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A USER'S GUIDE TO ECONOMY-WIDE MODELLING OF EXTERNAL ASSISTANCE EFFECTS, RESOURCE ALLOCATION AND GROWTH (WITH DEMONSTRATION OF A PROTOTYPE MODEL FOR EGYPT)

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Jeffrey B. Nugent
Charles S. Williams
Modelling Research Group
University of Southern California

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I. INTRODUCTION AND OVERVIEW

This User's Guide describes the economic and mathematical formulation of the economy-wide modelling package. The package allows the user to solve for economic equilibrium states in an economy whose characteristics are specified by the user. The user specifies the economic characteristics of the factors of production and sectors of output. The user supplies the package with a databank containing values for exogenous variables, values for predetermined variables used as initial conditions in generating solutions for the endogenous variables, and values for parameters such as the sector-specific elasticities of substitution. The user then chooses whether he (she) wants the solution to be found using general equilibrium iterations or via linear programming. As the model obtains its solutions, its results are placed in the databank where the user can select what and how the results are to be displayed.

The package further allows the user to solve sequentially for equilibrium solutions for each of several consecutive periods, the duration of each period determined by the user. Separate databanks are used for each time period. Each contains, in addition to the values of exogenous and predetermined variables from the previous period, the exogenous variables whose values have to be updated by the user.

A list of the available commands appears as follows:

1M1
10%

[illegible]

IT IS [illegible] ON [illegible]
ENTER [illegible] FOR A LIST OF THE MODELLING COMMANDS.
READY
COMMAND

ECONOMY-WIDE MODELLING COMMANDS:

EX MODELLER	START A MODELLING SESSION
EX MODELLER	RECONNECT TO A MODELLING SESSION ON THE SAME DAY [Snie Mme]

COMMANDS TO CREATE AND CONDUCT EXPERIMENTS WITH A MODEL:

ENTER:	TO:
ADDNAME	ADD NAMES OF DATA ENTERED IN A DATABANK
MODEL	1. SPECIFY ECONOMIC CHARACTERISTICS OF A NEW MODEL 2. SPECIFY DATABANK TO BE USED 3. SPECIFY TYPE OF ESTIMATION GEM OR GR
REPORT	SPECIFY TYPE AND LEVEL OF REPORTING OF MODEL RESULTS
UPDATE	UPDATE ENDOGENOUS VARIABLES FOR INTER-TEMPORAL SIMULATION

COMMANDS TO OBTAIN DOCUMENTATION:

ENTER:	TO FIND OUT ABOUT:
DOCUMENT BENCH	USERS' EXPERIENCE WITH CALIBRATION (BENCHMARK)
DOCUMENT DATABANK	CHANGING THE DATABANK CURRENTLY BEING USED
DOCUMENT DELETED	DELETING A DATABANK
DOCUMENT DELETED	DELETING EVERYTHING FOR A COUNTRY MODEL
DOCUMENT ERROR	RECOVERING FROM A SEVERE MODELLING ERROR
DOCUMENT INITIAL	THE INITIAL COMMAND
DOCUMENT INPUT	THE INPUT COMMAND
DOCUMENT LCOUNTRY	LIST THE NAMES OF DATABANKS FOR THE COUNTRY
DOCUMENT MAKECOPY	COPY A DATABANK
DOCUMENT MODEL	THE MODEL COMMAND
DOCUMENT MOVEDATA	MOVE A DATABANK TO T.S.O. AND BACK
DOCUMENT OVERVIEW	A SUMMARY DESCRIPTION OF THIS PROGRAM
DOCUMENT REPORT	THE REPORT COMMAND
DOCUMENT SIMULATE	AUTHORS' EXPERIENCE WITH SIMULATION
DOCUMENT STATS	MODELLING AND DATA OPTIONS IN EPROT
DOCUMENT TOPA	TECHNICAL INFORMATION ABOUT DATASETS AND DATABANKS
DOCUMENT UPDATE	THE UPDATE COMMAND
DOCUMENT WORDLIST	THE WORDLIST COMMAND

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'COMMENT' LEAVE YOUR COMMENTS FOR FUTURE USERS:

 ENTER:                 TO ADD:

 COMMENT  CALIB         USER'S EXPERIENCE WITH CALIBRATION
 COMMENT  SIMULATE      USER'S EXPERIENCE WITH SIMULATION
 COMMENT  UPDATE        USER'S EXPERIENCE WITH UPDATING VARIABLES
 COMMENT  OTHER         USER'S OTHER COMMENTS


COMMANDS TO MANIPULATE DATABANKS, ETC.
THESE COMMANDS ARE NORMALLY USED BY THE OTHER MODELLING COMMANDS.

 ENTER:     TO:

 CHECK      VERIFY THAT A DATABANK HAS NOT BEEN DAMAGED
 CREATE     DEFINE SPACE FOR A NEW DATABANK
 DATABANK   CHANGE THE DATABANK TO BE USED DURING A MODELLING SESSION
 DELETE     DELETE A DATABANK
 PRINTPGM   TYPE THE SOURCE LISTING OF A PROGRAM
 INITIAL    SET INITIAL VALUES FOR PARAMETER DATASERIES IN A DATABANK
 LCOUNTRY   LIST THE NAMES OF DATABANKS FOR THE COUNTRY BEING MODELLED
 MOVEDATA   MOVE A DATABANK TO A CARD IMAGE DATASET OR VICE-VERSA
 NAMECOPY   COPY ONE DATABANK TO ANOTHER WITH A DIFFERENT NAME
 START      CHECK MODELLING AND DATA OPTIONS IN EFFECT
 NOVALIDP   TYPE A WORKSHEET FOR REQUIRED EXOGENOUS DATASERIES

COMMAND TO RECOVER FROM A SEVERE MODELLING SYSTEM ERROR:

