experimenting with a number of policy-packages should greatly facilitate the task of identifying a development strategy for the future.

1.2 Methodology:Simulation.

A systems simulation approach is adopted in this study for describing and analysing the system of econo-

4) Unfortinately, but for goods reasons to be given later, the experiments were confined to a simplified version of the model which did not fully consider the issue of economic-demographic interaction.

mic-demographic interactions in preference to an econometric or mathematical programming approach, for several reasons. <u>First</u>, Systems Simulation has a remarkable capacity in modelling processes involving recursive and feedback effects, which dominate the dynamic interactions between economic and demographic factors. <u>Second</u>, systems simulation affords considerable flexibility in model building, with the possibility of decomposing complex functional relationships into simple and hence more manageable components, on the one hand, and experimenting with various options relating to the inclusion or exclusion of certain variables and equations, or replacing them with others as the simulation experiments may suggest., on the other hand. <u>Third</u> given the recursive nature of the equations and the possibility of simplifying complex relationships, the task of estimating the parameters of the model is greatly simplified. Some parameters may be estimated by applying ordinary least squares to each equation when relevant data are available, others may be calibrated by means of sensitivity analysis when data are lacking or poor. Fourth, the systems simulation approach is particularly useful in testing alternative policy-packages corresponding to different sets of targets. This is especially important from the viewpoint of long-term planning, since what really interests the planner or the policy maker is an exploration of his area of options and the probable consequences of different combinations or sequences of policies, rather than a unique or optimum solution.

In short, systems simulation involves relaxation or elimination of many of the strict assumptions and constraints underlying the econometric or mathematical programming models, minimizes the data requirements and estimational problems characteristic of those models, and satisfies more adequately the needs of the planner or policy maker in the area of long-term planning.[1] All this is on the positive side. However,

[1] For instance, typical simultaneous equations problems of econometric models(e.g. identification, estimation,etc) are avoided. Lagged values of the endogenous variables are generated by the simulation model itself, whereas they are the actual observed or predetermined values in econometric models. A long time series is normally required for econometric estimation of the parameters, =

to be fair, mention should also be made of some negative aspects of the systems simulation approach. Simulation experiments consume a lot of time and a great deal of effort. Calibrating the unknown parameters and model validation may require a great deal of trial and error, patience, persistence and ingenuity. The task of arriving at realistic values of the parameters is made extremely difficult when the range of initial guesses is wide, on the one hand, and when too many unknown parameters appear in the same equation, on the other. The task of model validation is also made difficult by the fact that the reliability of the separate components of the model provides no

= whereas a short one may suffice for calibrating the unknown parameters in a simultation model. A complete input-output table is essential in mathematical programming models, whereas knowledge of a few cells may be sufficient in a simulation model such as the one used in this study. The treatement of multiple objectives is much easier in simulation models than in mathematical programming ones. Finally, neither the unique solution of an econometric model nor the optimal solution of a programming model is of great relevance to long-term planning. See: Wuu-Long Lin and M.C. Ottaviani-Carra, "A systems Simulation Approach ..." for an interesting, though brief, discussion on the justification of the methodology of Systems Simulation(Section II). For a detailed discussion see: T.N. Naylor, J.S. Balintfy, D.S. Burdick andkong Chu, Computer Simulation Techniques, John Wiley, New York, 1966, PP. 4-9.

guarantee of the reliability of the model as a whole. Finally, great care is required in indentifying a reasonable number of alternative policy variable combinations or policy packages. Meaningful selection should be guided by intuition, past experience and experince gained from previous simulation experiments. Otherwise, the number of possible alternatives may be too large requiring an enermous number of runs which wastes too much time and effort and causes a great deal of confusion.

II

THE MODEL

The purpose of this section is to describe, formally as well as informally(verbally) the modified version of the Martos model which we shall call SMEE 1: a Simulation Model of the Egyptian Economy-version 1.

2.1 Sectoral Breakdown

The following 11 production sectors are distinguished in SMEE 1:

i) Agriculture(AGR)

1. Old-land, food sector(OF)
2. Old-land, non-food sector(O$\bar{F}$)
3. New-land, food sector(NF)
4. New-land, non-food sector(N$\bar{F}$)

ii) Industry(IND)

5. Capital goods sector(CA)
6. Intermediate goods sector(IN)
7. Consumer goods sector(CG)

iii) Construction(CN)

8. Construction sector(CN)

iv) Services(SER)

9. Education sector(ED)

10. Health sector(HL)

11. Other services(OG)

sector totals and subtotals are calculated according to the following definitions:

1. Old-land agriculture: $O = OF + O\bar{F}$
2. New-land agriculture: $N = NF + N\bar{F}$
3. Food sectors : $F = OF + NF$
4. Non-food sectors : $\bar{F} = O\bar{F} + N\bar{F}$
5. Agriculture : $AG = O + N = F + \bar{F}$
6. Industry : IND=CA+ IN+ CG
7. Services : SER=ED+ HL+ OG
8. Economy : EC =AG+ IND+ CN+ SER.

In comparing this sectoral breakdown with that of the Ministry of Planning, the following points should be borne in mind: AGR corresponds to the total of agriculture, irrigation and drainage. IND corresponds to the total of industry, mining, petroleum and electricity. SER corresponds to the total of distribution and service sectors which include transportation and communications, suez-canal, commerce and finance, housing, public utilities, and other services.

2.2 Components of SMEE 1

SMEE 1 consists of six submodels, with each submodel further divided into a number of sections. The submodels and their sections are the following:

Submodel 1: Agriculture

- Land input : AGR 1
- Labour input : AGR 2
- Capital stock : AGR 3
- Production : AGR 4

Submodel 2: Industry and Construction

- Labour input : IND 1
- Capital stock : IND 2
- Production : IND 3

Submodel 3: Services

- Production : SER 1
- Employment : SER 2

Submodel 4: National Economy

Domestic product and income distribution: ECN 1
Consumption : ECN 2
Investment and saving : ECN 3
Foreign transactions : ECN 4

Submodel 5: Labour Market

Labour supply : LAB 1
Employment and unemployment : LAB 2
Labour productivity : LAB 3

Submodel 6: Population

Education : POP 1
Population profile : POP 2
Births and survival : POP 3
Migration : POP 4

2.3. Variables and Parameters:

Notational System.

A variable is generally denoted by 3 sets of characters*. The first set consists of 3 characters which refer to the name of the variable. The second set usually consists of 2 characters which specify

* This paragraph applies also to the parameters of the model, since they may change from one time period to another and hence may be regarded as variables.