 ERROR                  CHECK DATABANKS FOR SYSTEM ERRORS


ENTER DOCUMENT OVERVIEW FOR FURTHER INFORMATION
ENTER DOCUMENT TOBEDONE FOR A LIST OF FEATURES NOT IMPLEMENTED


READY
```

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This economy-wide modelling package is designed to be operated from a slow-speed computer terminal connected to an IBM machine with an MVS operating system.

The primary technical documentation for using the package is in machine readable form. This documentation, the programs, the sample databanks and the installation instructions are all supplied directly on a data tape. The first file on the standard label tape contains the installation instructions for the rest of the datasets, including the documentation. Only a general summary providing an overview of the documentation is included in this User's Guide.

This User's Guide outlines (1) the basic features included in each of two modes of the Prototype Macroeconomic Model for Resource Allocation Analysis, (2) how each such mode would be utilized for analyzing external assistance effects and accompanying policy changes in a particular country, (Egypt), (3) how the basic prototype versions of the models could be modified to fit the different institutional and economic circumstances of virtually any other given country, and (4) the kinds of instructions that would be given to the user in order to ensure that a general economist with relatively little specific experience in macroeconomic modelling would be able to construct and then perform useful experiments on a model of his own design for any economy that he may want to analyze. The detailed documentation on the use of the models and the system is provided on the datatape itself.

The User's Guide is organized as follows: The general features of the Modelling System are outlined in Section II (which follows). Section III describes the general features and capabilities of models in each solution mode - general equilibrium or linear programming. Section IV contains both a general specification of the basic models of each mode and the specific functional forms and methods used in obtaining parameter values for the Egyptian Prototype. Section V contains some guidelines and suggestions on how alternative specifications could be implemented. Section VI provides an evaluation of the existing literature on

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foreign aid and its effects and suggests a series of simulation experiments that the user may want to employ in exploring foreign assistance - related issues. Section VII demonstrates what can be learned from such experiments by applying several such experiments to the Egyptian prototype version of the basic model of each mode. Section VIII contains some general instructions for creating and running a model. Section IX presents a bibliography of relevant references.

II. GENERAL FEATURES OF THE MODELLING SYSTEM

The system is designed in such a way that both the mode of operation and the specific model utilized can be chosen so as to be appropriate to the economy and issues under consideration. It contains a number of diagnostic features which should make it possible to ferret out data, computational, and specification errors quickly and easily, thereby avoiding the need to repeat a great number of calculations and facilitating use of the model for sensitivity analysis and simulation. The system design takes advantage of the fact that certain model components are common to each analytical mode and solution strategy.

A. Flexibility in Choice of Mode and Model

Rather than being two different models, the linear programming (LP) and General Equilibrium Model (GEM) solutions are looked at as two different variants on the same modelling system. For some institutional circumstances and types of questions an LP approach can be considered more realistic and advantageous than the GEM approach; in other circumstances, however, the GEM approach may be more appropriate; in still other circumstances various compromise approaches combining the two models may constitute the desired approach.

The model user may want to use both the GEM and LP approaches with identical data so as to test the sensitivity of the solutions to the quite different assumptions involved in each mode of operation. Another possibility is to combine the two approaches. For example, separate, single-period GEMs could be utilized to identify a series of internally consistent final demand patterns and/or optimal sets of input-output relations for use in a multi-period LP model. Likewise, dynamic or long-run LP solutions could be used to identify feasible ranges of final demands and/or sectoral capacities and values of exogenous variables for use in a single, long-run GEM or in a set of sequential GEMS.

B. Flexibility in Component Selection

The user is given maximum flexibility in model design by virtue of the fact that the model's design and estimation are organized on a component-by-component basis. For each component the user is led to an appropriate choice among several prespecified alternatives with respect to data requirements, functional form, variable specification and causal flow. In this way the user will be able to arrive at an overall model specification that is suitable for the economy and issues in which he is interested.

C. Ability to Diagnose Errors

Perhaps the greatest pitfall in large-scale modelling efforts is the possibility that errors can inadvertently creep into the analysis, thereby rendering the solutions invalid and, perhaps worse yet, biasing them in unknown directions. Considerable emphasis in model design is given to making it possible for the user to detect errors easily as they arise, pinpointing their origin and allowing the user to correct them at minimum cost in terms of time and effort.

By facilitating the detection and elimination of errors in data manipulation, specification, estimation, etc., the cost of developing such a model should be reduced. Also it should be possible for the user to generate more confidence on the part of himself and others in the model's use, thereby stimulating its use and therefore increasing its potential benefits.

D. Simulation and Sensitivity Analysis

For any mode and within any specification of the model's components, the user has the capability of over-riding parameters, equations, etc., thereby allowing him to determine the sensitivity of results to such differences. In this way the user should not only be able to identify those parameters, data values, etc. to which the results are most sensitive, but also to obtain much greater understanding of how the model works than can typically be obtained when ordinary packaged software programs

are used.

Since a severe constraint on economic modelling efforts for any developing country is likely to be data availability, wherever possible we have tried to utilize specifications and functional forms which can be made operational by supplementing the limited data available with assumptions about the realistic ranges of other more difficult-to-estimate parameters. Sensitivity analysis can then once again be utilized to identify both those ranges of parameter values to which the results are rather insensitive and those parameters and ranges of parameter values to which the results are relatively sensitive.

E. Ability to Deal with Basic Needs and Other Development Objectives

Because of the justifiable and growing concern among most development planners and policy-makers that development does not trickle down sufficiently, in both modes of operation the model-user is presented with a number of options of how to implement a requirement that certain identifiable basic needs be met. Certain income distribution measures are also calculated automatically and presented in the output reports.

F. Variety in the Choice of Adjustment Mechanisms

Another area in which the user is given considerable flexibility is in the choice of the variables and of the mechanisms whereby adjustments to temporary disequilibria in these variables are effected. For example, in the operation of the GEM mode, basic to the achievement of equilibrium within any single-period GEM are adjustments in commodity and factor prices. In each such case, the user has the flexibility to change both the order in which adjustments are made, the rules concerning how many adjustments are made and how large they are in order to facilitate the achievement of convergence to equilibrium solutions at minimum cost.

However, a number of other adjustment mechanisms are also provided for. For example, because of the recognized importance of macroeconomic forces or alternative

"closing rules" in the overall outcome of even multisectoral allocation models with lots of microeconomic trappings [Bruno (1979), Taylor and Lysy (1979), Lluch (1979)], options to modify savings-investment disequilibria with interest rate adjustments and foreign exchange imbalances with exchange rate adjustments are also provided.

G. Flexibility in the Choice of Sectors and Factors

The user has considerable flexibility in the number of sectors and factors to be distinguished, and complete freedom in the definitions and characterizations of such sectors and factors. This flexibility should allow the user to adapt the model to a variety of settings and to a variety of uses. For example, by restricting sectors and/or factors and their markets to certain regions or locations, interregional dualism can be represented. By representing dualism or market segmentation the model can be made more realistic for LDC conditions. As another example, by introducing skill differatiation and relating certain education and training sectors to the production of such skills, the model can be made to deal with issues in human capital formation and allocation.

III. GENERAL SPECIFICATIONS OF MODELS FOR EACH MODE AND POSSIBLE INTERRELATIONSHIPS BETWEEN THEM

The model user may use either of two solution strategies or modes:

1. general equilibrium (GEM)
2. linear programming (LP)

Both methods may use identical data, allowing a direct comparison of the different results from each type of solution. Such experiments are facilitated by the fact that the basic model of each such mode looks for variables and parameters of the same name.

Much of the data used by the model does not have to be supplied prior to starting the individual run, especially when the model is used sequentially. The model user has to supply only the over-riding parameters that he (she) wishes to change from a previous run or from the original initial conditions.

The model user may, after specifying which data series to use, select either general equilibrium or linear programming estimation and solution modes. The price-endogenous nature of the GEM approach makes it more suitable for modelling economies in which there are many decision makers, each with a limited range of decision-making power. The LP approach may be more appropriate in circumstances where many decisions are made by a central decision maker such as when resources are allocated, or alternatively when prices are set, by a central planning bureau.

However, the user may choose either mode and may want to switch back and forth between them. For example, linear programming estimation can be applied using instead of raw data the results of the general equilibrium estimation and vice versa.

A. An Overview of the General Equilibrium Mode

In the GEM approach the model solves for both prices and quantities in the factor and product markets. The numbers of factor markets and of product markets are variable and specified by the model user.

The general equilibrium solution strategy is one that explicitly states the path to convergence, defined as that state of factor and product prices and quantities in which any excess demands or supplies are considered to be insignificant in magnitude.

The complete solution is arrived at only at the end of a series of sequential steps, each one of which involves a different model component, each of which can be designed in such a way as to reflect the conditions that are considered relevant.

The exact pattern of the sequence will depend to some extent on the nature of the components chosen, the answers given by the model user at the outset to certain questions concerning institutions and behavior in the country under consideration, and with regard to the adjustment mechanisms and the order and rules by which they are to be executed. The following is a typical sequence in a case in which the only adjustment mechanisms are commodity and factor prices. [illegible]

1) Given initial assumed values of prices for domestic and imported commodities and factors, and assumed values of those factors or outputs which are considered fixed in the short run, profit-maximizing values of factor demands and output supplies are obtained.
2) Factor supplies are obtained from the same initial values used above.
3) Factor supplies and demands are compared, yielding an excess factor demand vector at the initial set of factor and commodity prices.
4) Factor prices are then adjusted according to the direction and magnitude of the disequilibrium and a priori estimates of the relevant elasticities.
5) Factor demands and supplies are recalculated at the new assumed factor prices and a new vector of excess factor demands is obtained. Steps 4) and 5) are repeated until approximate equilibration is achieved. [illegible]
6) The profit-maximizing output supply is found at this set of approximate equilibrium factor prices.

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7) Factor incomes are generated from the set of factor prices and demands.

8) Factor incomes are transformed into commodity-specific final demands and savings at the initial assumed commodity prices.

9) The final demands are added to the previously calculated interindustry demands for domestic and imported commodities, obtaining total commodity demands.

10) Commodity demands and supplies are compared, yielding an excess commodity demand vector.

11) Commodity prices are adjusted according to the direction and magnitude of the disequilibrium and a priori estimates of the elasticities.

12) New profit-maximizing values for factor demands and supplies are found using the new commodity prices and quantities.

13) Steps 1) through 12) are repeated until convergence to equilibrium is achieved in both factor markets, i.e., step 3) and product markets, i.e., step 10), simultaneously.

The sequence outlined above for iterative solutions to product and factor market equilibria does not exhaust the possibilities and the needs for iterative solution techniques. Additional areas of the model in which iterative solution techniques may turn out to be justified would be the savings-investment relationship, with a variable rate of return, and the balance of payments with a flexible exchange rate.

As has previously been mentioned, an important feature of the present modelling system is the component-by-component characteristic. This feature allows the user to choose an appropriate specification for each individual component, detect errors quickly and cheaply, and to interchange components between modes.

Depending on the degree of simultaneity or interrelatedness that is assumed to pertain to individual decisions and behavioral relationships within the overall model, differing numbers of model components can be identified.

In order to give the reader some idea of the flexibility that the user has in

this User's Guide, we describe at least briefly two of the most important and central components of GEM and some of the alternative approaches that are available to the user in each such component.

1. The Final Demand Generation Component Is this up-to-date?

In this component, the user has the capability to generate the most important components of final demand, such as the foreign, government, capitalist and various kinds of household components, and then to disaggregate each such component into the final demands for specific commodity-sectors, for use in the overall model. check

The user has options on how final demands are to be decided upon, instructions on how to apply some of the most common and useful estimation procedures, a catalog of the data requirements of each such procedure, an annotated list of the alternative functional forms available including the advantages and disadvantages of each, and some instructions on how to manipulate the data so as to meet the data requirements reliably and cheaply.

In some of the more neoclassical approaches available, certain of the component sectors of final demand, such as the wage-earning households of a certain skill-type or location, may make their allocation decisions on the basis of formal derivations from a utility-maximizing framework. In such an approach factor supplies may be determined simultaneously with commodity demand as, for example, when households choose between leisure and labor supply, and thereby indirectly the consumption of those commodities that they can purchase out of the wages they receive for not consuming more leisure. However, the user also has the flexibility of treating labor supplies as fixed, thereby separating the factor income generation process from the expenditure allocation process. Alternatively, these processes can be separated if the allocations are specified as being made independently from prices, for example on the basis of constant income elasticities or marginal expenditure propensities out of total factor income. In other words, one of the options the

user has is to choose the dividing line between one component and another.

Besides his (her) ability to define the boundaries among the components and the general character of each, the model user also has the flexibility to choose among a number of specifications of the specific variables to be included among the determinants and among a number of functional forms for transforming different factor incomes into the commodity-specific final demand components.

Specifically, the following functional forms will be considered:

(1) Strict or stepwise constant marginal propensities to spend/save for each type of factor income. (The price elasticities of demand in this approach are assumed to be zero).

(2) Linear Expenditure System (LES) or Extended Linear Expenditure System (ELES). In these approaches the composition of final demand is affected both by prices and income, in particular distinguishing between those consumption levels that are irreducible, i.e., are part of subsistence, and those out of discretionary income that are influenced by price.

(3) Cobb-Douglas or Linear Logarithmic Aggregate Consumption Functions. Such functions also allow incomes, interest rates and prices to determine aggregate consumption out of each type of factor income, the disaggregation into the demand for individual commodities being made by the LES functions.

2. The Input-Output Relationships and the Generation of Factor Demands and Output Supplies

The purpose of this component is to generate the factor demand and output supply relationships. If the user chooses one of the more neoclassical of such approaches, he (she) can allow price adjustments and factor substitutions to play a large role in determining the profit-maximizing, cost-minimizing input-output relationships. On the other hand, the user may choose less neoclassical approaches wherein fixed input-output relationships are assumed. Moreover, the user has the

capability of choosing fixity of some input-output relations but flexibility for others. For example, although fixity applies to the commodity (intermediate) inputs in the basic model, this assumption is not as limiting as it otherwise might seem. First, the model user has the flexibility to make his (her) own distinction between intermediate and primary inputs. In this way, he (she) may want to classify as primary those commodity inputs that are considered to be most price-sensitive. Second, the user always has at his (her) disposal the option to override the initial parameter values, and such overrides could be done on the basis of separate calculations as to how the input coefficients would be expected to adjust to relative prices in the expected range of such prices, as, e.g., when a considerably more general specification of the production function were utilized. Third, such a price-sensitive input could be grouped with its most important substitute as part of a single commodity input, the breakdown of which into its domestic and imported component is price-sensitive even in the basic model. [To utilize this approach it would be necessary to identify one of the components as an "import" though it need not be really imported.] As will be mentioned below, with respect to the primary factors the model user has the flexibility to specify which and how many such factors are considered fixed within any given period.

A common feature of many developing countries that the model-user may want to include is price or economic dualism. This characteristic often takes the form of different prices for the same input or output in different locations or sectors, e.g., different wage rates or interest rates in different sectors, often with no obvious explanation for the discrepancies. Two closely related, yet conceptually distinct, approaches are available to handle this case. To illustrate these approaches, let us assume that the discrepancy occurs with respect to the price of unskilled labor. The first approach is to assume that there is, in fact, a single wage rate for unskilled labor and, therefore, one overall supply curve of such labor. To the extent wage rate differentials between sectors exist, they may be regarded as the result of variations in self-imposed excise taxes from sector to sec-

is this okay?

tor. The second approach is to model each such sector having a different, perhaps horizontal, supply curve of unskilled labor. When the supply curves are other than horizontal, the wage rates will be endogenously determined. Overtime intersectoral wage rate differentials may be moderated by migration between periods as will be suggested in the labor supply update relations in Section IV E.

Another feature that is likely to be more important in a multisectoral model for a developing country than it would be in a developed country is monopoly power. Monopoly power arises primarily in situations in which a particular industry is dominated by a small number of firms such that the output of an individual firm can affect its price. In such situations, it is not the price which the firm (industry) compares with marginal cost in choosing its profit-maximizing factor demands and output supply. Rather, it compares its marginal cost with its marginal revenue, which depends, of course, on the elasticity of demand with respect to price within the relevant range. This creates a wedge between the price the consumer pays and that which the producer uses to determine his output and inputs. This wedge can, once again, be thought of as a self-imposed excise tax in which the tax revenues accrue to the producing firm (industry). Therefore, the user has the ability to treat monopoly behavior by simply specifying the elasticity of demand that he (she) feels is relevant to the average firm in the industry within the relevant range. wedge largely determined by elasticity? probably:

It is often alleged that producer behavior in developing countries is motivated to a much lesser extent by profit maximization and more by other factors. Whether such allegations are realistic or not is still an open question that can be answered only by careful empirical investigation of the matter. Nevertheless, such non profit-maximizing considerations can be approximated within the GEM framework by treating them as additional constraints. For example, a public enterprise may have a certain target level of employment, or even a private enterprise can under certain circumstances be forced to employ more or less workers of

a certain skill class than it might otherwise want to. Likewise, in a disequilibrium-pricing context in which certain scarce factors are in excess demand, a producing sector may be given only a fixed ration or quota to use. These considerations can be dealt with easily by treating the quantities of such factors as fixed within a period (just as capital is specified to be in the basic GEM model provided below). ok

Other perhaps more fundamental kinds of alleged non-profit-maximizing behavior can perhaps be better dealt with in the alternative LP mode of operation. In the LP mode any arbitrary objective can be utilized for the individual producing sector or for the economy as a whole.

Both Section V of this User's Guide and the programs and their documentation include instructions which outline the advantages/disadvantages of different approaches to measuring the appropriate input-output relations, not only with respect to functional form but also with respect to particular variables considered exogenous to the firm's decisions. Invariably there will be at least one input which is fixed. The model user may feel that producing sectors are constrained in the level of one or more of the inputs available to them, as for example when in the short run they are subject to fixed capacities of capital services from the capital stocks they have inherited from the past and to which they are limited until new investment decisions are made, carried out, and the required gestation period completed. Another situation in which the fixity of input levels may arise, and which the model user may want to characterize, is that in which scarce resources are rationed to individual sectors on the basis of certain administrative rules. In such situations where some inputs are variable and can be affected by relative prices

but others are fixed, the model user will be led to the use of a profit function approach, wherein the independent variables are the prices of the variable factors but the quantities of the fixed factors.

For each such approach the model user will be able to choose among the following functional forms with regard to the primary factors:

(1) Leontief fixed coefficients
(2) Cobb-Douglas
(3) CES

① OK - still ?
② All constant returns to scale ?

This component also allows the model user to utilize different approaches to the relationships among the primary inputs for different sectors. For example, some sectors may have Leontief production functions whereas other sectors may have more general forms.

3. Representation of Basic Needs

There are several ways in which the satisfaction of basic needs can be treated within the GEM mode.

One such way is to define the sectors whose outputs, demands, imports, exports and prices are determined sufficiently narrowly as to provide a sector corresponding to each identified "basic need". For example, one might want to have a food sector, a housing sector, a health service sector, an education sector and, by appropriate disaggregation of households into types and income levels, to keep track of how sectoral outputs are distributed across sectors. Policy interventions, such as the use of subsidies and taxes to introduce price discrimination among different demanders for such needs, can easily be handled. Likewise, the provision of minimum quantities of "basic need" commodities and services for specific household types can be represented by appropriate specification of the exogenous components of the final demand functions, e.g., the consumption constant for subsistence de-

mand in the LES version of the final demand generation component.

4. Iteration

Irrespective of the number of components and the character of the individual components chosen by the model user, an iterative procedure along the lines of that outlined above is to be used for achieving convergence. The nature of the iterations will naturally be affected quite considerably by the specification chosen, especially with regard to the choice of adjustment mechanisms and adjustment rules, but the fact of iteration between components is essential to operation and is retained in all cases.

Among the advantages of the iterative approach to convergence of GEM are the following:

(1) maximum flexibility in specifying the behavioral relations in different parts of the model that are realistic to the country and relevant to the issues under consideration,

(2) maximum ability to simulate the practice of specific policy experiments,

(3) the ability to diagnose problems and the potential cause of nonconvergence with very little training. (For example, if the model does not converge, then the last twenty iterative steps are displayed and the user can follow the process backwards until the likely causes of non-convergence are identified.)

(4) the ability to combine modes by, for example, utilizing one of the more neoclassical approaches within components of GEM, such as in final demand generation and/or in solving for the optimal input-output coefficients, but then an LP approach for maximizing income (value added) at the macro level within the relevant constraints,

(5) avoidance of complicated, often troublesome, and rather time-consuming procedures for solving simultaneous systems of nonlinear equations. Since the sophistication required of such methods varies with the degree of non-linearity, with the degree of simultaneity and with the required accuracy, by eliminating

the need for such a routine in effect it eliminates the need for a set of such routines, each being advantageous in some circumstances but not in others.

6. An Overview of the Linear Programming Mode

The LP version of the model solves for the value of a user-specified objective function. At the time of solution the values of basis variables and the dual prices are displayed. The user may set bounds on acceptable basis values before solving the model.

For multiperiod runs the variables exogenous to each period may be specified before the run is begun or altered after each period is solved. In other words, the user has the ability to guide the model results from one planning period to the next depending on intermediate solution values.

The LP mode can be utilized for individual sectors, for individual components of GEM, or for economy-wide planning models.

At the individual sector level, the LP mode could be used to choose among alternative technologies in order to determine the optimal, or alternatively the relevant "average", technology (taking constraints into consideration). The LP mode could also be used to find the relevant average technology for an aggregate sector in GEM by minimizing the costs of achieving the exogenously determined subsector mix of final demands for that sector. Likewise, the LP mode can be useful in modeling producer behavior when non-profit maximizing objectives are relevant.

At the economy-wide level, the basic LP model would be designed for a level of aggregation somewhere between three and twenty sectors. At this level of aggregation some of the basic questions concerning sectoral allocation can be posed in the relevant context of macro level constraints and significant intersectoral and intertemporal interdependencies over a planning horizon of three to ten years that is relevant to most national and foreign assistance planning efforts.

The LP format allows the user to simultaneously seek solutions for two of

the most important issues in foreign assistance planning. Namely, the solution to the primal problem suggests how far the country can get in achieving the flexible target, such as maximizing income growth over the planning horizon, and also how best this objective can be realized within the relevant constraints, such as those on the secondary targets and present and foreseeable resource availabilities. Secondly, solution to the dual problem provides the decision maker with the relevant set of intersectoral, intertemporal and other tradeoffs among the various targets and constraints included in the model including the effect of extra resources made available by foreign aid on the objective function. (See, e.g., Yotopoulos and Nugent (1976, Ch. 21)).

A particularly attractive feature of the LP mode is the ability to impose constraints allowing a basic needs-orientation to be reflected, if desired, in model solutions. For example, outputs of sectors satisfying basic needs can be subjected to lower bounds; lower bounds can also be imposed on the consumption of basic needs by specified target household or income groups. A basic needs-orientation can also be reflected somewhat more indirectly by imposing lower bound constraints on employment of target labor skill groups, and/or by attaching weights on the incomes of target groups in the welfare function to be maximized.

C. Combined and Iterative Use of the Two Solution Modes

As mentioned previously, one of our purposes in treating the LP and GEM approaches as alternative solution modes to the same basic model is to facilitate their combined as well as sequential use. In certain circumstances, it may be desirable to run each mode with the same data, and for the same time period, both for purposes of sensitivity analysis (i.e., to test for sensitivity of the solutions to the different sets of assumptions involved) and to complement each other in terms of the issues dealt with.

It may also be useful to utilize them sequentially, as suggested above, beginning with the LP version that would trace out feasible regions, optimal pro-

ductive structures and technologies and the time paths of exogenous variables and of optimal capital stocks over the longer run, and then followed by the GEM version that would solve for the specific steps along the way reflecting more concretely and completely the institutional and market realities.

Still another way in which the two modes can be utilized is to combine them within any period by using one mode for one or more model components and the other for other components within the overall iterative procedure that was outlined within GEM for achieving convergence. For example, the user might want to utilize a neoclassical approach, such as the Cobb-Douglas-LES or ELES options to final demand generation described in the above outline of the GEM approach, to determine the components of final demand on the basis of both incomes and prices, instead of assuming the strictly constant average or marginal shares of the typical LP. He then could utilize the LP approach to choose among alternative technologies or productive structures for satisfying those demands. So, too, the user might want to determine the optimal input-output proportions via the profit-maximizing or cost-minimizing derivations from the cost or profit functions outlined for the input-output component of GEM, but then, once these optimal input-output coefficients are known, to utilize them as fixed coefficients in an LP solution mode that attempts to maximize a macro planning goal within the relevant resource and other constraints.

D. Limitations

Although a major advantage of the modelling system is its flexibility and thus its ability to be utilized in a wide variety of institutional circumstances and ways, the system is not without its limitations. Some of these limitations are intentional but others are inadvertant, simply being necessary in order to obtain the other advantages of the system.

Most importantly, the system is not designed to incorporate financial or monetary considerations. It must be regarded as a model of the real sphere alone.

Naturally, the model, probably in the GEM mode, because of the iterative solution procedure utilized, could be integrated with a monetary model and thereby could be made to arrive at an overall monetary-real general equilibrium. At the present time, however, serious doubts have been expressed [e.g., by Srinivasan (1978)] about the ability to model real-monetary interactions in any realistic way, given the current state of knowledge. Purposely, therefore, we avoid the temptation to deal with monetary matters (as tempting as that might be) even though foreign assistance can have monetary consequences that can be of considerable importance in determining the overall effectiveness as well as the allocative effects of such assistance.

The latter limitation can, of course, be alleviated by exogenously changing variables or parameters or by introducing behavioral approximations to the effects of the monetary consequences of foreign assistance.

Likewise, the model is not designed to deal with locational or spatial issues. Since the most recent Egyptian plan gives very considerable emphasis to spatial deconcentration of economic activity, this limitation may be rather important in the Egyptian context. To bring in space and the comparative efficiencies of alternative urbanization and industrial location strategies would, however, require an order to magnitude increase in the size of the model. Moreover, to a large extent, it may be possible to deal with such issues separately. See, for example, Gordon (1979) for an informative discussion of such matters in the Egyptian context.

Although very considerable flexibility in the choice of functional form of the various behavioral and technological relationships is provided, the option to choose still more general forms like translog functions is deliberately ruled out. There are two reasons for this restriction. First, more general forms like that of translog require knowledge about the quantitative magnitudes of

a large number of parameters that is likely to go well beyond the capabilities of the model user to supply especially in a short period of time, and especially in the LDC context. Second, these more general functions are really too general, in the sense that in certain ranges of prices they can impose extremely unrealistic and undesirable properties that most users would be unable to detect.

GEM solutions are static or comparative static in nature. They are not dynamic. They contain no "look-ahead" features whereby the achievement of future objectives and the recognition of future constraints are taken into consideration in arriving at current period solutions. Neither is there any provision for partial or incomplete adjustment to exogenous changes in a single period GEM. Because these limitations do not necessarily apply in the case of the LP mode, and the ability to realistically model dynamic general equilibrium is again probably well beyond current capabilities, these limitations are thought to be far from fatal.

At the present time provision is made for no more than twenty (20) sectors and ten (10) factors. No more than two factors may be considered fixed within any period. These limitations are not really necessary but are in place unless provision is made to relax them. Note: that could be a problem: Probs with Final demand. note: Fixed coeff

Although the system is designed to allow the model user considerable room to maneuver and a strong basis for interaction with the model, parameter overrides and other changes, e.g., to provide appropriate approximation to behavior in the expected range of the variables, must be made prior to a run, rather than as the run is in progress, e.g., between iterations.

Finally, it should be pointed out that, despite the great flexibility in the choice of functional forms, modes of operation, numbers of sectors and factors, the distinctions between fixed and variable factors, and between commodity and primary inputs, and above all parameter values, the GEM calculations follow a certain and predetermined order which should be recognized if the model, and the means by which it arrives at solution values, are to be fully understood. The rigidity of the sequence can, however, be reduced by the user in so far as the user is free to specify the adjustment mechanisms and the rules that apply in the adjustment process.

IV. GENERAL AND DETAILED SPECIFICATIONS OF A BASIC MODEL FOR EACH MODE WITH SPECIAL REFERENCE TO THE EGYPTIAN PROTOTYPE

In order to give the reader some feel for the level of detail, nature, and scope of the versions of the models available for each mode of the model, we provide in Sections A and B general algebraic formulations of both the GEM and LP modes. In Section 6 we provide a more detailed formulation of the version of GEM used in the Egyptian prototype and subsequently describe the methods used for estimating the parameters and updating the exogenous variables.

To simplify the exposition and to facilitate sequential and/or combined use of the LP and GEM modes we utilize the same variable names, and subscript and superscript conventions throughout, and recommend that the user should do the same. Attached to the general version of GEM in Table 1 is a complete glossary of variable names and parameters. Bars over the variables indicate exogenous variables. Superscript S indicates supply whereas superscript D indicates demand. The variable names used by the computerized form of the model are expanded mnemonics of the variables in the glossary.

A. The General Specification of GEM

The GEM version of the model is formulated in two basic blocks - the first containing output supply, factor supply and demand and price determination, and the second dealing with final demand generation and commodity balances - each of which, in turn, is divided into two or more components. All blocks, and each and every component thereof, are linked via the iterative solution procedures that were identified and outlined in Section III above.

This general specification of the prototype GEM is intentionally simple, complications being postponed until Section C below, where the more detailed specification of the functional form for the Egyptian prototype is given.

The formulation begins in the first block, Block A, with the Production Relationships in Section I; this is followed in Section II by the price and profit relationships and Block A is completed with the Factor Supply and Demand and Output Supply relationships given in Section III. Block B begins in Section IV with Fac-

tor Income and Expenditure Generation and ends with the Commodity Balance Equations in Section V.

Equations (1), i.e., (1a) and (1b), are the production function for commodity-sector, X_s. Inputs into the production process are of two types: variable and fixed. Among the variable inputs are the n domestic and u imported intermediate goods X_{is} and M_{ks}, respectively, as well as the m primary resource inputs R_c. The production function for gross output in equation (1a) specifies that the sum of intermediate inputs per unit of output, and hence aggregate real value added per unit of output, are assumed to be fixed for any sector, although variable from one sector to another. The production function for the value added component, V_s, is given in equation (1b) and is not restricted to a specific functional form. Equation (1b) allows for a distinction between those primary inputs that are considered to be variable, $R_{is} \ldots R_{ms}$, and those that are considered to be fixed, K_s and Z_s. Technology is also allowed to vary with time, $\overline{T}$.

Naturally, the extent to which technology changes with time, and the distinction between variable and fixed factors of production, are greatly affected by the length of the time period. The length of the time period can be varied by the user, but for this specification to be realistic, the period should be no less than 1 year and no more than five years in length.

Equation (2) specifies that the individual input-output coefficients, a_{is}, are assumed to remain constant within any period. On the other hand, the split of the a_{is} coefficients into their domestically produced and imported components, d_{is} and m_{ks}, respectively, is specified in equation (3) to be affected by relative prices, making d_{is} and m_{ks} variable coefficients.

Although the fixity of commodity input coefficients a_{is} is an admittedly strong assumption, the user has the flexibility to mitigate the effective strength of this assumption in several ways. First, there is nothing to prevent the user from treating a price-sensitive commodity input as a variable primary input to be included

But it's got to get produced, & doesn't spend money: price?

30

in the vector R_s. Second, if the user were to believe that the substitution among commodity inputs was pair-wise, i.e., that input i substitutes only for input j, the user could treat the two together as an input i whose coefficient a_{is} is fixed, the breakdown into the two components being allowed to vary in equation (3), identifying one as an "import", even if it is, in fact, not imported. The latter fact could be taken care of by changing the definition of aggregate imports and the way that input's price is determined. Third, since the user has the ability to exogenously override any parameter, he (she) might well impose a value for the fixed coefficient a_{is} that has been solved for in a separate calculation, perhaps involving relative prices.

In any case these coefficients can vary over time. Conceivably, the optimal I-O coefficients could be solved for in a single-sector LP model and then inserted into the single period GEM. Nevertheless, given the accumulating evidence of relative proportionality of commodity inputs to output, nominal? physical? at least in the short-run, and the considerably greater data requirements and mathematical complexity of handling variable input-output coefficients, these assumptions are thought to be quite justified in the present context. As mentioned above, the fixity of the I-O coefficients a_{is} also requires that the value added coefficients, d_{is}, defined in equation (4), are constant. Equations (5) and (6) simply aggregate the intermediate or interindustry demands for domestic and imported goods over the sectors of destination.

In Section II the price variables are specified, allowing profits to be defined, and setting the stage both for the derivation of the profit-maximizing demands of primary resource inputs, and hence for output supply, in Section III and for the income generation and expenditure allocation functions of Section IV. Relative prices have potentially important roles to play in each of those sections.

Equation (7) defines the net unit value of output of s (or the price of value added per unit of output), Pv_s, as the before-tax price of output, $(1-td_s)P_s$, net

of the costs of domestic and imported inputs per unit of output, $\sum_i d_{is} Pd_i$ and $\sum_k m_{ks} Pm_k$, respectively, all divided by the value added per unit of output, d_{is}. Equation (9) defines unit profit, π_s, as the value of unit value added, Pv_s, less the unit cost of the variable primary resource inputs, $\Sigma r_{cs} Pr_c$. Equation (9) generates sectoral profits Π_s as the sectoral unit profit π_s multiplied by the sectoral level of output X_s. Equation (10) calculates the sectoral profit rate π_s^r by dividing Π_s by the fixed capital stock $\overline{K}_s$. assumed in nominal terms. In the same manner, equation (11) solves for the overall average rate of profit in the economy as a whole, π_{ave}^r. what about $\overline{Z}$

Equations (14) - (18) define a series of price indexes as weighted averages of the different component prices. Equation (14) indicates that the overall GDP price deflator, $\overline{P}$, is exogenous, presumably determined by the money supply and other monetary factors which, for reasons given in Section III D above, have been deliberately excluded from the model. The exogenous shifts in $\overline{P}$, therefore, shift the absolute prices of the individual commodity sectors, P_s. Equation (15) defines the price index for domestic investment goods, Pd_I. Equation (16) is the price index for imported investment goods, Pm_I, and equation (17) defines the overall price deflator for investment, P_I, as a weighted average of Pd_I and Pm_I. Equation (18) defines the consumer price deflator, P_C, as a weighted average of domestic and imported prices.

or: only relative prices change

We turn now to Section III where factor supplies and demands and output supply are determined. Equation (19) expresses the sectoral demand for variable resource c, R_{cs}^D, in terms of the sectoral price of value added, Pv_s, the vector of variable resource prices, $Pr_1 \ldots Pr_c \ldots Pr_m$, the fixed stock of capital in sector s, $\overline{K}_s$, any other factor considered to be fixed within any period, $\overline{Z}_s$, and time, $\overline{T}$. Equation (20) arrives at the aggregate demand for resource c, R_c^D. Equation (21) expresses the aggregate supply of resource c in terms of the vector of prices of the variable resources ($Pr_1 \ldots Pr_c \ldots Pr_m$), the consumer price deflator, P_C, and time, $\overline{T}$. Equation (22) sets the equilibrium condition between supply and demand

for c.

From equations (1a), (1b), (7) and (19) a supply function for X_s, X_s^S, can be derived. This function, given in equation (23), is in terms of the sectoral price of value added, Pv_s, the vector of variable resource prices $Pr_1 \ldots Pr_c \ldots Pr_m$, the fixed stock of capital, $\overline{K}_s$, and the quantity of any other fixed factor, $\overline{Z}_s$, and time.

Block B begins in Section IV where the disposable incomes of each factor type are generated and then allocated across the specific domestic and imported commodity classes and savings (as a residual). Specifically, equation (24) defines disposable income of household type (variable resource class) c, Y_c, as the price of resource class c multiplied by the aggregate quantity demanded of that resource class, R_c^D, net of income taxes, $(\overline{ty}_c\ Pr_c\ R_c^D)$, but inclusive of all transfers of household type c, $\Sigma\overline{TR}_{hc}$. Equation (25) defines disposable income of the enterprise sector, i.e., profits, Y_π, as aggregate profits net of taxes on profits $(1-\overline{t\pi})\Sigma\Pi_s$ plus net transfers to the enterprise sector, $\sum_h \overline{TR}_{h\pi}$. In the present specification, the returns to the owners of Z are simply included in profits, although in principle, such a separation could be made. Equation (26) defines aggregate revenue of the government, as the sum of the revenues collected on (a) production or sales taxes, $\Sigma\overline{td}_s P_s(1-\overline{td}_s)X_s$, (b) export taxes, $\Sigma\overline{te}_s P_s(1-\overline{td}_s)E_s$, (c) import duties, $\sum_k \overline{tm}_k \overline{Pm}_{wk} \overline{Pfe} M_k$, (d) income taxes, $\sum_c \overline{ty}_c Pr_c R_c^{D^S}$, and (e) profits taxes, $\overline{t\pi}\sum_s \Pi_s$, and inclusive of net transfers to government, $\sum_h \overline{TR}_{hG}$.

Equation (27) expresses exports as a function of the domestic export price, Pe_s, converted into foreign currency terms by dividing by the exchange rate, $\overline{Pfe}$, the world supply price of that type of exports, $\overline{Pe}_{ws}$, and an index of world demand for s, $\overline{E}_{ws}^D$. Equations (28) - (33) break expenditures out of disposable resource income, government revenue and enterprise income (profits) down into their domestic and imported components and the individual commodity classes thereof. In each case, these equations use the whole vector of (relative) prices, lagged expenditures and that sec-

tor's aggregate disposable income as explanatory variables.

Equations (34) and (35) define household savings and government savings in nominal terms as the residuals obtained after consumption expenditures have been subtracted from disposable incomes. Equation (36) specifies foreign savings, $\overline{S}_F$, our measure of foreign aid, to be exogenous and equal to the before-tariff value of imports, $\sum_k M_k \overline{Pfe}\ \overline{Pm}_{wk}$, less the after-tax value of imports $\sum_s Pe_s E_s$, and net transfers and factor income from abroad, $\sum_h \overline{TR}_{hF}$ and $(\overline{NFY}\ \overline{P}_{NFY})$, respectively. Equation (37) defines aggregate savings in nominal terms, and equation (38) defines the savings-investment equilibrium. This completes Section IV.

Finally, in Section V the commodity balance relationships are specified. Equation (39) defines the total demand for imports of type k as the sum of intermediate demand for k, M_k^I, the private consumption demand for k, $\sum_c Cm_{kc}$, the investment demand for k, Im_k and the government demand for k, Cm_{kG}. Similarly, equation (40) defines the total demand for domestically produced commodity s = i, X_s^D, as the sum of interindustry demand, X_s^I, consumption demand, $\sum_c Cd_{ic}$, investment demand, Id_i, government demand, Cd_{iG}, and export demand, E_s. Finally, equation (41) imposes the equilibrium condition between supply and demand for the domestically produced commodity class s.

A key assumption in the above formulation is that imported and domestically produced goods, even of the same commodity group, are imperfect substitutes for each other. For this reason, the price of imports of commodity k, Pm_k, will differ from the domestic price of the corresponding sector, P_s. Specifically, the P_s vector is determined, after successive iterations of the model, as that which equilibrates the above net supply (output less interindustry demand) from the first block and final demand determined in the second block. In our opinion this assumption of imperfect competitiveness of imports is realistic for most LDCs, including Egypt, especially given the highly-aggregated nature of the sectors, and also avoids the limitations that would be imposed were imports and domestic goods to be perfect

$ we can vary rate of sub?

substitutes and, therefore, to command an identical price, determined entirely by world prices and the instruments of trade policy - the exchange rate and tariff rates.

Table 1

General Equational Specification of GEM

BLOCK A

m factors c = 1, m

n sectors s = 1, n

u imports k = 1, u

I. Production Relationships

All Physical

Production Function for s (1a) $X_s = \text{Min}\left(\frac{V_s}{\bar{d}_{vs}}, \frac{X_{1s}+M_{1s}}{\bar{a}_{1s}} \ldots \frac{X_{is}+M_{ks}}{\bar{a}_{is}} \ldots \frac{X_{ns}+M_{us}}{\bar{a}_{ns}}, \bar{T}\right)$

(1b) $V_s = f(R_{1s} \ldots R_{ms}, \bar{K}_s, \bar{Z}_s, \bar{T})$ for each $s = 1 \ldots n$

Fixity for Intermediate Inputs (2) $X_{is} + M_{ks} = \bar{a}_{is}X_s = (d_{is}+m_{ks})X_s$ $i = k$

for each $i, s = 1 \ldots n$

Substitution between the Domestic and Imported Input Components (3) $(d_{is}/m_{ks}) = f(P_i/Pm_k)$ = ? parameters? for each $i = 1 \ldots n$ and $s = 1 \ldots n$ $(i = k)$

relative proportions shift in response to price.

Domestic Value Added per Unit of Output (4) $\bar{d}_{vs} = (1 - \sum_i d_{is} - \sum_k m_{ks}) = (1 - \sum_i \bar{a}_{is})$

Total Intermediate Demand for Domestically Produced Commodity i (5) $X_i^I = \sum_s X_{is} = \sum_s d_{is}X_s$ for each $i, i = 1 \ldots n$

Total Intermediate Demand for Imported Commodity k (6) $M_k^I = \sum_s M_{ks} = \sum_s m_{ks}X_s$ for each $k, k = 1 \ldots u$

II. Price and Profit Relationships

Net Unit Value of s at Producer's Prices (Price of value added) (7) $Pv_s = \frac{(1-td_s)P_s - \sum_i d_{is}P_i - \sum_k m_{ks}Pm_k}{1 - \sum_i d_{is} - \sum_k m_{ks}} = \frac{P^*_s}{\bar{d}_{vs}}$

for each $s, s = 1 \ldots n$

goes to $\bar{c}, \bar{z}$

Unit Profit (per unit output, not value-added, not capital) (8) $\pi_s = [Pv_s\bar{d}_{vs} - \sum_c^m r_{cs}Pr_c]$ for each $s, s = 1 \ldots n$

Sectoral Profits (9) $\Pi_s = \pi_s X_s = Pv_s\bar{d}_{vs}X_s - \sum_c^m R_{cs}Pr_c$ for each $s, s = 1 \ldots n$

note - no payments to $\bar{Z}$? or the Fixed Factor? Assumed to go into Profits, Prob.

Sectoral Profit Rate	(10)	$\pi_s^r = \Pi_s/\bar{K}_s$ for each s, s = 1...n
Average Profit Rate	(11)	$\pi_{ave}^r = \sum_s \Pi_s / \sum_s \bar{K}_s$
Import Prices	(12)	$Pm_k = \overline{Pm}_{wk} \cdot \overline{Pfe} \cdot (1 + \overline{tm}_k)$ for each k = 1...u
Export Prices	(13)	$Pe_s = P_s(1 + \overline{te}_s)$ for each s, s = 1...n
Aggregate Price Deflator	(14)	$\bar{P} = \sum_s \alpha_s Pv_s$
Domestic Investment Goods Price Deflator	(15)	$Pd_I = \sum_s B_s P_s$
Imported Investment Goods Price Deflator	(16)	$Pm_I = \sum_k \phi_{kI} Pm_k$
Aggregate Investment Goods Deflator	(17)	$P_I = \theta Pd_I + (1-\theta) Pm_K$
Consumer Price Deflator	(18)	$P_C = \sum_i \mu_i P_i + \sum_k \mu_k Pm_k$

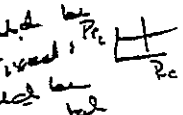
Note: $P_i \uparrow \Rightarrow P_{v_j} \downarrow \; P_{v_i} \uparrow$

predet? exos?

III. Factor Supply and Demand and Output Supply

Demand for Variable Resource Inputs	(19)	$R_{cs}^D = f(Pv_s, Pr_1 \ldots Pr_c \ldots Pr_m, \bar{K}_s, \bar{Z}_s, \bar{T})$ for each c and s, c = 1...m, and s = 1...n.
Total Demand for Variable Resource c	(20)	$R_c^D = \sum_s R_{cs}^D$ for each c, c = 1...m
Total Supply of Variable Resource c	(21)	$R_c^S = f(Pr_1 \ldots Pr_c \ldots, Pr_m, P_C, \bar{T})$ for each c, c = 1...m
Equilibrium in Variable Resource Markets	(22)	$R_c^S = R_c^D$ for each c, c = 1...m
Supply of Output	(23)	$X_s^S = f(Pv_s, Pr_1 \ldots Pr_c \ldots Pr_m, \bar{K}_s, \bar{Z}_s, \bar{T})$ for each s, s = 1...n

could be Fixed; could be horizontal



BLOCK B

IV. Factor Income and Expenditure Generation

Disposable Income of Variable Resources

(24) $Y_c = (1 - \overline{ty}_c)\, Pr_c R_c^D + \sum_h \overline{TR}_{hc}$ for each $c = 1, 2 \ldots m$

where $h = c, \pi, G, F$

big π

Disposable Enterprise Income

(25) $Y_\pi = (1-\overline{t\pi}) \sum_s \pi_s + \sum_h \overline{TR}_{h\pi}$

$h\pi$ from to. (+,-)

Government Revenue

(26) $Y_G = \sum_s \overline{td}_s\, P_s(1-\overline{td}_s) X_s + \sum_s \overline{te}_s\, P_s(1-\overline{td}_s)\, E_s$
$+ \sum_k \overline{tm}_k\, \overline{Pm}_{wk}\, \overline{Pfe}\, M_k + \sum_c \overline{ty}_c\, Pr_c\, R_c^D$
$+ \overline{t\pi} \sum_s \pi_s + \sum_h \overline{TR}_{hG}$

minder of world demand.

Export Demand

(27) $E_s = f(Pe_s/\overline{Pfe}, \overline{Pe}_{ws}, \overline{E}_{ws}^D)$ for each s, $s = 1 \ldots n$

Household Consumption of Domestic Goods

(28) $Cd_{ic} = f(P_1 \ldots P_i \ldots P_n, Pm_1 \ldots Pm_k \ldots Pm_u, \pi^r_{ave}, Y_c)$
for each i and c, $i = s = 1 \ldots n$, $c = 1 \ldots m$

Household Consumption of Import Goods

(29) $Cm_{kc} = f(P_1 \ldots P_i \ldots P_n, Pm_1 \ldots Pm_k \ldots Pm_u, \pi^r_{ave}, Y_c)$
for each k and c, $k = 1 \ldots u$, $s = 1 \ldots m$

Government Consumption of Domestic Goods

(30) $Cd_{iG} = f(P_1 \ldots P_i \ldots P_n, Pm_1 \ldots Pm_k \ldots Pm_u, Y_G, \overline{Cd}_{iG,t-1}$
for each $i = s$, $i = 1 \ldots n$

Government Consumption of Imported Goods

(31) $Cm_{kG} = f(P_1 \ldots P_i \ldots P_n, Pm_1 \ldots Pm_k \ldots Pm_u, Y_G, \overline{Cm}_{kG,t-1}$
for each k, $k = 1 \ldots u$

Investment in Domestic Goods

(32) $Id_i = f(P_1 \ldots P_i \ldots P_n, Pm_1 \ldots Pm_k \ldots Pm_u, \frac{S}{P_I}, \overline{Id}_{i,t-1})$
for each i, $i = 1 \ldots n$

Investment in Imported Goods

(33) $Im_k = f(P_1 \ldots P_i \ldots P_n, Pm_1 \ldots Pm_k \ldots Pm_u, \frac{S}{P_I}, \overline{Im}_{k,t-1})$
for each k, $k = 1 \ldots u$

Savings of Household Type c

(34) $S_c = Y_c - \sum_i Cd_{ic}\, P_i - \sum_k Cm_{kc} Pm_k$ for each c

Does the government invest?

Government Savings	(35)	$S_G = Y_G - \sum_i Cd_{iG} P_i - \sum Cm_{kG} Pm_k$
Foreign Savings	(36)	$\overline{S}_F = M_k \overline{Pfe}\, \overline{Pm}_{wk} - \sum E_s Pe_s - \sum_h \overline{TR}_{hF} - \overline{NFY} \cdot \overline{P}_{NFY}$
Total Savings	(37)	$S = \sum_c S_c + S_G + Y_\pi + \overline{S}_F$
Savings-Investment Equilibrium	(38)	$S = \sum_i Id_i P_i + \sum_i Im_k Pm_k$

remittances

are

note: all savings into a pool. Investment demand?

V. Commodity Balance Equations

Imports	(39)	$M_k = M_k^I + \sum_c Cm_{kc} + Im_k + Cm_{kG}$ for all $k = 1 \ldots u$
Aggregate Demand for Domestic Goods and Savings	(40)	$X_s^D = X_s^I + \sum_c Cd_{ic} + Id_i + Cd_{iG} + E_s$ for all $s = i$, $s = i = 1 \ldots n$
Supply-Demand Equilibrium for Domestically Produced Goods and Services	(41)	$X_s^D = X_s^S$ for all $s = 1 \ldots n$

Glossary of Variables

Endogenous Variables

X_s = the quantity of gross production of sector s

X_{is} = the quantity of intermediate inputs of domestic input i in sector s

X_i^I = aggregate interindustry demand for domestically produced input i

M_{ks} = the quantity of intermediate inputs of imported input k in sector s

M_k^I = aggregate interindustry demand for imported input k

R_{cs}^D = the quantity demanded of variable primary resource input of type c in sector s

V_s = value added in sector s

Pv_s = net unit value in sector s (price of value added)

$P_s = P_i$ = price of domestic goods at purchaser's prices

R_c^S = quantity supplied of resource type c in the whole economy

Pm_k = price of imported good k at purchaser's prices (in terms of domestic currency)

Pr_c = price of variable resource type c

R_c^D = quantity demanded of resource type c employed in the entire economy

π_s = profit per unit of output of s

π_s^r = profit rate per unit of capital in sector s

Π_s = aggregate profits in sector s

π^r_{ave} = average profit rate in the whole economy

Pe_s = export price (in domestic currency) of commodity s

Pd_I = price index of domestically produced investment goods

Pm_I = price index of imported investment goods

P_I = overall price index of investment goods

P_C = overall price index of consumer goods

Y_c = disposable income of household class (owners of resource type) c

Y_π = (after-tax) disposable income of enterprises

Y_G = government revenue

E_s = quantity of exports in sector s

Cd_{ic} = quantity demanded of domestically produced commodity i by household (resource) class c

Cm_{kc} = quantity demanded of imported commodity k by household (resource) class c

Cd_{iG} = quantity demanded of domestic commodity i by government

Cm_{kG} = quantity demanded of imported commodity k by government

Id_i = quantity demanded of domestic commodity i by the investment sector

S_c = savings of household class c

S_G = savings of government

Exogenous Variables

$\overline{K}_s$ = the fixed quantity of capital stock (or capacity service flow equivalent) in sector s

$\overline{Z}_s$ = the fixed quantity of resource Z in sector s

$\overline{Pfe}$ = price of foreign exchange

$\overline{Pm}_{wk}$ = world price of imports of type k (in terms of foreign currency)

$\overline{T}$ = dummy variable for time

$\overline{TR}_{hj}$ = transfers from sector h to sector j

$\overline{Pe}_{ws}$ = world export price for commodity s (in foreign currency)

$\overline{E}^D_{ws}$ = index of the quantity of world demand for exports of commodity s

$\overline{S}_F$ = foreign saving

$\overline{P}$ = the overall GDP price deflator

Parameters

d_{is} = domestic input of i per unit of gross production of sector s

m_{ks} = imported input of k per unit of gross production of sector s

$\overline{td}_s$ = rate of ad valorem tax on production, transactions or sales of commodity s

$\overline{t}_\pi$ = tax rate on profits

r_{cs} = input of resource c per unit of gross production of sector s. (This parameter is, however, really an endogenous variable).

$\overline{tm}_k$ = ad valorem import tax rate on imports of class k

$\overline{te}_s$ = ad valorem export tax rate on exports of class s

$\overline{ty}_c$ = income tax rate on household (resource) class c

For the same reason, export prices, after the addition of export taxes and converted into foreign price terms ($Pe_s/\overline{Pfe}$), can differ from world prices of the same commodity ($\overline{Pe}_{ws}$).

A second key assumption in the above formulation is that prices are uniform to all demanding sectors. An exception is, of course, exports which may be subject to export taxes which allow prices to domestic consumers to vary from those given to foreign consumers. This exception is of little significance as far as modelling is concerned since foreign consumers are not an integral part of the model. As shall be explained later on, the assumption of identical prices for all demanding sectors may not be realistic for all countries and since it is not for Egypt, the assumption will be relaxed in the more detailed specification of the GEM version of the model for application to Egypt.

Although the exposition of the model is decomposed into blocks and then further into components thereof, because both final demands and factor demands are affected by prices of commodities and factors, most of which are endogenously determined, and also because final demands are affected by factor incomes, the commodity and factor market balance equations have to be solved simultaneously, yielding the equilibrium solutions for sectoral outputs, imports, final demands, factor demands, commodity and factor prices, and sectoral profits. In other words, the blocks and their components are interdependent.

Note that the aggregate price level is exogenous, leaving room for a monetary appendage to the model to determine prices. The model is, therefore, a model of the "real" sphere of the economy alone. Additional links between the monetary and real sectors could easily be included, e.g., in the investment equations (32) and (33), in the government sector accounts, equations (26), (30) and (31), and elsewhere.

External assistance enters directly through $\overline{S}_F$, and then indirectly can influence investment, savings, and hence consumption and, via the impact of final

demand, employment, factor prices, product prices and indeed virtually all variables in the system. Because foreign assistance is often provided in the context of certain policy reforms, perhaps involving tax policies, subsidies, and exchange rates, it may be reasonable to simulate the effects of alternative foreign assistance packages with simultaneous changes in the exogenous tax rates, exchange rates, subsidy rates, levels and allocations of government expenditures, etc. Since all of these are included in the model, such analysis can be facilitated. Via model updates, moreover, the dynamic influences of external assistance and the associated policy changes can be captured. Section VI below will be devoted to simulations of this sort.

As has been explained above, our approach to solving the simultaneous system is an iterative one. Given either an initial set of final demands and the fixity of intermediate input coefficients (for goods of both domestic and foreign origin) from equations (1) - (5), or an initial set of product and factor prices, and capital stocks, the sectoral output levels and factor demands are determined. Factor demands and supplies are then compared; where disequilibrium exists, factor prices and subsequently factor demands and supplies are adjusted until the full employment equilibrium condition (11) is achieved. Equilibrated factor prices and quantities then generate factor incomes, which generate final demands and hence total demands that can be compared with the total supplies. Product prices are then adjusted iteratively until convergence is obtained.

Only minor respecifications of the system of equations given in Table 1 would be required to provide additional adjustment mechanisms for use in equilibrating the system. For example, an interest rate or marginal efficiency of investment variable could be added to the investment function to help bring about equilibrium between savings and investment. Alternatively, or in addition, the exchange rate, Pfe, could be cut loose and varied in proportion to the excess demand for foreign exchange. These modifications, which are provided for later on, can be very use-

ful in avoiding overdetermination and hence inconsistency in the specification of the model.

B. General Specification of the LP Mode

The LP model is designed for use in either single sector analysis or in economy-wide settings. Likewise, it may be used in either single-period or multiperiod formulations. The emphasis here will be on economy-wide applications dealing in an operational way with the problems and issues thought to be most important and relevant to foreign assistance planning in a typical LDC over a period of perhaps a decade.

1. Single Sector Analysis

Various kinds of sectoral analyses could be designed and utilized. We mention in this User's Guide only those that may be thought of as complementary to the other components of the system - namely the economy-wide GEM model or the economy-wide LP.

One use might be to find the optimal subsector mix or choice of technology to satisfy a given demand for that mix or a given level of output. For example, foreign assistance might be oriented toward increasing productive capacity in a particular sector. The analyst would like to know, however, which alternative technology or alternative set of projects to choose in designing the external assistance package. A distinct advantage of an LP approach in this context would be to utilize decision criteria other than ordinary profit maximization, and to recognize the relevant administrative, and political as well as technological and economic constraints. Thus, one might solve for the optimal technology or technological mix of producing the desired increased output of X_s that maximizes employment or minimizes the amount of capital required.

Alternatively, or in addition, the sectoral LP could look at dynamic considerations. For example, it could be set up in a multiperiod context in which the

single sector LP could be used to assess the tradeoffs between more employment in the short run (the current period) versus more ten years into the future, etc.

These optimal solutions to the single sector LP could then be used to come up with the appropriate fixed input-output coefficients and other technological parameters in a multisectoral GEM or LP.

2. Economy-wide LP

The economy-wide LP model is conceived of to have the same number of sectors, n, as in the multisectoral GEM model formulated above.

Table 2 provides a tentative general formulation of an economy-wide LP for a single time period. The formulation of the economy-wide LP begins with the specification of an objective function (1) which is a linear function of the sectoral outputs, X_s. The parameters of this objective function, Pv_s, could be defined by the user. In our specification, we have defined the parameters Pv_s as the net value added per unit of sectoral output X_s, i.e., what was defined as dv_s in Table 1 above. (Alternatively, and particularly to investigate the effect of the use of alternative objectives, one could, for example, define the parameters Pv_s as the employment coefficients r_{cs} so as to maximize overall employment, or to reflect the social value of such output to society as a whole, the social value weights taking not only price, but also externalities, into consideration.

In fact, of course, multiple objectives are likely to be relevant, such as employment maximization, growth maximization, foreign exchange minimization, income distribution goals, the achievement of certain basic needs, etc. With multiple objectives the user would have to specify the weights thought relevant to each objective. In practice, however, it is deemed difficult for the armchair analyst to do so and, therefore, the user is advised to follow the specification of Table 2 in choosing a single (primary) objective, but then imposing additional constraints so as to reflect the other (secondary) objectives. (Examples of this sort are provided in Yotopoulos and Nugent (1976, Ch. 21)). For example, among the alter-

native constraints that might be imposed to reflect these secondary targets we include in equation (3) of Table 2 the following:

a. Those specifying disposable incomes of each household class, Y_c, to be greater than or equal to some exogenously specified minimally acceptable level, ($\overline{Y}_{c\ Min}$), with Y_c being defined as in equations (24) of the general specification of GEM in Table 1 above, but with $\overline{Pr}_c$ given exogenously at least for a single LP run, and TR_{Gh} being given either exogenously as before or being determined endogenously so as to maintain equality in the above constraint.

b. Those specifying the aggregate real consumption requirements of each household class with real consumption determined, for an assumed set of consumer prices P_i and Pm_k, as linear functions of output via equations (24), (28) and (29) of the general specification of GEM in Table 1.

c. Those embodying constraints on the differences in relative income between household class groups c and j as specified in (36) with the parameter λ_{cj} representing the tolerance limit defined in terms of the per capita incomes of groups c and j, where $n_c = \frac{1}{Nc^0}$ and Nc is the number of people in group c.

d. Those relevant to the satisfaction of basic needs defined either in terms of minimal output supply or minimal consumption of each specific commodity (and household type) thought to be relevant to basic needs.

Equations (2a) and (2b) provide the commodity balance inequalities for domestically produced and imported goods, respectively. The $\sum_j D_{sj}$ and $\sum_j Dm_{kj}$ terms on the right hand sides of these inequalities represent the commodity-specific exogenous components of the final demand vectors, including perhaps portions of private and government consumption, exports and as formulated here all of investment. The endogenous portions of these demands would, of course, be included on the left hand side of these inequalities, which for a given set of relative prices would be linearly related to the disposable income of the class, Y_c, which as mentioned above, for given factor prices is a linear function of X_s. The employment coef-

Table 2

General Formulation of a Single Period, Economy-wide LP

(1) Objective Function

$$\sum_s Pv_s X_s = \text{Maximum}$$

where Pv_s is the net value added per unit of output

$$= P_s - \sum_i d_{is} P_i - \sum_s m_{Ks} Pm_s \qquad \text{for each } s = i,\ i = 1, \ldots, n$$

(2) Commodity Balance Equations

(a) Domestic Goods

$$X_s^s - \sum_s d_{is} X_s - i_s I - E_s - \sum_j b_{sj} Y_j \geq \sum_j \overline{D}_{sj} \quad \text{for each } s = i,\ i = 1, \ldots, n$$

(b) Imported Goods

$$M_k - \sum_s m_{ks} X_s - \sum_j m_{kj} Y_j \geq \sum_j \overline{Dm}_{kj} \qquad \text{for each } K,\ K = 1, \ldots, u$$

(3) Constraints corresponding to the Secondary Targets

(a) Absolute Real Income Constraints

$$Y_c \geq \overline{Y}_c \text{ Min} \qquad \text{for each } c = 1, \ldots, m$$

(b) Minimal Consumption Requirements of Each Household Class

$$\sum_i C_{ic} \geq \overline{C}_c \text{ Min} \qquad \text{for each } c = 1, \ldots, m$$

nice

(c) Relative Income Difference Constraints

$$n_c Y_c - n_j Y_j \leq \overline{\lambda}_{cj} n_c \overline{Y}_c \qquad \text{for each } c, j \text{ pair } j \neq c$$

$$n_j Y_j - n_c Y_c \leq \overline{\lambda}_{cj} n_c \overline{Y}_c \qquad c, j = 1, \ldots, m$$

(d) Basic Needs Constraints

1. Output - Supply Type

$$X_s \geq \overline{X}_s^S$$

2. Commodity-Specific Consumption Requirements

$$C_{ic} \geq \overline{C}_{ic\,Min} \qquad \text{for each } c,\ c = 1,\ldots, m;\ i = 1,\ldots, n$$

(4) Labor Constraints by Skill Group and Location

$$\sum_s r_{cs} X_s \leq \overline{R}_c^S \qquad \text{for each } c,\ c = 1,\ldots, m$$

(5) Capital and Z Good Constraints for Each Sector

$$k_s x_s \leq \overline{K}_s;\ z_s X_s \leq \overline{Z}_s \qquad \text{for each } s = 1, \ldots, n$$

(6) Savings Constraint

$$\sum_c S_c + S_\pi + S_G - P_I I \geq -\overline{S}_F$$

(7) Foreign Exchange Constraint

$$\sum_k \overline{Pfe}\ \overline{Pm}_{wk}\ M_k - \sum_s \overline{Pfe}\ \overline{Pe}_s\ E_s \leq \overline{S}_F - \overline{\Delta R}$$ remittances, inflows

(8) Export Demand Constraints

$$E_s \leq \overline{E}_{sw}^D$$

(9) Government Revenue and Savings

$$\sum_s te_s P_s (1-td_s) F_s + \sum_k tm_k Pm_{wk}\, Pfe\, Mk_j + \sum_c ty_c\, Pr_c\, R_c^D + \sum_s t\pi_s \pi_s + \sum_s td_s\, P_s\, (1-td_s) X_s - S_G$$

$$= \sum_i \overline{Cd}_{iG}\ Pd_{iG} + \sum_k \overline{Cm}_{kG}\ Pm_{kG} - \sum \overline{TR}_{nG}$$

(10) Household and Business Savings

$$(1-ty_c) Y_c - \sum_i C_{ic}\ Pd_{ic} - S_c = -\sum_n \overline{TR}_{wc} \qquad \text{for each } c$$

$$\sum_s (1-t\pi_s)(Pr_s - \sum_c Pr_c\ r_{cs}) X_s - S_\pi = -\sum_n \overline{TR}_{n\pi}$$

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ficients r_{cs} could be thought of as the profit-maximizing ones given the factor and product prices for example from equation (19) of the general specification of GEM in Table 1.

Inequality (4) is the aggregate labor supply constraint for each labor skill and location type c, with the coefficients r_{cs} defined in the previous paragraph.

Inequalities (5) linearize the constraints imposed by the sector-specific fixed quantities of capital K_s and any other input Z_s considered to be fixed within any period and which were represented more generally in equation (1b) of Table 1. Once again these input coefficients could be thought of as those derivable from the profit-maximizing solutions to the GEM model, i.e., from equation (19) and (1b)

Inequality (6) imposes the aggregate savings constraint, with household savings of each household type, S_c, defined for given consumer prices, as in equation (34) or equation (10) below, and likewise business savings, S_n, defined in terms of equation (25) of Table 1 or equation (10) below and government savings, S_G, defined as in equation (26) of Table 1 or equation (9) below. With given prices and tax rates, etc., these functions, too, would be linear in terms of the activity levels

For a given exchange rate, Pfe, and given the world prices of imported goods of class k, Pm_{wk}, and of domestic goods, P_s, and the export tax, te_s, the export price, Pe_s, is known from equation (13) of Table 1. This makes inequality (7) linear in the activity variables M_k and $\overline{R}_s$. The terms on the right hand side of (7) are the level of foreign assistance, $\overline{S}_F$, and ΔR, the latter term representing the exogenously specified desired increases in the stock of international reserves. The exogenous right hand side values in the export demand constraint (8) might well come from a calculation, for given $\overline{Pfe}$ and external prices, from an econometric analysis such as that given by equation (27) in Table 1.

This version of the model is completed by defining the various savings variables included in inequality (6). Government savings S_G is defined in equation (9) as the difference between total government revenue (comprised of export taxes,

import duties, income taxes, profits taxes and other indirect taxes), supplemented by the exogenously determined net transfers to government, and the exogenously determined government consumption expenditures.

Likewise, household savings are defined in equation (10) as in equation (24) of Table 1 in terms of the difference between disposable (after tax) income supplemented by the exogenously determined net transfers to households and the value of consumption expenditures -- both endogenous and autonomous. Finally, enterprise savings or profits are specified as the net after-tax difference between value added, supplemented by net transfers to enterprises, and the wage bill.

C. Detailed Specification of the Functional Forms of a Single Period GEM for the Egyptian Prototype

In section A we outlined a rather general version of a GEM model that would be applicable (with suitable modification) to virtually any developing country. In this section we attempt to give specific functional forms to the equations specified earlier. The functional forms utilized are chosen so as to be as general as possible, i.e., to make as few as possible limiting assumptions about behavioral parameters, within the range of alternative forms provided for which were listed in Section III above. But, at the same time, they are chosen so as to limit as much as possible the data requirements. Indeed, the specification we adopt in Table 3 below utilizes as its basic source of statistical data for the Egyptian economy the Social Accounting Matrix (SAM) for Egypt in the year 1976 provided by Eckaus, McCarthy and Mohie-Eldin (1978). This source of data is utilized for setting estimating the values of the more easily specified estimated parameters, such as input shares, and tax rates. The values of the other, more difficult-to-estimate, parameters, such as the elasticities of substitution among inputs of primary factors and between imports and domestically produced goods, are simply assumed, and then subjected to sensitivity analysis.

The specification and its solution strategy follows that of Section III A above. That is, we begin by assuming the prices of products and factors to be given initially, along with the existing sectoral stocks of capital. In contrast to the more general but simplified specification in Section A above, however, where commodity prices, P_i or Pm_k, were assumed to be identical for all demanding sectors, numerous studies of Egypt, including those of Eckaus, McCarthy and Mohie-Eldin (1978), Hansen and Nashashibi (1975), the World Bank and the International Monetary Fund, have made it very clear that prices are not the same to all purchasers. Indeed, the Egyptian mixed market system is replete with numerous instances of market fragmentation, segmentation and price differentials. Tax rates and subsidies vary considerably depending on who the purchaser is. Therefore, instead of simply having a vector of prices for domestically produced commodities and another for imported commodities, Pd_i and Pm_k, respectively, in this case we require price matrices, Pd_{ij}, and Pm_{kj}, where Pd_{ij} represents the price of domestic good i to purchasing sector j, and Pm_{kj} represents the price of import k to sector j.

As before, we assume that domestic and imported commodities, even if of the same commodity class, are not homogeneous and, therefore, need not command the same price. For this reason, we again classify imports with different class subscripts (k) than domestic goods (i) even though i and k may have the same name.

Other differences in assumptions between the earlier more simplified version of the GEM specification given in Table 1 above and the more detailed specification of GEM for the Egyptian prototype given in Table 3 are the following:

a. The aggregate supplies of all variable factors, instead of being considered to be variable, e.g., as determined by factor supply functions (equation 21) in Table 1, are in Table 3 assumed to be fixed. The reason for imposing this greater degree of inflexibility is primarily the absence of information about the size of the relevant supply elasticities and secondarily the desire for simplicity. This assumption can easily be relaxed by the user. Because of the relative importance and extent of rural-urban differences in wage rates, although, in principle each sector demands all six different types of variable factors (labor), in practice, the four rural sectors and eight urban sectors are specified to utilize only three mutually exclusive such types. This implies that the rural and urban labor markets are entirely separate, hence characterizing the labor markets as dualistic.

b. In contrast to Table 1 where government expenditures and their breakdown into commodities and sources (domestic and imported) were treated endogenously and affected by government revenues as well as prices, in Table 3 we assume, we think more realistically for Egypt, that government expenditures are exogenous and thus independent of both government revenues and commodity prices.

c. Because the savings-investment relationships for Egypt are deserving of more detailed specification, our presentation of the Egyptian prototype version of GEM in Table 3 includes a separate Section V for the savings-investment relationships, thereby increasing by one the number of sections of the model.

d. Instead of providing for two fixed inputs K and Z for each sector as in Table 1, the specification in Table 3 provides for only one fixed factor, K. As before, Section I contains the production relationships, most of which are physical relationships in terms of physical units; Section II contains the price and profit relationships, Section III provides the factor supply and demand relationships in

Section II subject to the production relationships in Section I. Section IV generates factor incomes and then allocates them into expenditures on the individual commodities and sources thereof. Section V is the new one dealing with savings and investment, formerly included in Section IV. Finally, the commodity balance relationships are included in Section VI.

As before, i.e., Table 1, the specification of the prototype version of GEM begins in Section I of Block A with the production functions, the global one for X_s, given by (1a) and that for the value added component, V_s, in equation (1b). Notably, the production function for V_s is of the CES form, where γ_s is the neutral technical efficiency parameter, α_{rs} is the labor share or distribution parameter, ρ_{rks} is related to the sectoral elasticity of substitution between capital (K) and aggregate labor (the variable resource, R) by $\sigma = \frac{1}{1+\rho}$, and R_s and $\bar{K}_s$ are the aggregate levels of the variable primary inputs (i.e., labor of all types) and of fixed capital in sector s. Note - non-constant returns to scale. ⇒ For solution procedure?

Equation (2) introduces the fixity of the overall input-output coefficients, a_{is}, which implies also the fixity of the value added-gross production coefficients, d_{vs}, given in equation (4). The substitution between the domestic (d_{is}) and imported (m_{ks}) components of a_{is} is provided for in equation (3) which is again of the CES form.

Section I is completed by the definitions of the interindustry demand for domestically produced and imported goods, equations (5) and (6) in Table 3, respectively.

We move now to Section II. The price index of domestic value added Pv_s is defined in equation (7) as the difference between the price of the finished product P_s and the weighted average of the domestically produced and imported commodity input prices, Pd_{is} and Pm_{ks}, respectively, per unit of value added, d_{vs}. There is no loss in generality for present purposes in normalizing the d_{vs} and hence Pv_s by setting $d_{vs} = 1$ for each s. & some gain in rigor

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Table 3

Detailed Specification of the Egyptian Prototype GEM

Block A

I. Production Relationships

Production Function for Gross Output (1a) $X_s = \text{Min}\left(\frac{Y_s}{d_{vs}}, \frac{X_{1s}+M_{ks}}{a_{is}} \cdots \frac{X_{is}+M_{ks}}{a_{is}} \cdots \frac{X_{ns}+M_{us}}{a_{ns}}\right)$

for each s, s = 1,...,12

Y/(x)

Production Function for Value Added (1b) $V_s = \gamma_s\left[\alpha_{rs} R_s^{-\rho_{rks}} + (1-\alpha_{rs}) K_s^{-\rho_{rks}}\right]^{-v/\rho_{rks}}$

variable returns to scale!? Does it allow Cobb-Douglas

for each s.

Fixity of Input-Output Coefficients (2) $\bar{a}_{is} = \frac{X_{is}+M_{ks}}{X_s} = \frac{X_{is}}{X_s} + \frac{M_{ks}}{X_s} = d_{is} + m_{ks}$

for each i,s = 1,...,12

Substitution Between Imported and Domestic Input Components (3) $\frac{m_{ks}}{d_{is}} = \frac{\bar{m}^0_{ks}}{\bar{d}^0_{is}}\left(\frac{Pd_{is}}{Pm_{ks}}\right)^{\sigma_{mds}}$

? base period

cF Demello:

k=u,s

for each k,s.

Domestic Value Added Per Unit of Gross Output (4) $d_{vs} = (1 - \sum_i a_{is}) = (1 - \sum_i d_{is} - \sum_k m_{ks})$

in principle cannot be added

for each s = 1,...,12

Interindustry Demand for Domestically Produced Commodity (5) $X_i^I = \sum_s X_{is}$ for each i = 1,...,12

Interindustry Demand for Imported Commodity k (6) $M_k^I = \sum_s M_{ks}$ for each k = 1,...,12

II. Price and Profit Relationships

Effective Price of Value Added (7)

$$Pv_s = \frac{P_s - \sum_i d_{is} Pd_{is} - \sum_k m_{ks} Pm_{ks}}{\underbrace{1 - \sum_i d_{is} - \sum_k m_{ks}}_{\text{unit added value}}} = \frac{P^*_s}{d_{vs}}$$

for each s.

Unit Profits (8)

$$\pi_s = Pv_s d_{vs} - \sum_c r_{cs} Pr_{cs}$$

for each s.

Sectoral Profits (9)

$$\Pi_s = \pi_s X_s = Pv_s d_{vs} X_s - \sum_c R_{cs} Pr_c = Pv_s d_{vs} X_s - R_s Pr_s$$

composite

for each s.

Sectoral Profit Rate (10)

$$\pi^r_s = (\Pi_s / \overline{K}_s)$$

Implicitly measured in $

for each s, s = 1,...,12

Average Profit Rate (11)

$$\pi^r_{ave} = \sum_s \Pi_s / \sum_s \overline{K}_s$$

Sectoral Resource (12)

$$Pr_s = \sum_c b^0_{cs} Pr_c$$

endogenous? predetermined: [0 ⇒ base period.]

for each s.

Purchasers' Prices of Domestically Produced Goods (13)

$$Pd_{ij} = P_s(1 + \overline{td}_{ij})$$

for each i,j.

matrix

note: to generalize?

Domestic Prices of Imported Goods (14)

$$Pm_{kj} = \overline{Pm}_{kw}\, \overline{Pfe}\, (1 + \overline{tm}_{kj})$$

for each k,j.

Aggregate GDP Deflator at Producers Prices (15)

$$\overline{P} = \sum_s e^0_s\, Pv_s$$

Price Index of Domestic Investment Goods (16)

$$Pd_I = \sum_i f^0_i\, Pd_{i\Pi}$$

Price Index of Imported Investment Goods (17)

$$Pm_I = \sum_k g^0_k\, Pm_{k\Pi}$$

Price Deflator for Investment (18)

$$P_I = \theta^0 Pd_I + (1 - \theta^0) Pm_I$$

Commodity-Specific Consumer Price Deflators (19) $P_{C_{ic}} = \mu^1_{ic} Pd_{ic} + \mu^2_{kc} Pm_{kc}$

for each i and each c.

Aggregate Consumer Price Deflator (20) $P_{C_c} = \sum_i v_i P_{C_{ic}}$ for each c = 1,...,6

III. Factor Demand and Factor Supply

Demand Function for Aggregate Variable Resources (21)

$$R^D_s = \frac{(1-\alpha_{rs})\overline{R}_s^{-\rho_{rk}} P_{rs}^{\rho/\rho+1}}{Pv_s^{\rho/\rho+1} \gamma_s^{\rho/\rho+1} \alpha_{rs}^{\rho/\rho+1} - \alpha_{rs} P_{rs}^{\rho/\rho+1}}^{-1/\rho}$$

Assumes CRS?

for each s.

Demand Function for Variable Resource Type c (22)

$$R^D_{cs} = R^D_s \sum h^0_{cs} \left(\frac{Pr_s}{Pr_c}\right)^{\sigma_{r_c r_s, s}}$$

for each c and s.

Rs is a composite of Rc's

Aggregate Demand for Variable Resource Type c (23) $R^D_c = \sum_s R^D_{cs}$ for each c.

Aggregate Supply of Variable Resource Type c (24) $R^S_c = \overline{R}^S_c$ for each c.

Full Employment Equilibrium (25) $R^S_s = R^D_c$ for each c.

Note: Does Pas relate to Prc the way we want? Yes: dual

Block B

IV. Factor Income Generation and Expenditure Allocation

Disposable Income of Household Class c (26) $Y_c = (1-\overline{ty}_c)\, Pr_c R^D_c + \sum_h \overline{TR}_{hc}$

can this be endogenous or not?

for each c where h = $c_1, \ldots, c_m, \Pi, G, F$

Disposable Income of the Enterprise Sector (27) $Y_\Pi = (1-\overline{t}_\Pi) \sum_s \Pi_s + \sum_h \overline{TR}_{h\Pi}$

0

where h = $c_1, \ldots, c_m, \Pi, G, F$

Disposable Income of the Government Sector (28)

$$
\begin{aligned}
Y_G = & \sum_i \sum_s \overline{td}_{is}(Pd_{is}-\overline{td}_{is})X_{is} \\
& + \sum_k \sum_s \overline{tm}_{ks}(Pm_{ks}-\overline{tm}_{ks})M_{ks} \\
& + \sum_i \sum_c \overline{td}_{ic}(Pd_{ic}-\overline{td}_{ic})Cd_{ic} \\
& + \sum_i \overline{td}_{iG}(Pd_{iG}-\overline{td}_{iG})Cd_{iG} \\
& + \sum_i \overline{td}_i\ (Pd_i\ -\overline{td}_i)Id_i \\
& + \sum_k \overline{tm}_{k\pi}(Pm_{k\pi}-\overline{tm}_{k\pi})Im_k \\
& + \sum_k \sum_c \overline{tm}_{kc}(Pm_{kc}-\overline{tm}_{kc})Cm_{kc} \\
& + \sum_k \overline{tm}_{kG}(Pm_{kG}-\overline{tm}_{kG})Cm_{kG} \\
& + \sum_i \overline{td}_{iE}(Pd_{iE}-\overline{td}_{iE})E_i \\
& + \sum_c \overline{ty}_c Pr_c R_c^D + \sum_s \overline{t}\pi\Pi_s + \sum_h \overline{TR}_{hG}
\end{aligned}
$$

Sectoral Exports (29)

$$E_i = \varepsilon_{io}\left(\frac{Pd_{iE}}{\overline{Pfe}\cdot\overline{Pe}_{ws}}\right)^{\varepsilon_{i1}} \overline{E}_{wi}^{\,D\ \varepsilon_{i2}}$$

Check McElroy: Spliced LES

Consumption Expenditures of Household Class c of Goods Type i (30)

$$C_{ic}P_{Cic} = \gamma_{ic}P_{Cic} + c_{ic}[Y_c - \sum_i \gamma_{ic}P_{Cic}]$$

for each i.

negative?

coeff don't sum to 1? Implicit savings coeff?

Poss. of negative savings?

for each i and each c.

Consumption Breakdown into Domestic and Imported Components (31)

$$\frac{m_{kc}}{d_{ic}} = \left(\frac{m_{kc}^0}{d_{ic}^0}\right)\left(\frac{Pd_{ic}}{Pm_{ks}}\right)^{\sigma_{md_{ic}}}$$

These always add up?

Import Component of Consumption of ~~Class~~ Good k by household Type c	(32)	$Cm_{kc} = \left(\frac{m_{kc}/d_{ic}}{1+(m_{kc}/d_{ic})}\right) C_{ic}$ for each k and c.
Domestic Component of Consumption of ~~Class~~ Good i by Household Class c	(33)	$Cd_{ic} = (C_{ic} - Cm_{kc})$
Government Consumption and Breakdown into Comestic and Imported Components	(34)	$Cd_{iG} = \overline{Cd}_{iG}$
	(35)	$Cm_{kG} = \overline{Cm}_{kG}$

V. Savings, Investment and Trade Balances

Household Savings	(36)	$S_c = Y_c - \sum_i P_{Cic} C_{ic}$ for each c.
Enterprise Savings	(37)	$S_\Pi = Y_\Pi$
Government Savings	(38)	$S_G = Y_G - \sum_i Pd_{iG} Cd_{iG} - \sum_k Pm_{kG} Cm_{kG}$
Foreign Savings	(39)	$\overline{S}_F = MN - EN - \sum_h \overline{TR}_{Fh} - NFY \cdot P_{NFY}$
Total Savings	(40)	$S = \sum_c S_c + S_G + \overline{S}_F + S_\pi$
Real Investment	(41)	$I = S/P_I$
Nominal Imports	(42)	$MN = \sum_s \sum_k M^I_{ks} \overline{Pm}_{wk} \overline{Pfe} + \sum_c \sum_k Cm_{kc} \overline{Pm}_{wk} \overline{Pfe}$ $+ \sum_k Cm_{kG} \overline{Pm}_{wk} \overline{Pfe} + \sum_k Im_{k\Pi} \overline{Pm}_{wk} \overline{Pfe}$
Nominal Exports	(43)	$EN = \sum_i E_i Pd_{iE}$
Investment Breakdown by Commodity	(44)	$I_i = \bar{a}_{iI} I$ — to even out demand. But next ~~goods~~ periods capital stock?
Domestically Produced Investment Goods	(45)	$Id_i = d_{iI} I_i \left(\frac{Pm_{k\pi}}{Pd_{i\pi}}\right)^{\sigma_{iI}}$

Imported Investment Goods	(46)	$Im_k = I_i - Id_i$

VI. Commodity Balances

Aggregate Demand for Domestically Produced Commodity i	(47)	$X_s^D = \sum_s X_{is} + E_i + \sum_c Cd_{ic} + Cd_{iG} + Id_i$
Aggregate Supply of Demand Equilibrium	(48)	$X_s^D = X_s^S$ for each s.
Imports of Class k	(49)	$M_k = \sum_s M_{ks} + \sum_c Cm_{kc} + Cm_{kG} + Im_k$ for each k.
Aggregate Imports	(50)	$M = \sum_k M_k$

Equation (8) defines unit profits as the residual obtained after subtracting the unit costs of the interindustry inputs, $\sum_i Pd_{is}\, d_{is} + \sum_k Pm_{ks}\, m_{ks}$, and of the variable primary inputs $\sum_c Pr_c\, r_{cs}$ from the price of output, P_s. Likewise, equation (9) generates sectoral profits as the profit per unit of output multiplied by the number of units of output. Equation (10) defines the sector-specific rate of profit, π^r_s, as sectoral profits per unit of the capital stock. Equation (11) gives the overall average profit rate, π^r_{ave}. Equation (12) defines the sector-specific price index of labor costs, Pr_s, as the weighted average of the price indexes of the different kinds of labor Pr_c, the weights b_{cs}, representing the relative quantity shares of each type of labor c in the aggregate wage bill of sector s. The matrices of domestic prices and import prices, Pd_{ij} and Pm_{kj}, respectively, are defined in equations (13) and (14) and are dependent on the homogeneous prices, P_s and $\overline{Pm}_{kw} \cdot \overline{Pfe}$, of domestic and imported goods as well as the matrix of tax rates on domestic and imported goods, $\overline{td}_{ij}$ and $\overline{tm}_{kj}$, respectively.

Equation (15) defines the aggregate GDP price deflator as a weighted average of the sectoral prices, the weights being the base period quantity shares of value added of sector s in total product or value added. Similarly, equations (16), (17), (18), (19) and (20) define price indexes for their respective expenditure types i.e., for domestically produced investment goods, Pd_I, imported investment goods, Pm_I, overall investments, P_I, consumption goods of type i by household type c, $P_{C_{ic}}$, and the overall price deflator of consumption for each household type P_{Cc}, as weighted averages of their component price indexes, Pd_{ic} and Pm_{kc}, respectively, the weights being the base period quantity shares.

Equation (21) consists of the profit-maximizing demand for variable input functions. It has been derived by maximizing profits, i.e., equation (9), subject to the constraint of the CES production function, with capital assumed to be fixed in the

short run. The advantage of these functional forms is not only their generality but also their ease-of-estimation. Specifically, one can assume the technical efficiency parameters γ_s to be equal to unity. The distribution parameters α_{rs} and $(1 - \alpha_{rs})$ are the shares of aggregate variable resources (labor) and capital in sectoral value added. Once again, these values can be taken directly from the Egyptian SAM. The parameter ρ_{rks} is, of course, related to the elasticity of substitution σ by $\sigma = \frac{1}{1+\rho}$. The value of σ can be assumed to be generally between 0 and 1, and a priori, can be assumed to vary among sectors, e.g., being higher in agriculture than in the manufacturing sectors. Note that each of these equations depends on the same variables and parameters. suggestions ?

Equation (22) provides for the disaggregation of the aggregate demand for labor into the demand for labor for each skill class c. Note that in this formulation the disaggregation depends partly on the base period quantity shares of each skill class, h^0_{cs}, and partly on the relative prices of the variable factors, Pr_c. By setting the values of $hc_s = 0$ for c = 1, 2, 3, and s = 1, 2, 3, 4 and for c = 4, 5, 6 and s = 5, 6, ... 12, rural-urban dualism in labor markets can be imposed. Once again, for the same reasons given above, the CES form is employed. The limiting assumptions of this specification are that the production function is separable, first, into capital and total labor and, then, into different labor types and that $\sigma_{r_c r_s, s}$ is identical among pairs of labor skill types. note

Equation (23) is the aggregate demand for each variable resource R^D_c. Equation (24) states that the aggregate supply of each variable resource type c is considered to be given in any period. Section III is completed with the full employment equilibrium condition for R_c, equation (25). The assumption of full employment, implying that variable resource prices, i.e., the wage rates of all skill types are flexible in both directions, is admittedly a strong one for low income, high population LDCs like Egypt. It is an assumption, however, that can easily be relaxed when it is deemed desirable to do so. For example, this could be done by dropping the equilibrium condition and substituting an exogenously determined vector of wage rates. The exogenously determined wage rate can be justified in any one of several cir- eq mon it

cumstances. For example, in the presence of surplus labor, the wage rate of the modern (profit-maximizing) sectors can be considered to be given by the subsistence wage or some multiple thereof. Alternatively, the exogenous wage rate can be defended for the modern sector on the basis of institutional rigidities - contractual agreements inherited from the past, transactions costs associated with hierarchical job structures, etc. Likewise, the wage rates of the different types can be assumed to vary freely so as to clear the market for each labor type or they can be assumed to remain in fixed proportions according to the inherited job structure and skill and experience compositions of the labor force. In practice, the fixed wage rate can be imposed most easily by simply setting the so-called "damping" or wage adjustment factor equal to zero. Alternatively, inflexibility can be confined to the case of excess supply and to labor of a certain type. This allows us to simulate the classical case of surplus labor with a subsistence wage rate. Nevertheless, the present specification is defended on the grounds that it takes fuller advantage of the GEM character. Likewise, it should be pointed out that the fixed supply assumption for the variable factors of equation (24) could easily be relaxed by adding a series of factor supply functions, as in the more general specifications given in Table 1 above.

Section IV begins by generating the disposable incomes of the variable factors, i.e., of the household types c, c = 1...m, Y_c, in equation (26), of the enterprises, Y_π, in equation (27), and of the government sector, Y_G, in equation (28). Since these equations are essentially definitions and follow the specification of Table 1 above, we feel it unnecessary to explain them further. Note that there are quite a number of different sources of government revenue involving a large number of different tax rate instruments, thereby increasing the policy relevance of the present specification of GEM. Once again, most of the tax parameter values can be taken directly from the Egyptian SAM.

Equation (29) is a demand function for exports of Cobb-Douglas form. While the values of ϵ_{i1} and ϵ_{i2} could be empirically estimated without great difficulty, there is a considerable amount of available information from other studies about such parameter values, making it appropriate to assume values for these parameters and then subsequently to subject them to sensitivity analysis.

The system of equations (29) is the extended linear expenditure system (ELES) which is especially convenient for empirical estimation in multisectoral models such as the present one [Phlips (1976), Lluch (1977), Theil (1979)], although quite demanding in terms of data, and estimation technique (imposing constraints across equations). In the case of the Egyptian SAM, however, values of the required parameters can be obtained easily if one is to assume that workers in the lowest skill groups, i.e., the lowest 60 percent of the rural and labor forces, respectively, can be regarded as operating at the subsistence margin. If so, their consumption patterns can be regarded as providing the subsistence components ($P_{C_{ic}} \gamma_{ic}$). The marginal propensities to consume c_{ic} out of discretionary income, i.e., that above the subsistence level, can then easily be estimated as the ratio of the additional expenditure to the additional income that such groups have. As mentioned above, the user also has the flexibility to choose other options for the form of the consumption function. Equations (31), (32) and (33) are CES demand functions that serve to disaggregate the total consumer demand for each commodity class down into its imported and domestically produced components. Equations (34) and (35) indicate that both components of government consumption are exogenously determined.

The separation of the consumption and savings functions into those relevant to different household types and different functional distribution of income sources reflects the belief that the functional distribution can be an important determinant of the savings rate. This is a reflection of the widely held Marks-Lewis hypothesis that the marginal propensities to save are very different out of different types of income, a hypothesis for which there is considerable empirical support, especially in the LDC context [Houthakker (1961), Williamson

(1968, 1970) and Holbrook and Safford (1971) . The user has the flexibility to redistribute all income to the households, thereby allowing the user to relax this assumption and to test for the sensitivity of the results to its imposition.

the subsistence level. Equations (31), (32) and (33) are CES demand functions that serve to disaggregate the total consumer demand for each commodity class down into its imported and domestically produced components. Equations (34) and (35) indicate that both components of government consumption are exogenously determined.

As mentioned above, Section V is concerned with savings, investment and the trade balances. Equations (36) - (39) define savings of the household sectors, S_c, of the enterprise sector, S_π, of the government sector, $\overline{S_G}$, and of the foreign sector, $\overline{S}_F$, respectively. While the first three types of savings are assumed to be endogenously determined, consistent with the basic purpose of the model, the level of foreign savings, $\overline{S}_F$, is exogenous. Equation (39) requires that solutions for imports and exports, both evaluated in nominal terms, consistent with the exogenous $\overline{S}_F$ be obtained. Equation (40) defines aggregate savings and equation (41) converts aggregate savings (in nominal values) into real investment by deflating by the price index of investment goods, P_I, which was defined in equation (16) above.

Equation (42) defines the nominal value of imports as the sum of the pretax values of intermediate goods imports, consumption goods imports, government imports and investment goods imports. Likewise, equation (43) defines the nominal value of total exports.

In the absence of an independent investment equation, according to equation (41) investment is essentially savings-determined. While this may well be unrealistic for some countries, especially in the short run, in the medium-to-long-term it is thought to be fairly realistic, especially for Egypt where there would seem to be no dearth of investment opportunities. This assumption will subsequently be relaxed by introducing an independent equation for investment demand. As in the case of the input-output coefficients, aggregate investment, I, is broken down into specific investment goods, I_i, in equation (44) by assuming fixed coefficients, $\bar{a}_{iI}$, and then subsequently into the domestic and imported components, Id_i and Im_k, in equations (45) and (46), respectively.

Finally, in Section VI are the commodity balance equations. These begin with the aggregate demand for domestically produced commodity s, X_s^D, in equation (47). The supply of s, X_s^S, from equation (1a) above is set equal to the aggregate demand for s in equation (48).

Equation (49) defines the aggregate demand for imports of type k (in real terms) and, finally, equation (50) aggregates over all commodity types to obtain total imports.

D. Data Preparation and Parameter Estimation of GEM for the Egyptian Prototype

As has been mentioned in the previous section, the functional forms for the Prototype GEM have been chosen in such a way as to provide considerable generality while at the same time economizing on data requirements. Indeed, as shall be demonstrated below with respect to the Egyptian case, all parameters specified in the model can be estimated, at least crudely, from data provided by a single Social Accounting Matrix (SAM) (or alternatively from an input-output table supplemented by a budget study), plus some educated guesses about some of the more difficult-to-estimate parameters.

The starting point is, therefore, the Egyptian SAM for 1976 provided by Eckaus, McCarthy and Mohie-Eldin (1978). This table provides for 12 productive sectors, six labor types, one capital type, imports and government taxes. Final demand is accordingly broken down by the six labor types, various types of government, exports and investment, and each of these is, in turn, disaggregated into the twelve commodity sectors, imports, taxes and savings.

Since the potential usefulness of SAM tables for development planning and policy analysis, especially for dealing with distributional issues, has already been demonstrated in a number of studies,[1/] we shall not belabor the point here. Rather, we shall simply assume that such a table is available, as it is in the case of Egypt, and proceed from there to describe how we arrive at estimates of the variable parameter values for the prototype GEM outlined in Table 3 above.

The methods used in constructing the Egyptian SAM for 1976 are described rather completely in Eckaus, McCarthy and Mohie-Eldin (1978). The basic ingredient was the Ministry of Planning's 1970-71 Input-Output Table for Egypt at producers' prices of 1969-70. That table was revised in such a way as to be consistent with the Egyptian National Accounts, disaggregated further with respect to the agriculture and housing sectors, aggregated further in other sectors, and then updated to 1976 on the basis of price indexes for the rows and quantum indexes for the columns by the RAS method and by other information[2/] so as to be consistent with 1976 final demand. Value added in each sector was disaggregated from data in the agricultural and industrial censuses into the functional income shares - land, capital and labor for the private sector and capital and labor for the public sector - each of which was then subsequently distributed into six household types - lower 60%, middle 30%, and the top 10% in both rural and urban areas - from the data provided

[1/] See, for example, Pyatt and Thorbecke (1976), Pyatt and Roe (1978), Adelman and Robinson (1978), Dervis and Robinson (1978), and Taylor (1979).

[2/] In this process account had to be taken of several important activities that were not present in 1970-71, notably the iron and steel and aluminum complexes and the reopening of the Suez Canal.

in the CAPMAS surveys of labor force, wages and hours worked and a residal for profits of the public enterprises. Emigrant remittances were also distributed among the six household groups. The expenditures of the six household income groups were then disaggregated into the twelve commodity classes and imports on the basis of the household budget studies. Another feature of the Egyptian SAM is that it spells out the role of the government sector quite carefully and in detail. For example, it distinguishes the various kinds of tax receipts, such as import tariffs, excise taxes, direct taxes, and export taxes, and also distinguishes various types of governmental expenditures, such as subsidies, government consumption, transfer payments and savings, by each of three types of government - conventional government, public enterprises and the state trading organization.

The sectoral classification of the Egyptian SAM would seem highly suitable for the various kinds of models used in this User's Guide. In particular, it is highly satisfactory that among the twelve sectors are four agricultural sectors, including one export-oriented sector (cotton), one staple food sector, one non-staple food sector and finally the rest of agriculture. The factor proportions and employment compositions of these sectors are quite different one to another, and of course, the demands for their products differ substantially from one household group to another. Some degree of disaggregation of agriculture, moreover, would seem important for any macro modelling efforts in LDCs because of the relative importance of agriculture in both Gross Domestic Product and employment. These shares are approximately one-third and one-half, respectively, in the case of Egypt.

Another advantage of the sectoral classification of the Egyptian SAM is that it separates out three other sectors of interest as far as basic needs are concerned - food processing, textiles and housing. It is also advantageous that certain other sectors that are important for investment and employment, such as transport and communication services and construction, are distinguished. Some disadvantages

are that both the machinery industries and electricity, which are, of course, very different industries and important in their own right, are included among the large and heterogeneous "Miscellaneous Industries" sector. Although the crude petroleum refining industry is separated out, the fact that electricity is included in a large miscellaneous industry sector would limit the usefulness of the Egyptian SAM for analysis of energy-economic interaction, which may be considered an important potential application of data of this sort.

Because of the appropriateness of the sectoral classification in the existing Egyptian SAM for most relevant applications, the sectoral classification system is retained intact. This is shown in Table 3 below. Similarly, because of the lack of a convenient alternative procedure, we rely on the same disaggregation of labor incomes and private non-wage income into the six household types -- (1) urban lowest 60%, (2) urban middle 30%, (3) urban top 10%, (4) rural lowest 60%, (5) rural middle 30% and (6) rural top 10%. As has been mentioned above, the rural-urban distinction would seem quite relevant not only for the Egyptian case but also for that of most LDC.

There are, however, five characteristics of the Egyptian SAM for 1976 and hence of the subsequent specification of GEM-type models by Eckaus, McCarthy and Mohie-Eldin (1978) that we consider suboptimal for use in the type of models provided for in this User's Guide.

First, the Egyptian SAM treats all imports as if they are, of a single type non-competitive with domestically produced goods. While this may have been realistic for Egypt in the past, it would seem unrealistic for the future, especially, considering the Egyptian government's strong commitment to an "Open Door" policy with respect to trade and investment. Moreover, while such a specification is common in many planning models of the LP type, this assumption would not allow the user to take full advantage of the GEM approach. Although, in fact, reality may be somewhere in between, we have chosen to treat all imports as potentially competitive, but with varying degrees of elasticity of substitution between domestic production and imports. This treatment requires, of course, the disaggregation of the single import row in the Egyptian SAM into several classes of commodities k = 1...n. As has been stressed above, we deem it appropriate to consider each

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class of imports k as different from the corresponding class of domestically produced goods, thereby commanding a different price.[3/]

how? p. 68

Second, because of the rather massive evidence that commodity prices vary from one user to another because of varying taxes and subsidies resulting in some confusion in the treatment of subsidies and taxes in the Egyptian SAM,[4/] we have found it important to create a matrix of net tax rates that allow commodity prices to vary by user.

Third, although the relative size and importance of the public sector and the rather different roles played by public sector enterprises, conventional government and the state trade organization indeed justify the disaggregation of government in the Egyptian SAM into these three sectors, both the current context of foreign assistance planning and resource allocation, and the usefulness of the Egyptian prototype model for other LDCs where such distinctions are either unimportant or impractical lead us to simplify the analysis by dropping this distinction. Because of the inclusion of a full tax matrix, this simplification in no way reduces the usefulness for policy of the present specification.

Fourth, the lack of inclusion of data on sectoral capital stocks or alternatively on maximum flows of capital services in the Egyptian SAM would seem to be an important shortcoming, at least in the current context in which short or medium term models are considered and applied, and especially in view of the scarcity of capital in contemporary Egypt. In contrast to most of the specifications of GEM-type models in the literature (which generally use either a neoclassical cost function approach or a generally less neoclassical production function approach), as noted above our approach emphasizes a profit function approach in which the existing

[3/] See especially Eckaus, McCarthy and Mohie-Eldin (1978), World Bank (1977), International Monetary Fund (1978), Hansen and Marzouk (1965), Hansen and Nashashibi (1975), Abdel-Fadil (1975), and Mabro and Radwan (1976).

[4/] The confusion in this respect has been noted in correspondence between the MIT group (i.e., the authors of the Egyptian SAM) and Mike Crosswell of AID.

capital constraints are made explicit in the (cost-minimizing or profit-maximizing) determination of the demands for the variable factors of production and the supplies of output. For this reason we deem it important to supplement the Egyptian SAM with estimates of the existing sector-specific capital stocks.

Fifth, the figures given for profits in the SAM table are unrealistically low. Indeed, they are zero in some sectors. The reason for this is that the profits given are only those of the public corporations, profits of the private sector having been treated as going directly to households and therefore eliminated from profits in the table. By making the labor shares in value-added unity (or close to it) in several sectors and the non-labor shares in value added zero (or close to it), this assumption plays havoc with simulation experiments based on the functional forms specified above. Although we have used the profits figures as they are in the SAM table (Model 1), we place greater emphasis on what we consider to be the more realistic case in which private profits are added to profits but then are redistributed to households in the proportions stipulated in the text accompanying the SAM table [Eckaus, McCarthy and Monie-Eldin (1978)]. This modified treatment is referred to as Model 1 M1, i.e., Model 1 Modification 1.

Note see p. 79

Next, we describe in each case our method for implementing the proposed changes in or supplements to the Egyptian SAM for 1976. For convenience of reference the 1976 Egyptian SAM is given in Appendix Table A-1.

Imports

The Egyptian SAM for 1976 provides in Rows 25 and 26 imports by sector of destination, the distinction between rows 25 and 26 being whether the imports are undertaken by the Government Trade Organization (Row 25) or not (Row 26). Since, as explained above, this distinction would seem unimportant for present purposes, we aggregate the figures in these two rows and then attempt, to disaggregate them by commodity class, k, k = 1...12 corresponding to the twelve sectors

designated as rows 1-12 in the Egyptian SAM, the definitions of which are reproduced in Table 4 above. The disaggregation was accomplished by taking into consideration the distribution of such imports available in the 1954 input-output table,[5/] the one and only I-O table for Egypt that breaks all elements of the table down into domestic and imported components, as well as the detailed commodity classification of imports available from the UN Yearbook of International Trade Trade Statistics (various years) and from the Statistical Appendices of the World Bank and IMF Reports.[6/]

The Tax Matrices

Similarly, the Egyptian SAM for 1976 given in Appendix Table A-1 provides row vectors of indirect taxes on imports (row 28), other indirect taxes (row 29) and subsidies (row 30). Since subsidies are simply negative indirect taxes, these two rows can be aggregated into a single row vector of net indirect taxes (other than import tariffs) which apply to both domestic and imported goods. We then proceed to disaggregate these row totals into the individual commodities taxed according to various information about tax rates, the nature of the subsidies, etc.[7/] Although, the procedure followed was admittedly ad hoc, we believe the resulting matrices for domestic td_{ij} and imported goods tm_{kj} presented in Tables 6 and 7 to be fairly representative.[8/] In any case, as alternative estimates become available, the new tax rates can simply be inserted by altering the data base.

[5/] See Eleish (1964, Table 1).

[6/] World Bank (1977, Volume 6, Tables 7.30-7.32, 3.7, 3.15, 3.16), International Monetary Fund (1978, Appendix III, Table 51).

[7/] Especially useful in this regard were the nominal and effective tariff rates available in Mabro and Radwan (1976, Table 4.3, p. 61), World Bank (1977, Volume 6, Table 5.9, 5.10) and International Monetary Fund (1978, Appendix III, Tables 28-30).

[8/] Note also that the Egyptian SAM itself and the description of methods used therein [Eckaus, McCarthy and Mohie-Eldin (1978, Sections II 6 and III) contain the tax rates applied to the export commodities and to machinery imports, i.e., imports of Commodity 7.]

Table 4

Sectoral Definitions for the Twelve Sector Egyptian Prototype GEM

Sector No.	Sector Name	Description
1	Staple Food	(wheat, barley, maize, millet, rice, beans, lentils, lupine, chickpeas, and fenugreeck)
2	Non-Staple Food	(flax seeds, peanuts, sesame, sugar cane, vegetables and onions, fruits, milk, live animals and birds for fresh meat, eggs, honey, fishing, hunting)
3	Cotton	(cotton, cotton seed)
4	Other Agriculture	(linen, flax, jute, fodder, wool, sponges, flowers, logs, firewood, animal labor, organic fertilizers, other crops)
5	Food Processing Industries	(processing of foods, beverages and tobacco including fresh meat, vegetable oil, cheese, flour, sugar)
6	Textile Industries	(spinning and weaving of cotton, wool, silk and synthetic fibers, footwear, ready-made clothing)
7	Miscellaneous Industries % of Value Added?	(mining and quarrying, wood and furniture, paper and painting, leather, rubber, chemicals, non-metallic minerals, basic metals, non-electrical machinery, electrical machinery, repair and miscellaneous industries, electricity)
8	Construction	(construction and maintenance)
9	Petroleum and Petroleum Products	(crude oil, natural gas, petroleum products, coal and coke)
10	Tranport and Communication	(transport, communication, storage, Suez Canal)
11	Housing	(housing services)
12	Other Services	(financing, banking and insurance, commerce, public utilities, health services, education, recreation, tourism)

Aggregation of Government

The third change, namely the aggregation of the government sectors, is a straightforward calculation based on the data contained in rows and columns (23) and (24) of the Egyptian SAM given in Appendix Table A-1. Since row (22), profits of public enterprises, are treated as returns to capital, these flows are kept separate as returns to the fixed factors of production, K_s.

Capital Stocks

While there are some existing estimates of the capital stocks in some sectors of the Egyptian economy for various years in the past,[9] to our knowledge there are no existing estimates for recent years. In the absence of such data, we attempted to get upper bound estimates of the sectoral capital stocks by assuming that the incremental sectoral capital-output ratios (ICORs), computed from planned increases in gross production (1976-1985) and accumulated gross investments (1975-1984) from recent planning projections of the Institute for National Planning in Cairo, would be equal to the average capital-output ratios. The ICORs and resulting estimates of the sectoral capital stocks are given in the first two columns of Table 8. These ICORs were considered to yield overestimates of the sectoral capital stocks both because the incremental capital-output ratios are undoubtedly considerably larger than the average ratios, and because at the present time the inherited capital stock in most sectors of the economy is considered to be in varying degrees of deterioration, resulting from long periods of neglect, insufficient maintenance and considerable obsolescence. The overestimation of effective capital stocks by this procedure was thought to be especially great in the transport services industry, sector 10, in which the above calculation yielded an unrealistically high capital-output ratio. The high capital-output ratio and hence high value of the capital stock computed for sector 11, housing, is more realistic. In

[9] See for example Mabro and Radwan (1976, p. 156).

Table 5

The Matrix of Imports by Sectors of Origin and Destination
(in millions of Egyptian Pounds)

	1	2	3	4	5	6	7	8	9	10	11	12	Total Intermediate	The Household Sector. 1	2	3	4	5	6	Total Household	Total	G	I
[illegible]	5			2	100							15	122	4	4	5	3	3	2	21	193		
[illegible]		1		1	80								82	12	13	16	12	9	6	68	1.0		
[illegible]																							
[illegible]		5				7							12	1	1	1	1	0.6	0.4	5	17		
[illegible]	1	17		1	94		2					12	127	8	8	10	7	6	4	43	170		
[illegible]					2	20	3						25	7	7	10	6	4	3	37	62		
[illegible]	12	32	13	17	107	17	349		2	9		5	559	207	196	262	172	118	65	1.02	661		331
[illegible]																							
[illegible]	1	2	1	2	5	1	22		46	20		1	101	7	7	9	6	6	3	38	139		
[illegible]					2	1	5		18	20		15	61	3	3	4	3	2	2	17	78		
[illegible]																							
[illegible]	2	4			10	1	54			2		46	119	1	3	3		1	2	10	171		
													1208								341		

Source: See text

Table 6

TD
12×21

The Matrix of Tax Rates Td_{ij} on Domestically Produced Commodities
by Sector of Origin and Destination

	1	2	3	4	5	6	7	8	9	10	11	12		15	16	17	18	19	20		G	I	Ex
					0.06									0.23	0.30	0.19	0.18	0.28	0.44				1.3
2					0.07																		0.78
						0.38																	.55
			0.10																				
5												0.64		0.15	0.13	0.13	0.03	0.07	0.09				
12	0.53		0.52		0.65		0.06					0.10		0.24	0.24	0.24	0.27	0.43	0.18				
			0.26	0.25		0.08			0.11	0.28													0.41
17			0.19	0.30		0.06				0.22													

Source: See Text.

Table 7 The Matrix of Tax Rates Tm_{kj} on Imported Commodity by Sector of Origin and Destination

	1	2	3	4	5	6	7	8	9	10	11	12		1	2	3	4	5	6		G	I	Ex.
1	[illegible]			0.25	0.10					—		0.20		0.25	0.25	0.20							
2					0.63									0.35	0.38	0.38	0.17	0.33	0.33				
3																							
4						0.29																	
5					0.74							0.25		0.34	0.13	0.20	0.14	0.08					
6					0.50	0.60																	
7	[illegible]	1.2	0.38	0.60	0.57	0.47	0.34		0.50			0.60		0.29	0.61	1.15	0.15	0.42	0.69				
8																							
9					0.20		0.23		0.72					0.29	0.29	0.33	0.33	0.33	0.33				
10																							
11																							
12					0.20																		

Table 8

Estimates of Planning ICORs, and Sectoral Capital Stocks Under Alternative Assumptions

			Alternative Estimates of Capital Stock			
			A	B	C	Implicit ICOR?
			By Applying ICOR to 1976 Gross Value Added	Calculated from Equation (1b) in Table 3 with Actual V_s, R_s $\gamma = 1$, $\sigma = .5$		
	Sector	ICOR		V1	V1M1	
1.	Staple Food	2.25	713	611.4	352	
2.	Non-Staple Food	2.25	1804	1535	783	
3.	Cotton	2.25	454	404	228	
4.	Other Agriculture	2.25	986	876	492	
5.	Food Processing	1.73	327	318	159	
6.	Textiles	1.73	623	593	412	
7.	Other Industries	1.73	561	687	565	
8.	Construction	.60	152	378	315	
9.	Crude Oil	.60	202	234	106	
10.	Transport	5.37	2438	489	458	
11.	Housing	8.53	1143	254	133	
12.	Other Services	.77	1655	4015	2984	

Source: See Text

this case, however, because of the much lower depreciation rate in this sector, in terms of capital service flow equivalents the effective capital service yield of this sector is likewise seriously overestimated. In contrast, it was suspected that the ICOR for sector 12, other services, was seriously underestimated and, therefore, that the measure of the existing capital stock in sector 12 given in column 2 of Table 8 is unrealistically low.

Given the dubious quality of these estimates, we subsequently revised these estimates downward as part of the calibrating process, specifically by solving for K_s in equation (1b) in Table 3 given the base data on R_s, V_s, the labor shares in value added α_{rs} and assumed values of γ ($\gamma = 1$) and σ. The results of this alternative calculation of K_s are given in the third column, column B, of Table 8.

Other changes that were required in order to carry out the above changes were the following:

a. The items in row (24) of the Egyptian SAM in Appendix Table A-1 - government sales - are redistributed to the rows (primarily (1), (4), (5) and (7)) representing the forms - which the government trade sales take. The commodities exported directly by the government trade organization, i.e., 17 millions of E.L. in sector (1), 2 millions in sector (2), and 100 millions in sector (3), are aggregated with real exports, column (26) of the same table; the remaining purchases of government trade, column (24), are aggregated with household consumption, according to the distribution discernible from row (24) and the commodity composition of these elements in column (24) of the Egyptian SAM table.

b. The items in column (25) of the Egyptian SAM, "price differential", are removed from the real flows affecting the commodity balances, etc. but are incorporated and used for computing the sector-specific export tax rates in the Td_{ij} matrix, i.e., the matrix of sector and commodity-specific tax rates on domestically produced goods.

Although these differentials are not called export taxes, arising instead

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from the differential exchange rates attached to these "traditional" export items, they play the same role as export taxes and, therefore, are treated as such in our model. We feel that this procedure is more correct than the procedure utilized by Eckaus, McCarthy and Mohie-Eldin (1978). However, since in their treatment these differentials serve as real flows, this change results in aggregate demand being less than aggregate supply by exactly the amount of these export taxes. In order to agree with the SAM table "solutions" for 1976, therefore, we have had to add these amounts into Aggregate Demand exogenously as "XSEXOGENOUSDIFFERENCE" which in the program is called "XSDIFF". Likewise, since the Egyptian SAM table does not including these differentials as tax revenues, by adding them to export taxes we make total tax revenues and hence government savings turn out to be higher than those reported in the SAM table by exactly the amount of these differentials. Therefore, in order that our solutions agree with those of the SAM table we also introduce these differentials as exogenous subtractions in the government savings equation.

c. The direct taxes in row (32) of the Egyptian SAM are treated as profits taxes for the producing sectors, columns (1) - (12), but as income taxes for the household classes, columns (15) - (20).

d. The household class elements of the import tariffs row, row 28 in the Egyptian SAM, are inexplicably missing despite the presence of the sum given in column (21). Therefore, we have had to estimate these components.

Estimation of the Consumption Function

After the consumption taxes and import tariffs (net of subsidies) have been added to the total expenditure (i.e., the price multiplied by the quantity consumed of domestic plus imported) rows of the household expenditure columns for each of the six household class columns, i.e., rows (15) - (20), in the Egyptian SAM for 1976. The expenditure sums of the lowest 60% of the population in both urban,

Notes Savings Problem

column (15), and rural, column (18), $\sum_i \gamma_{ic} P_{C_{ic}}$, can be computed. These groups are considered to be living at the subsistence levels: hence their per capita expenditures are defined to be subsistence expenditures. no savings ? The second income (skill class) groups in urban and rural areas, i.e., columns (16) and (19), have half as many people and hence are considered to have "subsistence expenditures" ($\gamma_{ic} P_{C_{ic}}$) in each category equal to one-half the subsistence expenditures for columns (15) and (18). Similarly, for the top 10%, i.e., columns (17) and (20), "subsistence expenditures" are defined as one-sixth of the subsistence expenditures of columns (15) and (18). Such expenditures are then compared with actual disposable incomes. Any excess of disposable income for one of these household classes over subsistence expenditures for that class is defined as discretionary or supernumerary income YS. Similarly, any excess of actual expenditures over subsistence expenditures for any household class c in any commodity class i is defined as discretionary expenditure of that household type and commodity class, ES_{ic}. The marginal propensity of spend of that household type on that commodity type, c_{ic}, is measured by $c_{ic} = \frac{ES_{ic}}{YS_c}$. $\forall s$

Knowing the values of $P_{C_{ic}}$ for the base period from the assumption of $P_s = Pm_{wk} = Pfe = 1$ and the previously measured tax rates, this method provides a convenient way of estimating the subsistence and discretionary expenditure components, and thus the parameters γ_{ic} and c_{ic} for the linear expenditure system, equation (29) in Table 3. Note that the allocation of consumption in physical units will, however, be influenced by relative prices as well as the level of income.

Virtually all the remaining parameters in the system can be estimated as simple quantity or value shares. The user can list the dataseries in the sample databank for Egypt to see the values the authors have used for these parameters.

The Egyptian SAM for 1976 given in Appendix Table A-1, together with the aforementioned modifications, provides all the data and parameter values required for implementing the prototype version of GEM given in Table 3 above, other than

the hard-to-estimate elasticities of substitution and so on, the values of which have simply been assumed. The user is free to choose whatever values he (she) wants. Our assumptions are that all the remaining parameters in the system are equal to unity with the exception of the elasticities of substitution in the production functions which are equal to one-half.

As mentioned earlier on, we consider the calibration of the model to the base year data, i.e., that for 1976, to be absolutely essential for debugging purposes. The calibration routine provided in the package allows the user to overide the values calculated by the model with exogenously given values, e.g., the actual values for the base year. This procedure allows the user to debug and test out the model one component at a time. Finally, with each of the components debugged, the whole model can be allowed to run freely to see if it generates the correct values of the endogenous variables, given the actual base year values for the exogenous and predetermined variables.

Our own experience is that this process takes a considerable amount of time, longer than is generally anticipated. Yet it is essential to follow it through to its completion if indeed inadvertant errors in specification, estimation, measurement and so on are to be avoided. The base year data, parameter values, etc. for the Egyptian prototype are all available in the databank and can be obtained with the proper commands.

Early on in our experience with the prototype model, we realized several weak points in the basic model, Model 1. The principal difficulty arose from the lopsided and unrealistic functional distribution of income shares resulting from the Egyptian SAM even with the above modifications. Specifically, the capital shares tended to be extremely small, the CES functions with these unrealistically small shares being excessively sensitive to vary small changes in K, the very item that is most difficult to estimate precisely. To mitigate this shortcoming we modified the data base and model in the following way. The revised Model is referred to a "Model 1 Modification 1" or "Model 1 M1".

Modification 1

The purpose of this modification is to more realistically represent the relative contributions of capital and labor and the indirect way in which private sector profits are redistributed to households.

Since the SAM table reproduced in Appendix Table A-1 included private profits along with wages directly in household income, in order to separate out private non-labor income, we utilize the tables provided by Eckaus, McCarthy and Mohie-Eldin (1978). Specifically, we take the sectoral values of Private Value Added from the first table in Section 5 of their report and then the shares in private value added of capital and rent from the third table in the same section. We then subtract the resulting estimates of private non-labor income from household income (row 21 in the SAM table) in order to arrive at a new series for labor income that excludes private profits and rent. On the other hand, the excluded private profits and rent are added to the public sector profits (row 22 in the SAM table). These calculations are shown in Table 9.

Next, in order to disaggregate the revised wage income figures into the six household classes we utilize the fifth and sixth table in the same section of Eckaus, McCarthy and Mohie-Eldin which provide data on the shares of each household class in the value added generated by private labor, capital and land as well as labor in public enterprises of each productive sector. These shares are multiplied by the private non-labor income data provided in row 2 of Table 9. The results are shown in Table 10. The values are then subtracted from the corresponding figures in rows 15 - 20 of the SAM table to yield the sector - and household class - specific figures for labor income shown in Table 11.

Employment and wage rate by household class are calculated as follows:

(1) Employment is obtained by dividing total income of each household type from row 41 columns 15 - 20 of the SAM table (Appendix Table A-1) by the corresponding "income per earner" figures at the bottom of the SAM table. These figures are

Table 9

Derivation of Labor and Non-Labor Incomes by Sector for Use in Modification 1

	Concept	Sectors 1	2	3	4	5	6	7	8	9	10	11	12
1	Private Value Added	289	731.9	202.0	438.0	133.6	160.7	109.5	75.7	57.7	28.2	123.9	1093.0
2	Value Added Generated by Private Capital	161	459.6	109.9	240.5	93.7	110.2	67.6	38.2	53.8	17.3	74.3	655.8
3	Household Value Added inclusive of Private Capital (2+4)	302	755	202	438	150	277	274	170	75	193	125	1962
4	Value Added from Labor	141	295.4	92.1	197.5	56.3	166.8	206.4	131.8	21.2	175.7	50.7	1306.2
5	Value Added from Capital and Land	176	510.6	109.9	240.5	107.7	163.2	362.6	122.2	302.8	278.3	83.3	742.8
		317	806			164	330	569				134	[illegible]

Source: Row (1) from Eckaus, McCarthy and Mohie-Eldin (1978, Section 5 first table)
Row (2) from Eckaus, McCarthy and Mohie-Eldin (1978, Section 5, third table)
Row (3) Row 21 in Appendix Table A-1
Rows (4) and (5): See text.

Table 10

Non-Wage Income Accruing to Household Class by Sector for Use in Modification 1

Household Class	Sectors 1	2	3	4	5	6	7	8	9	10	11	12	Total
1	0	0	0	0	14.1	16.5	10.1	5.7	0	2.6	14.9	131.1	195.0
2	0	0	0	0	32.8	38.6	23.7	13.4	16.1	6.1	22.3	196.7	349.7
3	0	0	0	0	46.8	55.1	33.8	19.1	37.7	8.6	37.1	328.0	566.2
4	30.4	72:1	14.7	28.0	0	0	0	0	0	0	0	0	145.2
5	60.4	184.7	44.3	92.4	0	0	0	0	0	0	0	0	381.8
6	70.2	202.8	50.9	120.1	0	0	0	0	0	0	0	0	444.0
Total	151.0	459.6	109.9	240.5	93.7	110.2	67.6	38.2	53.8	17.3	74.3	655.8	

Source: See text

Table 11

Labor Income by Sector and Household Class for Use in Modification 1

Household Class	Sectors 1	2	3	4	5	6	7	8	9	10	11	12	Total
1	0	0	0	0	26.47	78.36	76.69	30.56	0.93	49.76	19.18	500.33	782.28
2	0	0	0	0	12.38	51.27	65.41	22.07	12.32	55.16	17.82	450.26	686.69
3	0	0	0	0	17.45	37.17	64.31	79.17	7.95	70.78	13.70	355.61	645.14
4	104.74	217.79	75.61	152.29	0	0	0	0	0	0	0	0	550.43
5	26.81	55.37	14.21	35.89	0	0	0	0	0	0	0	0	132.30
6	9.45	22.24	2.28	9.31	0	0	0	0	0	0	0	0	43.28
Total	141.0 ~~114.7~~	295.4	92.1	197.5	56.3	166.8	206.4	131.8	21.2	175.7	50.7	1306.2	2841.10

Source: See Text

in row 1 of Table 12.

(2) The wage rate is obtained by dividing the total labor income (the "total" column in Table 9) by the number of earners calculated from row 1 of Table 12. The results are given in Row 2 of Table 12.

Sectoral values for the average wage rates Pr_s are calculated by multiplying the shares of each household type in aggregate labor income of each sector from Table 11 by the new wage rates given in row 2 of Table 12. The results are given in Table 13.

These adjustments also require adjustments in the tax rates for profits. The tax rates on profits under the new definition of profits inclusive of private profits and the tax rates on income alone are both given in Table 14. Also shown in Table 14 is the distribution of profits among six household classes, government (in the form of profit taxes) and retained by enterprises.

[illegible] in this drift from non-labor income?

E. Updating the Egyptian Prototype GEM for Sequential Solution

The updating process uses the general equilibrium solution values of endogenous variables as a starting point. The model user is required to update the exogenous variable values which will be taken by the model for a sequential solution.

The model user must have information about:

a. how the aggregate investment generated in the GEM solution for period t is distributed among the productive sectors becoming part of the capital stocks of these sectors - in period t + 1,

b. the sector - specific rates of depreciation,

c. the growth rates for the aggregate supplies of the variable factors,

d. the growth rates for exports by sector, and of net factor income from abroad [illegible]

e. the sectoral price indexes of world imports,

f. the growth rates of the sectoral values of the technical efficiency parameter, γ_s.

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Table 12

Employment and Wage Rate by Household Class for Use in Modification 1

	Household Class						
	1	2	3	4	5	6	Total
Employment (RCSUPPLY)	3.999,386 40.0	1,999,644 20.0 66.7	666,565 6.7	3,168,395 30	1,584,058 15 50	539,451 5	11,957,499 11.67
Wage Rate (PRC)	195.60	343.41	969.36	137.19	137.19	137.19	

Table 13

The Average Effective Price of Labor by Sector (PRS) for Use in Modification 1

		1	2	3	4	5	6	7	8	9	10	11	12
Labor Shares by Household Class (Share RCS)	1	0	0	0	0	.4702	.4698	.3716	.2319	.0439	.2832	.3783	.3831
	2	0	0	0	0	.2199	.3074	.3169	.1674	.5811	.3140	.3515	.3447
	3	0	0	0	0	.3099	.2228	.3115	.6007	.3750	.4028	.2702	.2722
	4	.7428	.7373	.8209	.7711	0	0	0	0	0	0	0	0
	5	.1901	.1874	.1543	.1817	0	0	0	0	0	0	0	0
	6	.0671	.0753	.0248	.0472	0	0	0	0	0	0	0	0
PRS		150.31	149.78	157.49	152.92	467.89	413.42	483.47	685.14	571.66	553.68	456.62	457.16

Table 14

OK - does this distribution make sense?

Distribution of Profits and Revised Tax Rates for Use in Modification 1

		Sectors											
		1	2	3	4	5	6	7	8	9	10	11	12
Private Profits	URB. L60	0	0	0	0	0.1062	0.0854	0.0242	0.0466	0	0.0094	0.1789	0.1555
	URB. M30	0	0	0	0	0.2472	0.1998	0.0568	0.1097	0.0509	0.0219	0.2677	0.2334
	URB. U10	0	0	0	0	0.3527	0.2852	0.0809	0.1563	0.1194	0.0309	0.4454	0.3892
	RUR. L60	0.1727	0.1412	0.1338	0.1164	0	0	0	0	0	0	0	0
	RUR M30	0.3432	0.3617	0.4031	0.3842	0	0	0	0	0	0	0	0
	RUR. U10	0.3989	0.3972	0.4631	0.4994	0	0	0	0	0.	0	0	0
Profits Retained by Enterprises		0.0852	0.0999	—	—	0.1055	0.2743	0.7064	0.6874	0.7885	0.9378	0.1080	0.1032
Government Profits (profit taxes)		—	—	—	—	0.1884	0.1553	0.1317	—	0.0412	—	—	0.1167
Total Profits		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

	Household Types					
	1	2	3	4	5	6
Income Taxes Rates	.00634	.03252	.05832	.00532	.02937	.05254

(g) the growth rates for government consumption, by sector.

(h) the levels of net transfers between sectors.

We have obtained this information by consulting and combining various sources for each subsection above.

1. The Sectoral Capital Stocks

Planned allocations of investment over the period 1975-1990 were taken from the projections used by Ali Nassar of the Institute of National Planning. Since Nassar's projections were for sectors specified according to a somewhat different classification, the following adjustments were made.

First, Nassar's projections for agriculture as a whole were broken down into the four separate agricultural sectors distinguished in the prototype version of GEM, according to the proportions of the estimated capital stocks of these four sectors for the base year 1976 shown in Table 8 above.

Second, his projections for "industry and mining" were aggregated with those of "electricity", and then broken down into the three industrial sectors distinguished in our model, i.e., sectors (5), (6) and (7), according to the estimated proportions of these sectors in total industrial capital stock, again taken from Table 8 above.

Third, Nassar's projections for "trade and finance", "public utilities", and "services" were aggregated into our sector (12), "other services".

Since Nassar's plan projections revealed considerable change over time in the relevant proportions, we have calculated separate changes for different subperiods of the plan horizon. Specifically, we have calculated the values and the resulting sector shares for each of three periods 1975-79 thought to be relevant to the first update, the period 1980-84 thought to be relevant to the second update of the Egyptian prototype GEM and the period 1985-89 thought to be relevant to the subsequent updates.

The resulting calculations are shown in Table 15. The update program is set

Table 15

Estimates of Gross Investment by Sector of Destination for Use in Updating the Sectoral Capital Stocks

Sector	Period 1975-1979 Value	%	1980-1984 Value	%	1985-1989 Value	%	Assumed Depreciation Rate
1	116.4	1.74	191.5	1.52	271.4	1.36	.1
2	324.2	4.85	533.5	4.21	756.2	3.78	.1
3	60.1	0.90	98.9	0.78	140.1	0.70	.1
4	118.7	1.78	195.3	1.55	276.8	1.38	.1
1-4	619.4	9.27	1019.2	8.06	1444.5	7.22	
5	769.9	11.92	1835.3	14.52	3330.7	16.63	.15
6	463.5	6.93	1067.5	8.45	1937.2	9.68	.15
7	728.9	10.91	1678.6	13.28	3046.4	15.22	.15
5-7	1989.3	29.76	4581.4	36.25	8314.3	41.53	
8	156.1	2.34	252.7	2.00	404.3	2.02	.2
9	298.6	4.47	670.6	5.31	719.6	3.59	.1
10	2072.6	31.01	3245.0	25.67	5396.4	26.96	.1
11	440.1	6.57	671.1	5.31	837.9	4.18	.03
12	1108.5	16.58	2199.2	17.40	2902.0	14.50	.07
Total	6684.6	100.00	12639.2	100.00	20019.0	100.00	

Source: Ali Nassar, Institute of National Planning, Egypt; with modifications described in the Text.

up so as to either utilize the absolute levels of sector investment or the sectoral shares. In the update of the Egyptian prototype, we have used the sectoral shares from the second column under the 1975-1979 period. Because of the assumption that each GEM corresponds to a three-year period, the estimates of the gross increases in the sectoral capital stocks can be obtained by multiplying these shares by three times the annual aggregate gross investment determined in the base period Egyptian prototype. (The multiplier of 3 accounts for the fact that the relevant investment would be that over the whole three-year period, not just the annual average calculated in the base period GEM solution.) These gross increases in capital stock have to be added to the depreciated value of the capital stocks used in the base-period GEM given in Table 8, with the assumed annual depreciation rates given in the last column of Table 15.

2. The Supplies of the Variable Factors R_c^S

The growth rates in the supplies of the variable factors, in this case the supplies of labor of each of the six types, are taken from the historical pattern. Specifically, it was assumed that the urban labor force, household types 1-3, would continue to grow at the historical rate of 2.51 percent per annum, while the rural labor force, household types 4-6, would continue to grow at 0.67 percent per annum. The updating of the supplies of the variable factors normally requires that two other adjustments be made as well. First, it requires the upward adjustment of each row of the "Wage Bill" matrix by the corresponding percentage increase in R_c^S. This step would be required in order to preserve comparability between the solutions to Pr_c in the GEM of the initial period with that for the update, given the use of the normalization rule that is used in the calibration process wherein Pr_c is initially set equal to unity.

However, if one wanted to simulate an increase in the <u>quality</u> of labor rather than the <u>quantity</u> of labor from one period to the next, this wage bill adjustment can be suppressed. This latter modification might well be used if

there was an improvement in the satisfaction of basic needs of workers of skill class c in period t, e.g. through better nutrition, that would be expected to increase labor productivity (translated into the effective supply of labor) in period t+1.

Second, since the percentage increase in labor force may fairly realistically be assumed to be approximately equal to that of population of each household class, the subsistence component of consumption of each household class also needs to be increased by the same percentage.

These adjustments are made automatic in the updating process.

3. Sectoral Exports E_s and Foreign Transfers TR_{FH}

Utilizing historical data provided in the Statistical Appendix to the World Bank Report for recent years, both in value and quantity terms, we have calculated the historical percentage growth rates shown in columns 1 and 2 of Table 16. Based on these calculations plus informed judgement about future prospects, we have arrived at the assumed annual rate of growth in sectoral export quantities and foreign transfers (mostly remittances from Egyptian workers abroad) given in column 3 of the same table.

4. Remaining Assumptions for Updating the Egyptian Prototype GEM

For government consumption we have assumed for simplicity that consumption of each domestically produced component of aggregate government consumption would grow over the plan horizon at a rate of 8 percent per annum. We also assume that the prices of all types of imports would rise by 5% per annum and that the overall domestic rate of inflation in $\overline{P}$ would be 10 percent per annum. The technical efficiency parameters, γ_s, are all assumed to grow at 1 percent per annum, and the transfers from households to profits (social security) at 4 percent per annum.

Using the base period values from the databank for the Egyptian prototype version of GEM, the update program itself is able to update the values of all the variables required.

Table 18

Historical and Projected Growth Rates of Sectoral Exports and Foreign Transfers for Use in Updating the Prototype GEM

Sector	1 Growth Rate in the Value of Exports 1971-1975	2 Growth Rate in Export Quantities 1965-1974	3 Assumed Annual Rate of Growth in Export Quantities over Plan Horizon
1	9.2%	-58.8%	-5%
2	94.5%	72.2%	10%
3	27.6%	-29.2%	0%
4	159.0%	126.3%	10%
5	155.2%	214.9%	10%
6	101.0%	0.0%	0%
7	108.8%		5%
8	—		—
9	1876.0%		25%
10	1070.5%		15%
11	—		—
12	244.5%		12%
Foreign Transfers (Remittances)	278.1%		10%

Sources: Calculations in column 1 were based on the following tables in the World Bank's Statistical Appendix: for sectors 1, 2, 3, 4, 9: Table 3.7 for sectors 5, 6 and 7: Table 8, 15, and for sectors 10, 12 and Foreign Transfers: Table 3.3.

V. GUIDELINES AND SUGGESTIONS FOR IMPLEMENTATION OF ALTERNATIVE SPECIFICATIONS

The purpose of this section is to provide guidelines for and offer suggestions to the user on the means of implementing alternative specifications of the modelling system. Since the GEM specification is considerably more complicated, and most of the GEM features that are transferable to LP can be converted to the LP format rather easily, we concentrate on the alternative functional forms and procedures for GEM.

While the key feature of the modelling system provided is flexibility, there is of necessity some limit to the flexibility provided. The limitations were spelled out in Section III D above.

Perhaps the most important thing the user can do to understand the workings of the GEM model and its iterative solution strategy and also both how the specification can be changed and the limitations on what can be modelled and changed is to gain familiarity about the order of the calculations made by the model in arriving at the general equilibrium solution.

Table 17 presents the order of the calculations. We cannot overemphasize the importance of the user being familiar with this sequence of operations.

1. Alternative Specifications of Investment

In both the general specification of GEM and the detailed specification of the Egyptian prototype given in Section IV above, investment was specified as being savings-determined. Given the well-known sensitivity of GEM-type models to the specification of savings-investment relationships as reflected for example in the recent symposium on the subject in the Journal of Development Economics [Bruno (1979), Taylor and Lysy (1979), Lluch (1979)] and the particular importance of such relationships as far as foreign assistance effects are concerned, we deem it especially important to provide the user with flexibility in the specification of how aggregate investment is determined.

Table 17

Purchasers' Prices of Domestically Produced Goods	(13)	$Pd_{ij} = P_s(1 + \overline{td}_{ij})$ for each i,j.
Domestic Prices of Imported Goods	(14)	$Pm_{kj} = \overline{Pm}_{kw}\ \overline{Pfe}\ (1 + \overline{tm}_{kj})$ for each k,j.
Substitution Between Imported and Domestic Input Components	(3)	$\frac{m_{ks}}{d_{is}} = \frac{\overline{m}^0_{ks}}{\overline{d}^0_{is}} \left(\frac{Pd_{is}}{Pm_{ks}}\right)^{\sigma_{iks}}$ for each k,s.
Fixity of Input-Output Coefficients	(2)	$\overline{\alpha}_{is} = \frac{X_{is} + M_{ks}}{X_s} = \frac{X_{is}}{X_s} + \frac{M_{ks}}{X_s} = d_{is} + m_{ks}$ for each i,s = 1,...,12
Interindustry Demand for Imported Commodity K	(6)	$M^I_k = \sum_s M_{ks}$ for each k = 1,...,12
Interindustry Demand for Domestically Produced Commodity	(5)	$X^I_i = \sum_s X_{is}$ for each i = 1,...,12
Effective Price of Value Added	(7)	$Pv_s = \frac{P_s - \sum_i d_{is} Pd_{is} - \sum_k m_{ks} Pm_{ks}}{1 - \sum_i d_{is} - \sum_k m_{ks}} = \frac{P^*_s}{d_{rs}}$ for each s.
Domestic Value Added Per Unit of Gross Output	(4)	$d_{vs} = (1 - \sum_i \alpha_{is}) = (1 - \sum_i d_{is} - \sum_k m_{ks})$ for each s = 1,...,12

Aggregate GDP Deflator at Producers Prices	(16)	$\overline{P} = \sum_s e_s^0 \, Pv_s$	
Sectoral Resource	(12)	$Pr_s = \sum_c b_{cs}^0 Pr_c$	for each s.
Demand Function for Aggregate Variable Resources	(21)	$R_s^D = \dfrac{(1-\alpha_{rs})\overline{K}_s^{-\rho_{rk}} p_{rs}^{\rho/\rho+1}}{Pv_s^{\rho/\rho+1} \gamma_s^{\rho/\rho+1} \alpha_{rs}^{\rho/\rho+1} - \alpha_{rs} p_{rs}^{\rho/\rho+1}}^{-1/\rho}$	for each s.
Demand Function for Variable REsource Type c	(22)	$R_{cs}^D = R_s^D \Sigma h_{cs}^0 \left(\dfrac{Pr_s}{Pr_c}\right)^{\sigma_{cc's}}$	for each c and s.
Aggregate Demand for Variable Resource Type c	(23)	$R_c^D = \sum_s R_{cs}^D$	for each c.
Aggregate Supply of Variable Resource Type c	(24)	$R_c^S = \overline{R}_c^S$	for each c.
Full Employment Equilibrium	(25)	$R_s^S = R_c^D$	for each c.
Unit Profits	(8)	$\pi_s = Pv_s d_{vs} - \sum_i r_{cs} Pr_{cs}$	for each s.
Sectoral Profits	(9)	$\Pi_s = \pi_s X_s = Pv_s d_{vs} X_s - \Sigma R_{cs} Pr_c = Pv_s d_{vs} X_s - R_s Pr_s$	for each s.

Production Function for Value Added (16) $V_s = \gamma_s \left[\alpha_{rs} R_s^{-\rho_{rks}} + (1-\alpha_{rs}) K_s^{-\rho_{rks}} \right]^{-\nu/\rho_{rks}}$

for each s.

Disposable Income of the Government Sector (28)

$$
\begin{aligned}
Y_G = & \sum_i \sum_s \overline{td}_{is}(Pd_{is}-\overline{td}_{is})X_{is} \\
& + \sum_k \sum_s \overline{tm}_{ks}(Pm_{ks}-\overline{tm}_{ks})M_{ks} \\
& + \sum_i \sum_c \overline{td}_{ic}(Pd_{ic}-\overline{td}_{ic})Cd_{ic} \\
& + \sum_i \overline{td}_{iG}(Pd_{iG}-\overline{td}_{iG})Cd_{iG} \\
& + \sum_i \overline{td}_i (Pd_i - \overline{td}_i)Id_i \\
& + \sum_k \overline{tm}_{k\pi}(Pm_{k\pi}-\overline{tm}_{k\pi})Im_k \\
& + \sum_k \sum_c \overline{tm}_{kc}(Pm_{kc}-\overline{tm}_{kc})Cm_{kc} \\
& + \sum \overline{tm}_{kG}(Pm_{kG}-\overline{tm}_{kG})Cm_{kG} \\
& + \sum \overline{td}_{iE}(Pd_{iE}-\overline{td}_{iE})E_i \\
& + \sum_c \overline{ty}_c Pr_c R_c^D + \sum_s \overline{t}\pi \Pi_s + \sum_h \overline{TR}_{hG}
\end{aligned}
$$

34 34 34 34 34 Step 34 45 45 Step 45 34 34 34 19 Step 19

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22	Disposable Income of the Enterprise Sector	(27)	$Y_{\Pi} = (1-\bar{t}_{\Pi}) \sum_s \pi_s + \Sigma \overline{TR}_{h\Pi}$ where $h = c_1, \ldots, c_m, \Pi, G, F$
23	Enterprise Savings	(37)	$S_{\Pi} = Y_{\Pi}$
22	Disposable Income of Household Class c	(26)	$Y_c = \left[(1-\bar{ty}_c)\ Pr_g R^D_c\right] + \sum_h \overline{TR}_{hc}$ for each c where $h = c_1, \ldots, c_m, \Pi, G, F$
23	Commodity-Specific Consumer Price Deflators	(19)	$P_{Cic} = \mu^1_{ic}\ Pd_{ic} + \mu^2_{kc}\ Pm_{kc}$ for each i and each c.
24	Aggregate Consumer Price Deflator	(20)	$P_{C_c} = \sum_i v_i P_{C_{ic}}$ for each c = 1,...,6
25	Consumption Expenditures of Household Class c of Goods Type i	(30)	$C_{ic}P_{Cic} = \gamma_{ic}P_{Cic} + c_{ic}[Y_c - \sum_i \gamma_{ic}P_{Cic}]$ $c_{ic} < 1$ for each i and each c.
26	Consumption Breakdown into Domestic and Imported Components	(31)	$\frac{m_{kc}}{d_{ic}} = \left(\frac{m^0_{kc}}{d^0_{ic}}\right)\left(\frac{Pd_{ic}}{Pm_{ks}}\right)^{\sigma_{ij}}$
27	Imported Component of Consumption of Class k by Household Type c	(32)	$Cm_{kc} = \left(\frac{m_{kc}/d_{ic}}{1-m_{kc}/d_{ic}}\right) C_{ic}$ for each k and c.

	Domestic Component of Consumption of Class i by Household Class c	(33)	$Cd_{ic} = (C_{ic} - Cm_{ic})$
	Household Savings	(36)	$S_c = Y_c - \sum_i P_{Cic} C_{ic}$ for each c.
30	Sectoral Profit Rate	(10)	$\pi_s = (\Pi_s / \overline{K}_s)$ for each s, s = 1,...,12
31	Sectoral Exports	(29)	$E_i = \varepsilon_{io} \left(\frac{Pd_{iE}}{\overline{Pfe} \cdot \overline{Pe}_{ws}} \right)^{\varepsilon_{i1}} \overline{E}_{wi}^{\varepsilon_{i2}}$ for each i.
32	Nominal Exports	(43)	$EN = \sum_i E_i Pd_{iE}$
33	Government Consumption and Breakdown into Domestic and Imported Components	(34)	$Cd_{iG} = \overline{Cd}_{iG}$
		(35)	$Cm_{kG} = \overline{Cm}_{kG}$
35	Government Savings	(38)	$S_G = Y_G - \sum_i Pd_{iG} Cd_{iG} - \sum_k Pm_{kG} Cm_{kG}$
36	Total Savings	(40)	$S = \sum_c S_c + S_G + \overline{S}_F + S_\pi$
37	Price Index of Imported Investment Goods	(17)	$Pm_I = \sum_k g_k^0 Pm_{k\Pi}$
38	Price Index of Domestic Investment Goods	(16)	$Pd_I = \sum_i f_i^0 Pd_{i\Pi}$
39	Price Deflator for Investment	(18)	$P_I = \theta^0 Pd_I + (1 - \theta^0) Pm_I$

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40	Average Profit Rate	(11)	$\pi^{r}_{ave} = \sum_s \Pi_s / \sum_s \bar{k}_s$
41	Real Investment	(41)	$I = S/P_I$
42	Investment Breakdown by Commodity	(44)	$I_i = \bar{a}_{iI} I$
43	Domestically Produced Investment Goods	(45)	$Id_i = d_{iI} I_i \left(\frac{Pm_{k\pi}}{Pd_{i\pi}}\right)^{o_{iI}}$
44	Imported Investment Goods	(46)	$Im_k = I_i - Id_i$
46	Nominal Imports	(42)	$MN = \sum_s \sum_k M^I_{ks} \overline{Pm}_{wk} \overline{Pfe} + \sum_c \sum_k Cm_{kc} \overline{Pm}_{wk} \overline{Pfe} + \sum_k Cm_{kG} \overline{Pm}_{wk} \overline{Pfe} + Im_{kI} \overline{Pm}_{wk} \overline{Pfe}$
47	Imports of Class k	(49)	$M_k = \sum_s M_{ks} + \sum_c Cm_{kc} + Cm_{kg} + Im_k$ for each k.
48	Aggregate Imports	(50)	$M = \sum_k M_k$
49	Aggregate Demand for Domestically Produced Commodity i	(47)	$X^D_s = \sum_s X_{is} + E_i + \sum_c Cd_{ic} + Cd_{iG} + Id_i$
50	Aggregate Supply of Demand Equilibrium	(48)	$X^D_s = X^S_s$ for each s.
51	Foreign Savings	(39)	$\bar{S}_F = MN - EN - \sum_h \overline{TR}_{Fh} - NFY \cdot P_{NFY}$

The first alternative provided to the original savings-determined specification of investment (in equation (41) in the detailed specification of the prototype version given in Table 3 above) is the following specification of an independent investment function

$$I_t = I_0\left(\frac{GDP_t}{GDP_0}\right)^{\varepsilon_{IGDP}}\left(\frac{MEI_t}{MEI_0}\right)^{-\varepsilon_{IMEI}}$$

This function says that actual investment would be equal to the base value of investment I_0 multiplied both by the ratio of GDP to its base value to an assumed exponent ε_{IGDP}, and by the ratio of the Keynesian marginal efficiency of investment, MEI, to its base value to another exponent, the two exponents representing the elasticities of investment with respect to the GDP and MEI, respectively. The latter exponent is expected to be negative, as the higher the level of investment, the lower will be the marginal efficiency of investment (which is in turn derived from the marginal efficiency of capital). The GDP term may be interpreted as an economic activity index that serves to signal investment.

Since the user has with this specification to specify the relevant elasticities as well as the base value of investment I_0, by setting the elasticities equal to zero, the user can make the level of investment completely exogenous.

The second alternative is similar in specification but involves, instead of a profit-rate determined marginal efficiency of investment, an "interest rate" IR which is to be a price that would be adjusted iteratively according to the relative size of the excess demand for savings.

$$I_t = I_0\left(\frac{GDP_t}{GDP_0}\right)^{\varepsilon_{IGDP}}\left(\frac{IR_t}{IR_0}\right)^{-\varepsilon_{IIR}}$$

where IR may be thought of as an index of interest rates which would be adjusted relative to its base period index values (1.0) as follows:

$$IR_t = IR_{t-1} + \lambda_{IR}\left(\frac{I_{t-1} - S_{t-1}}{S_{t-1}}\right)$$

where IR_t and IR_{t-1} are the value of the interest rate at iterations t and t-1, respectively, λ_{IR} is the damping factor set exogenously by the user, and $\left(\frac{I_{t-1} - S_{t-1}}{S_{t-1}}\right)$ represents the excess demand for investment relative to the aggregate supply of savings in period t-1.

It has been our experience that the latter specification may be especially useful in assisting in the achievement of convergent solutions, in as much as savings-investment disequilibrium is what often impedes the convergence to equilibrium in the commodity markets.

Hence, considering these alternative approaches to the original specification, the user has the ability to simulate behavior of the system under a wide range of assumptions about savings and investment behavior ranging from extreme savings - determination of investment to investment determination of savings.

The user should also realize that, by varying the parameters of the factor demand functions, and of the subsistence and marginal propensity coefficients in the final demand system, there is also a great deal of flexibility in the specification of savings.

2. Variable Labor Supply

Instead of assuming the labor supplies to be fixed exogenously within any period, the user can cause the model to generate supplies of labor varying with the real wage rate, income per capita, the wage rate structure. The user can further specify the magnitude of the influence of each term on the supply of labor of each type.

The variable labor supply equation for skill class c is:

$$R^S_c = R^S_{c_{base}} \frac{\left(\sum_c w_{co} \frac{P_{rc}}{P_{cc}}\right)^{\sigma r^S_{c1}}}{\left(\sum_c w_{co} \frac{Pr_{co}}{Pc_{co}}\right)} \left(\frac{Y_c}{P_{cc}/R_c}\right)^{\sigma r^S_{c2}} \left(\frac{Pr_c / Pr_{co}}{Pr_j / Pr_{jo}}\right)^{\sigma r_{c3}}$$

The labor supply of labor type c is thus its base value, $R^s_{c_{base}}$, scaled upwards or downwards by the three terms on the right, each subject to a possibly different elasticity. Let us examine each term separately. The first term is the ratio of the current weighted average real wage rate to its base value. The elasticity of σs_{c1} should be expected to be positive, the term as a whole capturing the extent to which the overall labor supply or labor force participation rate increases as the overall real wage rate rises. The second term involves the level of per capita real income (from all sources) of household class c relative to its base value. The elasticity attached to this variable, σr^s_{c2}, should be non-positive and would reflect to which the demand for leisure increases (and hence labor supply decreases) as per capita real income rises relative to its base value. The last term represents the influence of the relative wage rate between classes, specifically the ratio of the real wage rate of class c to that of class j relative to the base value of this ratio. Its elasticity, σr^s_{c3}, would be assumed to be non-negative. It can be interpreted as representing the degree to which workers may move from one labor class to another. Since in the short-run, i.e., within a period, it is unlikely that workers will be able to change skill types, and since in our Egyptian prototype version of the model rural-urban labor market dualism has been postulated, the only case in which interclass mobility would seem realistic is between class 4, unskilled rural labor and class 1, unskilled urban labor. All other forms of migration are handled only in the interperiod updates of the $R^s_{c_{base}}$ values.

Notice that the case of a fixed labor supply can be obtained by setting all the elasticities in the equation to zero. Likewise, the supply of labor can be made sensitive to only the overall real wage by setting σr^s_{c1} to some positive value but all the other elasticities to zero.

3. Alternative Specifications of Price Level and Relative Price Adjustments

In the basic specification of both the general and prototype versions of GEM, the price level $\overline{P}$ and the price of foreign exchange $\overline{Pfe}$ have been assumed to be exogenously given, but with the individual product and factor prices variable.

First, we need to explain how the price adjustments, which, as explained above, are a key part of our iterative solution strategy, are made. Second, we will explain how the flexibility of product prices is matched with the exogeneity of the aggregate price level. Third, we shall explain briefly some additional options at the disposal of the user.

As noted in Table 17 above, commodity prices are required relatively early in the overall calculation procedure for GEM. Our procedure is that the commodity price (in producer's prices) of commodity s for iteration t, $P_{s,t}$, is as follows:

$$P_{s,t} = P_{s,t-1} + \lambda_{P_s} \left(\frac{X^D_{s,t-1} - X^S_{s,t-1}}{X^S_{s,t-1}} \right)$$

where $\left(\frac{X^D_{s,t-1} - X^S_{s,t-1}}{X^S_{s,t-1}} \right)$ is the excess demand for s relative to the aggregate supply of s in iteration t-1. The λ_{P_s} is a damper factor which is set exogenously by the user according to various guidelines that will be given below. These λ_{P_s} are referred to as "Sector Price Flex" in the program. In addition, the user is able to specify threshold levels of disequilibrium which must be exceeded for the price adjustment switch to be turned on.

Optionally, the price level of GDP which is, of course, a weighted average of the individual Pv_s, the weights being the shares of sectoral value added in aggregate product, can be given exogenously. If so, the above adjustment process is used to obtain the vector of values of P_s for iteration t, Ps_t, s = 1...12,

the weighted average of the Pv_s values implied by these P_s values (with the aforementioned weights) is then computed via equation (15) of Table 3 and compared with the exogenously specified $\overline{P}$. The P_s vector is then scaled up or down so as to maintain consistency between the computed weighted average price level and the exogenously specified level $\overline{P}$.

The user is given the flexibility, however, to turn off the switch for the exogenously given price level, making all commodity prices fully flexible not just in relative price terms but also in absolute terms. When the switch is on, it is only the price vector P_s, s = 1...12, given $\overline{P}$ that is used in the calculations of iteration t.

But there's some indeterminacy!

The factor price adjustments are obtained by the same process, i.e.,

$$Pr_{ct} = Pr_{c,t-1} + \lambda_{Pr_c}\left(\frac{R^D_{c,t-1} - R^S_{c,t-1}}{R^S_{c,t-1}}\right)$$

To more realistically model surplus labor conditions wherein the real wage rate is fixed at a subsistence level, the user has the option to limit the flexibility of the wage rate to the upward direction and/or to non-substance labor markets. Thus wage rates can be made to be inflexible downward in the case of excess supply of subsistence-type labor.

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In Section 1 above we have specified that in the alternative specification in which investment is sensitive to changes in the interest rate index, the interest rate index would be adjusted between iterations in exactly the same way.

Finally, because of the relevance of the foreign exchange gap to changes in net foreign assistance levels, and the possible inflexibility of some of the components of the demand and supply of foreign exchange, especially in certain formulations, the user is provided with an option whereby the exchange rate, Pfe, could be endogenized, according to the now familiar adjustment mechanism

$$Pfe_t = Pfe_{t-1} + \lambda_{Pfe}\left(\frac{MN - EN - NFY - \sum_h TR_{FH}}{EN + NFY + \sum_H TR_{FH}}\right)_{t-1}$$

Because the institutional arrangements whereby and wherein foreign exchange equilibration takes place may vary considerably from country to country, it is especially important to provide for user flexibility in how foreign exchange disequilibrium is to be rectified.

A second alternative would be something of a compromise between the fixed and flexible exchange rate. For example, the exchange rate relevant to exports might be fixed while that on imports allowed to vary until equilibrium is achieved. In the latter case the flexible portion of the exchange rate might be interpreted as either a floating rate applicable to imports or a variable scarcity premium on imports. In the latter case, since the tariff rate would apply to the value of imports inclusive of this premium, the model would allow the government to tax a certain percentage of this premium. Indeed the model user would be encouraged to adjust the import tax rate so as to realistically reflect the degree to which the government is successful in taxing such premiums in whatever form they may do so, e.g., in the form of licensing fees collected on sales of import licenses, by auctioning foreign exchange or the imported goods directly. In those circumstances in which foreign exchange disequilibria are treated on a more ad hoc basis with

varying effective exchange rates between sectors, it will be simpler to handle these situations by changing the exogenously determined sector-specific tariff rates. While at least one set of model-builders [Dervis and Robinson (1978)] has advocated introducing a rationing-incidence ratio measured by the ratio of actual imports (or foreign exchange availability) to desired imports (those levels consistent with the prevailing relative prices of imports), we have intentionally avoided this specification. The reason for our rejection of this specification is not that it is unrealistic but rather that it requires producers to be "off" their production functions, thereby jeopardizing the validity of the general equilibrium character that is the centerpiece of the GEM mode. Although in their work Dervis and Robinson skillfully limit the scope of such departures from equilibrium by introducing the device of a flexible utilization or efficiency parameter, such an option in the hands of a less skilled and experienced user could get the user into considerable trouble. Moreover, to our knowledge there would be prescious little but pure guesswork involved in measuring the degree to which the efficiency parameters or utilization ratios would respond to the degree of import rationing. To our way of thinking, sooner or later and in one form or another the effective cost of those imports winds up being raised in which case the flexible import premium version would seem more realistic.

4. Alternative Specification of the Commodity Markets

The basic model and the Egyptian prototype version both assume that all commodity markets are characterized by perfect competition. Alternatively, the user may wish to specify a certain degree of monopoly power in a certain sector.

Specifically, the user can specify a percentage markup between marginal cost and price (or alternatively wedge between price and marginal revenue). The monopolistic employer will thus demand labor only up to the point of marginal cost and marginal revenue but will earn an additional monopoly profit.

5. Alternative Consumption (Savings) Functions

Recall from the description of the GEM equations above that the model uses an extended linear expenditures system of consumption functions to determine consumption and savings from non-subsistence income by means of the user-supplied marginal propensities to consume out of income. Thus consumption patterns (and therefore savings) may change as income, prices or relative prices change. But, savings (consumption) is not explicitly sensitive to an interest rate or alternatively to any existing disequilibrium between aggregate real savings and real investment. As mentioned in section 1 above, the model optionally can make use of an "interest rate" which adjusts to help match the levels of real investment and savings. The optional types of consumption functions which are also sensitive to this "interest rate" will now be described. Each of these types and the ELES function are mutually exclusive. One only can be asked for in a given model run.

There are two common elements in these optional consumption functions. First, in both cases the level of real consumption is not uniquely determined by the level of income and prices. Rather, real consumption is partially determined with the "interest rate." The level of savings by household groups thereby becomes sensitive to any disequilibrium in the real savings - real investment market.

Second, both types use a linear expenditures system instead of the ELES system to disaggregate total consumption into its separate commodity components. The marginal consumption propensities therefore, in this case, add to unity and do not reflect any decisions with respect to the level of savings by any household group from their total income. (If the user chooses this type of consumption function, the marginal propensities provided for the ELES formulation, which implicitly include a propensity to save, will be automatically adjusted to become

marginal propensities out of real consumption, not income.)

One optional consumption function type is a Keynesian function with autonomous, real income-sensitive and interest rate-sensitive terms to find real consumption levels for each household group. The equational form is:

$$c_c = c_{oc} + c_{1c}Y_c + c_{2c}(R-R_o)$$

The other optional consumption function is a Cobb-Douglas relationship where elasticities influence the level of real consumption by acting on percentage changes in the interest rate, the level of real income, and the price level. This equational form is:

$$c_c = c_{oc}\left(\frac{Y_c}{Y_{co}}\right)^{\eta_{cy}}\left(\frac{R}{R_o}\right)^{\eta_{cr}}\left(\frac{P_c}{P_{co}}\right)^{\eta_{cp}}$$

restrictions?

With the linear function, the user can set the desired level of autonomous consumption and the real income and interest rate coefficients to be used in a given model run. With the C-D function only the elasticities can be set by the user: the base level of real consumption is set by the model.

3. Alternative Methods for Updating the Exogenous Variables

While most of the updating procedures are simply accounting procedures and based on historical trends which leave little room for alternatives, the sectoral allocation of investment and therefore the updating of the sectoral capital stocks, and also the updating of the labor force could be done in various other ways.

For each variable to be updated the user is given the flexibility to enter the update information in either one of two ways. The primary method may be that utilized in Section IV E above where most of the required information was entered

in the form of annual rates of growth. It may be recalled that the user was originally asked a question about the number of years thought relevant to a single period GEM. The assumed growth rate entered in the update process is automatically allowed to compound for the number of years designated as the length of a period. The second method whereby the update information can be entered is in the form of the levels that are assumed relevant to the updated GEM. While the first alternative method may be attractive because of its ease of use, this second alternative has the advantage that the user can use any method he (she) wants in arriving at the updated values of the exogenous variables to be entered.

As noted in Section IV above, the user has the flexibility to decide whether an independent investment function is to be utilized. In either case, however, it is only aggregate investment that is determined in GEM. Various alternatives may be used for arriving at the sectoral allocation of investment.

One alternative the user may wish to employ is a simple model for the sectoral allocation of investment to be used in the interperiod update process. A simple but nevertheless perhaps satisfactory approach would be to use the historical sectoral shares of aggregate investment as a base but to add a term that would allow some sensitivity to the relative rate of return.

$$I_{st} = i_{s0} I_t \left(\frac{\pi_s^r}{\pi_{ave}^r} \right)^{\sigma_I}$$

nice

Another alternative would be to make the sectoral allocations of investment and the capital stock updates on the basis of the relative shadow prices derived from the sector-specific capital constraints in the solution of a single-period or multiperiod LP.

In the case of the labor force, rather than simply assuming that the labor force of each household-type or skill-type category would grow at the historical rate of growth, as we have done in Section IV E above, some sensitivity to changes

in relative wage rates between such household or skill types could be introduced into the update process.

For example, one could specify:

$$R^S_{ct+1} = R^S_{ct}(1 + g_c)^n \left(\frac{\dot{P}r_{c_t}}{\dot{P}r_t}\right)^{\sigma_{r^S_c}}$$

where $\frac{\dot{P}r_c}{\dot{P}_r}$ is the rate of change during the previous period in the price of variable factor c relative to that of all variable factors, g_c is the annual natural rate of growth of the supply of factor c, and n is the number of years in a period. Alternatively, of course, a price-sensitive supply function could be introduced directly into the static GEM of any period, and in such a case this removes the need for price sensitivity in the interperiod update. In the context of the Egyptian prototype, where the major distinction between types of labor is that between urban and rural location of the labor force, a function of the above type could be interpreted as a migration function.

In versions of GEM in which equilibrium in the labor markets is not expected to be achieved, and therefore some or all of the variable resources R_c are assumed to be available in unlimited supply within the relevant range, the variable to be updated exogenously in GEM would be the prices of the variable factors Pr_c and not R^S_c. Pr_c would then have to be updated between periods on the basis of perhaps a partial adjustment to changing product prices.

$$Pr_{c_{t+1}} = Pr_{c_t} + \lambda_c(P_{ct} - P_{c,t-1})$$

where P_c is the overall consumer price deflator.

The user must realize that the above models for updating variables whose levels are to be read in exogenously are only suggestions that the user would have to set up and execute himself. They are not part of the modelling package itself. However, as stated above, we feel that the user's ability to input the update infor-

mation in either of the two ways provided for should be of considerable help in allowing the user to approximate reality as far as the updating of the exogenous variables is concerned.

VI. FOREIGN AID AND ITS MODELLING - SOME SUGGESTED EXPERIMENTS

A comprehensive survey of the literature on the effects of foreign aid on recipient countries is well beyond the scope of this User's Guide. The literature, moreover, is already so voluminous and deals with such a wide variety of issues as to make it impractical to survey this literature in one place (such as the current chapter) even if it were appropriate to do so.

Our presentation will be divided into two parts. First, we identify some of the major issues that have been raised in the literature which the present system is at least potentially capable of handling. Second, we describe briefly some of the modelling efforts to date and outline the way in which the present system could in fact be used to simulate the effects of foreign aid in realistic circumstances.

A. Issues and Methods in Foreign Aid Analysis

In studying the development effects of foreign aid, the existing literature has employed one or another of three different methods: (1) case studies, (2) macroeconomic and/or cross-country empirical investigations and (3) planning or simulation models.

Not suprisingly, each of these different types of analysis has emphasized different types of effects. For example, the case studies have tended to be microanalytic or political-economy-oriented and to emphasize the effects of specific foreign aid projects or programs in specific countries on employment, capital formation, foreign exchange, inflation, resource allocation, economic and social policies and social and political institutions, and the indirect influences arising from them on income, growth, distribution and the satisfaction of basic needs. The case studies have almost invariably been extremely broad in their perspective and have tended to emphasize indirect and non-economic effects arising from very specific types and forms of aid.

The macroeconomic and/or cross section studies have been much narrower in scope, being limited to the effects of levels of aggregate foreign assistance (rarely distinguishing between different types or forms of aid and focussing on the effects on measurable macroeconomic variables such as savings, investment, income and the growth thereof over time.

The planning or simulation studies which are, of course, most closely related to the present study, although often embedded in detailed multisectoral models of the optimizing variety, have also tended to focus on the more narrowly defined macroeconomic effects. As such the effects of foreign aid in such models are heavily dependent on the specific assumptions made in the macroeconomic underpinnings of such models.

In addition to the differences in emphasis and in the issues raised between the different types of analysis that have been applied in the literature, there are also very considerably variations within any such type of analysis from one study to the next and to some extent also from one vintage of such analyses to the next.

Some studies of each type conclude rather positively that foreign aid is likely to raise income, employment, and growth in the recipient country whereas others stress the likelihood that negative effects are likely to dominate. It is important for any realistic simulation exercise that the model builder not rule out by assumption either the potential negative or the potential positive effects. Among the mechanisms identified in the literature whereby negative influences are registered are the following:

(1) reducing the efficiency of world resource allocations and the effectiveness of foreign aid by tying aid to specific kinds of imports and even to specific suppliers of specific types of imports that may be low in priority and high-cost and otherwise non-competitive in world markets.

(2) encouraging inefficiency in domestic resource allocation by allocating

resources to projects that have popular appeal to donors and/or to host governments but which are not necessarily as cost-effective in net social benefit terms as other alternatives. (These resource misallocation effects are likely to be especially strong when foreign aid allows imports to be underpriced as a result of impeding the required adjustments in the price of foreign exchange and/or capital to be underpriced with disequilibrium interest rates coupled with credit rationing.)

(3) discouraging export activities with their various direct as well as indirect positive effects on growth and employment as a result of the aformentioned tendency of foreign aid to preserve an artificially low price of foreign exchange, thereby reducing the profitability of export activities.

(4) discouraging domestic savings as a result of (a) lowering interest rates relative to what they otherwise would be thereby decreasing private savings, (b) causing individuals and groups to mistake temporary increases in purchasing power for increases in permanent income thereby increasing consumption (via the permanent income hypothesis) and decreasing private savings, and (c) lowering the incentives for government savings and indeed often requiring extra government current expenditures, e.g. on road maintenance, as a condition for the aid.

(5) discouraging the development of indigenous entrepreneurship and skilled labor as a result of foreign capital's propensity to bring with it its own foreign managers and technicians, who are not likely to find it in their personal interest to phase out their own positions by training indigenous replacements.

(6) postponing the need for creating a domestic capital market, financial intermediaries and other such institutions that are so conducive to efficiency in resource allocation and to faster accumulation.

(7) encouraging recipient countries to undertake more debt, and hence more future debt servicing (or foreign capital and profits outflows) than can be sup-

ported in the long run.

(8) postponing the undertaking of basic economic, social and political reforms and policy changes whose undertaking may be regarded as essential to the creation of the proper incentives for equitable and sound long-term development.

(9) stimulating excessive capital intensity (though perhaps also the underutilization of capital) and hence underutilization of labor by the underpricing of capital, and of capital goods imports relative to labor, and by the aforementioned tendency to tie aid to capital goods imports.

(10) by making recipient countries increasingly dependent on donor countries for capital, technology and decision-making, thereby undermining local self-reliance and the various kinds of linkages that can cause development to spread throughout the society of the aid-recipient country.

On the other hand, as foreign aid optimists are anxious to point out, under appropriate circumstances the same influences that would otherwise yield negative effects on development and distribution can be turned around so as to yield distinctly positive effects:

(1) Foreign aid can be targeted for or channeled into specific kinds of activities that can relax other binding constraints on development, in general, and can help overcome the aforementioned deleterious effects of foreign aid, in particular. For example, foreign aid can be used to help expand export industries, or to enhance labor productivity, hence offsetting the anti-export and anti-employment biases of foreign aid.

(2) Since foreign aid, even when provided in the form of loans, is often given on special concessionary terms, it invariably increases the total supply of scarce capital resources 0 even in present value terms. Because of possible multiplier effects arising from the extra income that these resources generate, it is quite possible that foreign aid can actually increase domestic savings. This possibility can be enhanced, moreover, by making the provision of foreign

aid conditional on "self-help" measures such as increased government or private savings.

(3) Rather than having the effect of necessarily postponing the desired policy changes and reforms as seen by foreign aid pessimists, optimists point to the possibility that foreign aid may actually have the effect of inducing such changes, for example by providing the palliatives and incentives that will make it politically and "socially" feasible to adopt the changes. Alternatively, many would argue that in many circumstances the greater political and economic stability that foreign aid may provide may be more conducive to development than any amount of reforms.

(4) Foreign aid can be designed so as to take on forms that are more likely to be complementary to domestic resources rather than competitive to them. For example, foreign aid may well go into basic social overhead capital, thereby enhancing the productivity of private or government enterprise investment in directly productive activities, thereby stimulating rather than squeezing out indigenous capitalists and their investments.

(5) Likewise, what is seen by pessimists as increasing the foreign aid recipient's dependence on foreign resources and markets could alternatively be seen more favorably as in some circumstances having the desirable effect of "opening up" an otherwise excessively closed or inward-looking economy to new technologies, new market opportunities, and to the desirable static, and especially dynamic, efficiencies associated with these "opening up" and trade and exchange-creating effects.

Naturally, the actual effects are likely to be influenced not only by the terms and interests of donor countries but also by the particular circumstances in recipient countries. Indeed, one whole branch of the literature has been devoted to identifying characteristics of recipient countries wherein foreign aid is likely to be more productive. Moreover, foreign aid, especially when it is

provided in large doses, is likely to be part of some overall pro[illegible]r developmental strategy such that the effects can properly be analysed [illegible] assessed only if, besides dealing with the level of capital and other resources transferred or loaned, the nature and magnitude of all the other components of the foreign aid programs, and the various policies of conditions associated with those programs are also explicitly dealt with.

B. Modelling of Foreign Aid

Even the more formal models of foreign aid on which we focus and which have been used in both the empirical studies and simulation planning models, have gone through rather distinct changes in character and results.

The earliest formal models used for assessing the impact of foreign aid was the Harrod-Domar model wherein the aggregate growth rate (G) was defined in terms of the ratio of the savings rate (s) to the marginal capital productivity coefficient or incremental capital output ratio (c)

$$G = \frac{s}{c}$$

Given c, the growth rate will be proportional to s. If s could be decomposed into different components, e.g., $s = s_p + s_g + s_f$, when s_p, s_g and s_f are the ratios of private, government and foreign savings to aggregate income, in the absence of any interdependence between these different sources of savings, an increase in the foreign savings component, s_f, would have the effect of raising the aggregate s by exactly that amount and raising the feasible growth rate proportionately.

As is obvious, this simplistic growth model ignores not only any possible interdependencies between the different sources of savings, but also any constraints on growth besides that of capital. Hollis Chenery and his colleagues [Chenery and Bruno (1962), Chenery and Strout (1966), Vanek (1967)] attempted to develop a more realistic model for relating foreign aid to growth. Although still strictly macroeconomic, this model recognized the dual role of foreign aid in the development process, i.e., that of relaxing the foreign exchange constraint and also the capital or savings constraint, hence the name "two-gap" model. "Two-gap" analysts recognized that the capital or savings gap may not

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be the binding constraint in any given LDC situation, and hence the savings need not be to raise the growth rate.

Nevertheless, in the hands of foreign aid advocates and practitioners, including Chenery himself, the first generation of two-gap models and applications of such models tended to demonstrate the generally positive effects of foreign aid, especially when it was rationally planned. Even if one of the two gaps was not binding, the other and binding constraint would be likely to be an underpriced resource, implying that the social contribution of these extra resources would be greater than their nominal value [Rosenstein-Rodan (1961), Millikan and Rostow (1957), Chenery and Bruno (1962), Chenery and Adelman (1966), Chenery and Strout (1966)]. Where an exogenous increase in domestic savings would relax only one constraint on development, foreign aid might relax two simultaneously. The real payoff to properly planned foreign aid was said to arise, therefore, when it relaxes two constraints simultaneously. The degree to which either or both of these constraints would be binding at any point in time would, of course, depend on circumstances in the recipient countries. The above-mentioned search for countries in which foreign aid would be most productive, in the hands of two-gap modellers, therefore, amounted to the identification of those particular countries in which the two gaps are of roughly equal size in the ex ante sense. (Ex post the two gaps have to be equal.)

The need for two-gap analysis arises primarily because of imperfections in international capital markets. If it were not for such imperfections, LDCs would be able to (and would want to) borrow just as much as would be profitable at the going interest rate, and the current account balance would also be equal to the savings gap and be of no special relevance. In a world in which there are substantial imperfections in the international capital market, however, there is a

reason to look at the two gaps and a potentially special role for foreign aid.

The fact that the two-gap models recognize no more than two gaps or constraints derives from the traditional stress on capital scarcity in both the simple growth models of the Harrod-Domar variety and the early literature of development economics. In principle, of course, the same framework could be extended to consider other gaps (constraints) such as skilled labor and management.

While still within the framework and spirit of the pro-foreign aid, first generation of two-gap models, the Chenery-Strout (1966) paper represents a benchmark in the literature. This is because it was the first to call attention to the fact that even within the two-gap framework, foreign aid would tend to reduce domestic savings in trade-constrained countries. The explanation for this is important for an understanding of the standard two-gap model and hence is repeated here. Foreign aid is defined (for simplicity and as it conventionally has been in the two-gap literature) as the current account deficit. Since ex ante one of the two gaps is likely to be larger than the other, one will be more binding than the other. When the larger of these gaps is the trade or foreign exchange gap, and foreign aid is just sufficient to fill this gap, it is obviously more than sufficient to cover the savings gap. Since ex post the two gaps must be equal, it is obvious that if investment is fixed at its required level, the adjustment process would involve some reduction of domestic savings relative to its potential level (i.e., that which would have materialized had there been somewhat less foreign aid). Hence, foreign savings in the case of trade-constrained countries, should have the effect of substituting, at least partially, for domestic savings.

There are many assumptions and weaknesses in the two-gap model, including the fact that the underlying adjustment or substitution mechanisms are not explicit in the model [Findlay (1971), Fei and Ranis (1968)]. Nevertheless, the framework has been

adopted by many other analysts, and indeed a whole second generation of two-gap models has evolved wherein increasing attention is given to the limited effectiveness and other disadvantages of foreign aid.

There followed in quick succession a series of empirical studies showing that foreign aid tends to reduce domestic savings [Houthakker (1965), Rahman (1968), Griffin and Enos (1970)]. None of these studies utilized the two-gap framework however, with its implication that the effect would depend on which of the two ex ante gaps is the binding one, and suggesting that the actual (ex post) data for trade-constrained countries cannot be taken to be representative of the ex ante values that would be relevant for estimating the behavioral relationship between foreign aid and domestic savings [Fei and Ranis (1968), Weisskopf (1972)].

Chenery and Strout (1966), Strout (1965), Chenery (1970), Landau (1971) and Weisskopf (1972) have all suggested procedures for classifying countries according to which constraint is binding. While Chenery and Strout relied on variations in the revealed behavior of international reserves, import propensities, export ratios, ICORs, etc., over time relative to their "normal patterns" that were somewhat arbitrarily defined, Landau and Weisskopf have proposed more formal procedures. For example, Landau suggested that potential domestic savings and imports Sd* and M*, respectively, could be expressed as simple linear functions of GNP (Y).

(1) $$Sd^* = a_1 + b_1 Y$$

(2) $$M^* = a_2 + b_2 Y$$

The ex post or actual values of these variables, on the other hand, Sd and M, would also be related to the level of foreign savings, S_F

(3) $$Sd = a_1 + b_1 Y + c_1 S_F$$

(4) $$M = a_2 + b_2 Y + c_2 S_F$$

Since as has been explained already, a savings-constrained country can be characterized by equations (1) and (4), whereas a trade-constrained country can be characterized by the combination of (2) and (3), empirical estimates of the parameters in equations (3) and (4) should allow one to classify countries. Any country whose data yielded positive estimates of c_2 in equation (4) but insignificant estimates of c_1 in (3) could be classified as savings-constrained, whereas any country with insignificant estimates of c_2 but negative values of c_1 could be classified as trade-constrained.

Using data on 18 LDCs in Latin America for the period 1950-1966, Landau identified eight as trade-constrained, four as savings-constrained and six alternating between the two. Even with all countries included, his pooled estimates showed a significant negative value for c_1 indicating the dominance of the trade constraint on economic growth during this period in Latin American countries.

Weisskopf's procedure is somewhat similar though based on a more complete exposition of the two-gap model. Specifically, following McKinnon (1964) he formulates the following model:

(5) $Y = C + I + \overline{E} - M$

(6) $Sd = Y - C$

(7) $\overline{Sf} = M - \overline{E}$

(8) $Sd \leq a_1 + b_1 Y + c_1 \overline{Sf} + d_1 \overline{E}$

(9) $M \geq a_2 + b_2 Y + e_2 I$

(10) $Y \leq \overline{Y}$

where is aggregate income, C is aggregate domestic consumption, E is exports, I is gross investment, and Sd, Sf and M are defined as before. With bars over the variables indicating the variables that are exogenous to the system, it can be seen that this is a system of six equations and inequalities in Y, C, I, M, Sd, i.e., in five endogenous variables. Weisskopf argues that only two of the three inequalities would be binding, i.e., would be equalities, at any point in time.

Note that in Weisskopf's formulation both exports and foreign savings can influence domestic savings, investment replaces foreign savings as a second determinant of imports (in addition to income), and in the short-run there is a maximum level of productive capacity.

With three inequalities, i.e., (8), (9) and (10), only two of which can be binding, i.e., are equalities, for any country at a given point in time, there are three alternative pairs of binding constraints, the savings and trade constraints (8) and (9), savings and capacity constraints (8) and (10) and trade and capacity constraints (9) and (10). To simplify the analysis, Weisskopf focusses on two endogenous variables, I and Y, that LDC planners should presumably be most interested in. For these variables Weisskopf works out the following

reduced form equations:

(11) $I - b_1 Y \leq a_1 + (1+c_1)S_F + d\bar{E}$

(12) $I + \frac{b_2}{e_2}Y \leq -\frac{a_2}{e_2} + \frac{1}{e_2}S_F + \frac{1}{e_2} + \bar{E}$

(13) $Y \leq \bar{Y}$

$Y, I \geq 0$

He then estimates the investment function with the three alternative sets of relevant exogenous variables checking for consistency between the estimated coefficients and the a priori expectations. By applying his classification procedure to a sample of 44 LDCs with time series data varying in length of series from seven years (1960 - 1966) to seventeen years (1950 - 1966), Weisskopf found that six countries had to be excluded because they were trade surplus countries; of the remaining 38 countries 17 were identified as savings-constrained, 8 as trade-constrained, 6 as both savings-and trade-constrained, and 7 were left unclassified due to inadequate data.

Then, for the sample of countries identified as savings-constrained (for which ex post values of savings may be reliable estimates of ex ante values), Weisskopf estimated an equation like that of equation (3) above but with exports added as an additional exogenous variable. In each case the estimate of the coefficient of S_F on Sd was found to be negative, and generally quite significant.

As mentioned before and as can be seen from the formal expositions of the two-gap model given above, both the standard versions of the model and the testing procedures used in quantifying the effects of foreign savings on domestic savings and other macroeconomic variables are subject to some important criticisms. For those readers and potential users of this User's Guide who might mistakenly feel that the existing literature has resolved the various issues involved and therefore provided general and transferable knowledge of the effects of foreign aid,

we point out some of the shortcomings, first, in the testing procedures employed and then in the models themselves. Finally, we outline how the modelling system provided here and the Egyptian prototype model in particular can be used to explore some of these issues.

The pitfalls in the testing procedures that have been employed quite naturally vary with the study and the specific procedures employed. We point out only some of the more common and perhaps more important ones.

(1) The measure of foreign aid has almost invariably been the current account deficit, which, of course, is much broader and more inclusive than simply foreign aid. The measure includes as aid, therefore, decumulation of international reserves, all sorts of private investment and commercial credit flows many of which are dependent on the levels of imports, exports and hence on other items in the current account deficit. Clearly, then, studies based on measuring the effects of this standard measure of foreign aid imply relatively little about foreign aid per se, especially since official foreign aid flows usually finance only a small proportion of the current account deficits of LDCs, and since official foreign aid flows may finance quite different kinds of activities and expenditures than other items in the capital accounts. (Note, however, the empirical study of Papanek (1973) which separates foreign aid from private capital flows.)

(2) Even the way in which the current account deficit is measured is deficient and likely to impose biases on the estimates of the effects of foreign savings on domestic savings. For example, as Corbo and Askari (1977) note, the current account deficit is generally measured in constant prices and limited to the difference between imports (M) and exports (X). For LDCs, where net factor income flows (NFY) are of considerable importance in the overall current account balance (generally being large and negative), and where current transfers and more importantly the terms of trade (measured by changes in the prices of exports relative to those of imports) are both volatile and subject to significant trends,

M-X in constant prices may be a rather poor measure of the current account deficit and hence of foreign aid.

(3) The way in which domestic savings are measured, specifically as investment (I) less foreign savings (S_F), has the unfortunate effect of making the dependent variable in any regression of S_d on S_F subject to the <u>same</u> measurement error as S_F. Moreover, a distinct negative bias is introduced into the resulting estimates by virtue of the fact that any over-estimate of S_F will bring about an underestimate of S_d, and vice versa. Since for reasons given in (2), the utilized measure of S_F, M-X, is a rather poor measure of the actual current account deficit, $P_mM - P_xX - P_{NFY}NFY - TR$, one cannot help but suspect that this negative bias could be quite strong, shedding considerable doubt on the conclusion drawn from such studies that S_F reduces S_d.

(4) As mentioned above, most of the empirical studies have not attempted to distinguish savings-constrained countries from trade-constrained countries as the two-gap literature suggests is essential in order to avoid specification error, but rather have applied the same regression model to all countries. Those relatively few studies that have attempted to do so can be criticized either (a) for the generally arbitrary manner in which the authors of such studies have made their distinctions between trade constrained and savings-constrained countries (as in the Chenery studies), or (b) the effect that their classification procedures may have on the test outcomes (as in Weisskopfs procedure).

(5) Several difficulties arise because of the disequilibrium character of the two-gap models. First, in order to write inequalities like those in Weiskopf's formulation, i.e., (8), (9) and (10), as equations, additional (slack) variables would need to be added but thereby adding additional endogenous variables to the system and making it underdetermined rather than overdetermined. Second, empirically the problem of differences between <u>ex ante</u> and <u>ex post</u> values of variables like domestic savings requires more sophisticated estimation procedures, utilizing

more *a priori* information and constrianed estimation procedures than have been utilized [See, e.g., Goldfeld and Quandt (1973), Kelejian (1970). Third, the specification of the *a priori* or behavioral relationships have been overly simplified, perhaps even naive. Landau's specifications, for example, of potential savings and imports as linear functions of the level of income alone as in equations (1) and (2) above, have generally been found to be of rather poor explanatory power and to ignore many influences that could be considered to be important in this context such as interest rates, prices, the different functional sources of income, demographic influences the components of final demand, and the distinction between transitory and permanent income.

(6) Most empirical studies, and especially the more sophisticated ones of Landau and Weisskopf, have been overly static ruling out any dynamic effects of S_F on I, Y and S_d that take place from one period to the next. Even worse, many of these studies treat variables like I and Y as exogenous to the model thereby ruling out even any short-run impacts of S_F on S_d and Y.

On top of these criticisms that apply to the empirical studies based on the two-gap models, are shortcomings of the two-gap models themselves. Since these deficiencies have been widely discussed in the literature [e.g., in Corbo and Askari (1977), Findlay (1971), Yotopoulos and Nugent (1976)], we mention here only a few of them and very briefly at that. The primary limitation is that the models are overly static, excessively aggregated and macroeconomic in character, pay insufficient attention to supply considerations and to prices including relative prices. Further, by limiting attention to only two gaps, capital and foreign exchange, they ignore other major constriants on development. Finally, in the context of the policy applications of such models, the fact that many existing models of the two-gap variety, especially the larger and more detailed ones, e.g., Vanek (1967), treat foreign savings as endogenous rather than exogenous makes it impossible to explore the effects of foreign aid on the rest of the system.

In short, two-gap models have been successful in calling attention to the shortcomings of the even simpler Harrod-Domar type models that had previously been widely used in foreign aid planning and analysis. They have also been successful in calling attention to various kinds of developmental disequilibrium and to their possible interrelations and to a variety of relevant policy issues. Existing empirical studies of the effects of foreign aid based on these models are, however, subject to grave shortcomings, and to severe biases, making the conclusions derived from such studies of very dubious value.

It is our expectation and hope that the models developed in this system have the potential for overcoming many of the shortcomings cited above. The reliability of the conclusions derived will, however, depend rather heavily on the validity of the assumptions made by the user, the realism of the parameter values inputed, etc.

While other GEM and LP models have been developed in the literature, none offer the degree of flexibility and the capability of focussing on foreign-aid related issues to the extent that those provided here do. Indeed, many of the other models have treated S_F as endogenous rather than exogenous.
The various means whereby different kinds of foreign aid packages and different country characteristics can be incorporated into the LP and especially the GEM models developed here have already been detailed at the relevant places in the text.

In order to test for the likely effects of varying levels of foreign aid and the robustness of such effects on different macroeconomic assumptions, parameter values, and price adjustment mechanisms we have developed a detailed set of experiments in the context of the Egyptian prototype that we deem desirable. The detailed set of experiments and results with respect to the Egyptian prototype can be supplied upon request.

The experiments are of several types. Basically, we propose to investigate the following experiments with respect to alternate levels of foreign aid:

1. The Base Case Level of Foreign Aid S_F
2. S_F set up by 10%
3. S_F set down by 10%
4. S_F set up by 10%

but tied to various realistic conditions of extra government consumption and investment of specific kinds.

We suggest that each of these foreign aid alternatives be applied to a host of alternative assumptions about consumption functions, various degrees of basic needs orientation, exchange rate and interest rate flexibility, the degree to which the aggregate price level is free to adjust, the variability in labor supplies and their susceptibility to variations in relative wage rates, income-leisure choices, etc. All these alternatives apply to the static single period model. We also suggest a series of experiments for dynamic multiperiod simulations.

VII. GENERAL INSTRUCTIONS FOR CREATING AND RUNNING A MODEL

The user has three general tasks to perform.

1) specify the model and create the original databank.
2) calibrate the model by altering values in the databank (including parameter values) until the model converges to base-year values for the endogenous variables
3) conduct simulation experiments with the calibrated model via the alteration of exogenous variable values in the databank. Optionally, if intertemporal simulations are conducted, the user must alter values in the databank to reflect the passage of time.

The commands to perform these tasks and their associated documentation are available at the user's terminal.

To begin a terminal session, follow the computer installation logon procedures for T.S.O. and enter "EXEC MODELLER". Then enter the command "COMMANDS".

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APPENDIX 1

This economy-wide modelling package has four basic components and several ancillary utility components. The components are made available by entering EXEC MODELLER or optionally by entering EXEC MOCKUP if EXEC MODELLER has already been entered since the last time your installation's accounting programs were run.

Basic components:

INPUT PROGRAM

Function: add or modify data in a databank

Invocation: INPUT command

Subcommands: ADD, CHANGE(or replace), DELETE, LIST, INVENTORY.

For help: enter DOCUMENT INPUT, or a question mark when the input program is running.

MODEL PROGRAM

Function: obtain dataseries from an existing databank, apply either general equilibrium or linear programming estimation to it, and optionally record the results either in the existing databank or in a new databank.

Invocation: MODEL command

Subcommands

before the model begins: CALIBRATE, STEP, TEST, DISPLAY, COMMENT.

while the model is running, if step option was selected: YES, NO, STEPOFF, GDP.

while the model is running, after the ATTN or BREAK key is pressed: STOP, DISPLAY, SAVE, SHOWALL, STEPON.

after the model finishes: DISPLAY, SAVE.

For help: enter DOCUMENT MODEL or a question mark before model starts running.

REPORT PROGRAM

Function: selectively print the contents of a databank at the terminal.

Invocation: REPORT command

Subcommands: ALL, ENDOGENOUS, PREDETERMINED, EXOGENOUS, SECTOR, SECTOR#, FACTOR, FACTOR#, VARIABLE, LINESIZE, PAGELENGTH, PATTERN, USEPATTERN, LISTPATTERNS, TITLE, TABLEHEADER, PAGEHEADER, DELETEPATTERN.

For help: enter DOCUMENT REPORT, or a question mark after the report program starts.

UPDATE PROGRAM

Function: interactively alter some exogenous variables in databank to reflect the passage of time.

Invocation: UPDATE command

Subcommands: none

For help: enter DOCUMENT UPDATE, or a question mark after the update program starts.

To run a simulation with this economy-wide modelling package you should (must?) have a databank with "correct" values for the exogenous and predetermined variables. Those values are those which will generate the base-year values for the endogenous

variables.

Creating the benchmark databank: You may use the INPUT command to add all the dataseries which are required by your model to the databank, as we did. This can even be done before "specifying" a new model via the MODEL command. There is a way to create your benchmark databank which is much less time-consuming for you.

Follow these steps:

1) enter MODEL to get into the MODEL command. This command will determine if your model is new, that is, for a country that does not have an existing model. (If this is because you have misspelled the country name, press the break or attn key.)

2) Specify the model. Respond to the MODEL command's questions about factors of production and sectors of output. For preparation, enter DOCUMENT MODEL.

At this time you should have a well-formulated concept of the model (economy) that you want to simulate. Forexample, you should know which sectors of the economy are able to import commodities which can substitute for domestically produced goods. (If you make a misteak, press the break or attn key and start over with step one above.)

3) When the MODEL command asks if you want a list of the required dataseries names, enter YES.

You will get an astonishing amount of required names. Many of them, it turns out, are parameters: that is, various elasticities and constants used by the model equations.

4) Enter the special command INITIAL. This command will set all

elasticities and parameters to unity (with the exception of SIGMACIDP, and a few others which will be set to .9).

5) Enter the MODEL command again. Run your model without any additional options. You will get a list of required dataseries still not found in your databank. The MODEL command will then stop.

6) The list of required dataseries not found (step 5) together with the required number of observations (from step 3) will tell you the dataseries that you must supply and their length.

7) Enter the special command WORKLIST. Your terminal will print a worksheet with spaces for the required exogenousand predetermined variables. Make sure that you have several sheets of paper.

8) Put values for these dataseries into your databank with the INPUT command. For preparation, enter the command DOCUMENT INPUT.

9) Enter the MODEL command. Request additional options STEPON, TEST and CALIBRATE. Repeat steps (8) and (9) until no dataseries are "NOT FOUND".

10) Calibrate your model. For preparation enter DOCUMENT BENCH.

The database used by all the program is a keyed (by datasetnames) indexed virtual storage access file. The program uses the Virtual Storage Access Method of IBM to read and write the file with the LIST, CHANGE, ADD, and DELETE commands in direct access mode. The file is opened for sequential input in the INVENTORY mode.

Each record is composed of a varying number of card images. Every record has at least two card images. The first one (header) contains such constant information as name, type, periodicity, number of data observations and counters for the number of other types of card images that are in the record. The second card image contains information on dates: date added and date last changed, as well as other counters. The second and subsequent card images are in a varying length character string two thousand four hundred and eighty bytes long. Thus, a record with no information other than name would have a record length of 162: two card images plus two bytes for the dope vector describing the varying length string. Each record is able to hold up to five title card images, five comment card images and twenty data card images. The maximum record length then becomes 2562, 400 for titles, 400 for comments, 1600 for data values, 80 for the header, 80 for first (only) dates, and 2 for the dope vector.

Please see the input program listing and member STRUCT of dataset INCLUDE.CNTL for more details. Enter "PRINTPGM INCLUDES" and "PRINTPGM INPUT" to list these programs at your terminal.

The file organization means that a databank can only be read by a specialized program or by an IMB utility program such as the PRINT command of Access Methods Services.

The advantages of this file organization are that:

1) Typical problems in retrieving information such as knowing where it is, what data representation it is in, and what format describes it, are transparent to the user.

The user need only know the name of the record, which can be found from the inventory or through trial and error. The following paragraph is NOT IMPLEMENTED in this version.

The record is essentially card images. Each card image has ten positions of identification field generated by the program. Columns one thru six are a unique name, compressed from the real name, which is forty positions long. Columns seven thru twelve are a sequence number, with sequence numbers for the data section starting at 1000. If sequence numbers below 1000 are extracted and what is left is sorted by positions one thru ten then the information can be read by programs such as SAS or SPSS, TSP/ESP, SPEAKEZ/FEDEASY. A program is provided (TSOVSAM) which does this. All records, that is to say card images, can be edited using T.S.O. edit if required. Entering the command MOVE invokes the TSOVSAM utility program to copy the databank to an unnumbered T.S.O. control dataset. Command MOVE can also return the perhaps edited databank to an indexed file.

2) The user need not know about end-of-volume or end-of-extent problems (system completion codes B37 or E37). When the file or the

overflow extents are full, the program is able to issue a message to the user to expand the file without losing information.

3) The data is BCD. It is visible to a human being when edited.

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APPENDIX 2

GLOSSARY OF USER-ACCESSIBLE VARIABLES

TYPE	NAME	DIMENSION	KNOWN AS
/* [illegible] */	[illegible]	(#FACTORS)	
/* N */	CC	(#SECTORS,#FACTORS)	$C_{ij} = C_d + C_m$
/* N */	CCONS	(#FACTORS)	$C_E + C_L$
/* N */	CCONSREAL	(#FACTORS)	C_E
/* N */	CCONSREALTOTAL	(ONE)	
/* N */	CDC	(#SECTORS,#FACTORS)	$C_{dj\ell}$
/* X */	CG	(#SECTORS)	
/* N */	CMC	(#SECTORS,#FACTORS)	$C_{mj\ell}$
/* R */	CONSCOEFAUTON	(#FACTORS)	
/* R */	CONSCOEFMRC	(#FACTORS)	
/* R */	CONSCOEFR	(#FACTORS)	
/* R */	CONSELASP	(#FACTORS)	
/* R */	CONSELASP	(#FACTORS)	
/* R */	CONSELASY	(#FACTORS)	
/* X */	CPROP	(#SECTORS,#FACTORS)	$z_{j\ell}$
/* X */	CPROPCONS	(#SECTORS,#FACTORS)	
/* X */	CPROPD	(#SECTORS,#FACTORS)	
/* X */	CPROPM	(#SECTORS,#FACTORS)	
/* R */	ECONOMIESOFSCALE	(#SECTORS)	
/* X */	EXPBASE	(#SECTORS)	ξ_{jo}
/* R */	EXPELASP	(#SECTORS)	ξ_{jp}
/* R */	EXPELASQ	(#SECTORS)	ξ_{jq}
/* N */	EXPNOMINAL	(ONE)	ξN
/* N */	EXPREAL	(ONE)	ξE_L
/* N */	EXPSREAL	(#SECTORS) ✓	E_L
/* X */	EXPWORLD	(#SECTORS)	E_{WL}
/* C */	FACTORITERATIONS	(ONE)	
/* C */	FACTORPRICEFLEX	(#FACTORS)	
/* R */	FIXLD	(#SECTORS,#SECTORS+#FACTORS+3)	
/* [illegible] */	FORCEXOLMAND	(ONE)	

N [illegible]
R [illegible]
X [illegible]
R [illegible]
C [illegible]

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TYPE	NAME		DIMENSION	KNOWN AS
/* N */	FOREYSUPPLY		(ONE)	
/* X */	GAMMAC		(#SECTORS,#FACTORS)	[illegible]
/* R */	GAMMACSCALER		(#FACTORS)	
/* R */	GAMMAP		(#SECTORS)	γ_s
/* R */	GAMMAPEXOGENOUS		(#SECTORS)	
/* R */	GDEFICIT		(ONE)	
/* N */	GDP	VALUE ADDED	(ONE)	
/* N */	GDPFINAL	FINAL DEMAND	(ONE)	
/* N */	GREV		(ONE)	Y_G [illegible]
/* N */	GREVCD		(ONE)	[illegible]
/* N */	GREVCM		(ONE)	
/* N */	GREVEXP		(ONE)	
/* N */	GREVG		(ONE)	
/* N */	GREVINVD		(ONE)	
/* N */	GREVINVM		(ONE)	
/* N */	GREVPROFIT		(ONE)	
/* N */	GREVXD		(ONE)	
/* N */	GREVXM		(ONE)	
/* N */	GREVYDISP		(ONE)	
/* N */	GSPEND		(ONE)	
/* N */	INVD		(#SECTORS)	I_{Ds}
/* R */	INVELASGDP		(ONE)	ε_{IGDP}
/* R */	INVELASMEC		(ONE)	ε_{IMEC}
/* P */	INVELASR		(ONE)	ε_{IR}
/* N */	INVM		(#SECTORS)	I_{Ms}
/* N */	INVREAL		(ONE)	I
/* N */	INVT		(#SECTORS)	I_s
/* N */	IOD		→(#SECTORS,#SECTORS)	d_{ls}
/* N */	IODINV		(#SECTORS)	d_{Ts}
/* N */	IOM		→(#SECTORS,#SECTORS)	m_{ls}
/* N */	IOMINV		(#SECTORS)	

TYPE	NAME	DIMENSION	KNOWN AS
/* N */	*PS	(#SECTORS)	
/* N */	PVAS	(#SECTORS)	
/* N */	RCDEMAND	(#FACTORS)	
/* R */	RCELASP	(#FACTORS)	
/* R */	RCELASREALWAGE	(#FACTORS)	
/* R */	RCELASRELATIVEWAGE	(#FACTORS)	
/* R */	RCS	(#SECTORS,#FACTORS)	
/* R */	RCSEXOGENOUS	(#SECTORS,#FACTORS)	
/* R */	RCSUPPLY	(#FACTORS)	
/* C */	REALWAGEINCOMEGROUP	(#FACTORS)	
/* N */	RINTEREST	(ONE)	IR
/* C */	RINTERESTFLEX	(ONE)	
/* N */	RS	(#SECTORS)	
/* N */	S	(ONE)	
/* N */	SC	(#FACTORS)	
/* N */	SCT	(ONE)	
/* C */	SECTORITERATIONS	(ONE)	
/* C */	SECTORPRICEFLEX	(#SECTORS)	
/* C */	SECTORREPEATS	(ONE)	
/* X */	SF	(ONE)	
/* N */	SG	(ONE)	
/* N */	SHAREDTU	(#SECTORS,#SECTORS+#FACTORS+3)	
/* X */	SHAREPROFITSVA	(#SECTORS,#FACTORS)	
/* X */	SHAREWAGESVA	(#SECTORS)	
/* R */	SIGMACAPR	(#SECTORS)	
/* R */	SIGMAINV	(#SECTORS)	
/* R */	SIGMAMD	(#SECTORS,#SECTORS+#FACTORS+3)	
/* R */	SIGMARCS	(#SECTORS,#FACTORS)	
/* C */	SUBSISTENCEINCOMEGROUP	(#FACTORS)	
/* X */	TD	(#SECTORS,#SECTORS+#FACTORS+3)	
/* X */	TOTINDIRECT	(#SECTORS)	

TYPE	NAME	DIMENSION	KNOWN AS
/* N */	KJOPPLY	(#SECTORS)	$\bar{K}_s$
/* N */	MARKUPCOEFFICIENT	(#SECTORS)	
/* N */	MCNOMINAL	(#FACTORS)	C_{nm_c}
/* N */	MCREAL	(#FACTORS)	
/* N */	MINOMINAL	(ONE)	I_{nm_s}
/* N */	MIREAL	(ONE)	
/* N */	MNOMINAL	(ONE)	$\bar{M}N$
/* N */	MREAL	(ONE)	M
/* N */	MSNOMINAL	(#SECTORS)	M_s
/* N */	MSREAL	(#SECTORS)	
/* X */	NFY	(ONE)	NFY
/* X */	PBAR	(ONE)	$\bar{P}$
/* N */	PCONSC	(#FACTORS)	P_{c_c}
/* X */	PEXPWORLD	(#SECTORS)	
/* N */	PFE	(ONE)	$\bar{P}_{fc}$
/* C */	PFEFLEX	(ONE)	
/* N */	PFEPREMIUM	(ONE)	
/* C */	PFEPPEMIUMFLEX	(ONE)	
/* N */	PINV	(ONE)	
/* N */	PINVD	(ONE)	
/* N */	PINVM	(ONE)	
/* X */	PMWORLD	(#SECTORS)	$\bar{P}_{m_{raw}}$
/* P */	PRC	(#FACTORS)	P_{r_c}
/* P */	*PRC SOLUTION VALUES	(#FACTORS)	
/* N */	PROFIT	(ONE)	π_s
/* N */	PROFITC	(#FACTORS)	
/* N */	PROFITRATE	(#SECTORS)	
/* N */	PROFITRATEAVERAGE	(ONE)	
/* N */	PROFITS	(#SECTORS)	
/* N */	PRS	(#SECTORS)	P_{r_s}
/* P */	PS	(#SECTORS)	

TYPE	NAME		DIMENSION	KNOWN AS
/* X */	TINCOME		(#FACTORS)	[illegible]
/* X */	TN		(#SECTORS,#SECTORS+#FACTORS+3)	[illegible]
/* C */	TOLERANCE		(ONE)	
/* X */	TOPOFIT		(#SECTORS)	[illegible]
/* X */	TRANSFG	—	(#SECTORS)	[illegible]
/* X */	TRANSFH		(#FACTORS)	[illegible]
/* X */	TRANSFP	—	(#SECTORS)	[illegible]
/* X */	TRANSGH		(#FACTORS)	[illegible]
/* X */	TRANSGP	—	(#SECTORS)	[illegible]
/* X */	TRANSHH		(#FACTORS)	[illegible]
/* X */	TRANSHP		(#FACTORS)	[illegible]
/* Q */	UNEMPLOYMENTWEDGE		(#FACTORS)	
/* D */	VAS		(#SECTORS)	V_S
/* P */	#VAS	SOLUTION VALUES	(#SECTORS)	
/* N */	VASREAL		(#SECTORS)	
/* X */	WAGESILL		(#SECTORS,#FACTORS)	Rec fra
/* P */	XD		(#SECTORS,#SECTORS+#FACTORS+3)	X_{LS}
/* P */	*XD ✓	SOLUTION VALUES	(#SECTORS,#SECTORS+#FACTORS+3)	
/* P */	XM		(#SECTORS,#SECTORS+#FACTORS+3)	M_{LS}
/* P */	*XM ✓	SOLUTION VALUES	(#SECTORS,#SECTORS+#FACTORS+3)	
/* P */	XS		(#SECTORS)	X_S
/* P */	*XS	SOLUTION VALUES	(#SECTORS)	
/* N */	XSDEMAND		(#SECTORS)	
/* X */	XSEXOGENOUSDIFFERENCE		(#SECTORS)	
/* N */	XSSUPPLY		(#SECTORS)	
/* N */	XT		(#SECTORS,#SECTORS+#FACTORS+3)	$X_{LS}-M_{LS}$
/* N */	YDISCRC		(#FACTORS)	$Y_c-Z_{c-[illegible]}$
/* N */	YDISPC		(#FACTORS)	Y_c
/* N */	YDISPCREAL		(#FACTORS)	
/* N */	YSUBSC	subsistence	(#FACTORS)	[illegible]
/* N */	YSUBSCD		(#FACTORS)	
/* [illegible] */	YSUBSCH		(#FACTORS)	

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APPENDIX 3

Model calibration experience:

Before the model can be applied to evaluate the possible impacts of policy and other changes, it should be calibrated so as to simulate the past correctly. In other words, the model must be capable of converging to its base year values when using base year exogenous data. This implies tuning the model's various behavioral relationships until an acceptable degree of convergence between actual and simulated values is achieved.

This process may well be time-consuming and frustrating to the model user, since consumption functions, production functions and elasticities will have to be re-estimated and tested. Suggestions as to how to proceed will be included in this guide as users get experience with the model. The built-in diagnostics will also help in identifying a suspect relationship or coefficient.

The above caveat applies to both the GEM and LP modes. The LP mode has unique features which can cause additional problems. For example, upper or lower bounds may be required if solution variable values are implausible. These should be set separately and individually to be able to separate the direction and magnitude of the effect on the other solution values.

Model exogenous variable updating instructions

Enter the MAKECOPY command to make a copy of your current databank if you plan to use its benchmark exogenous values again. Then enter the DATABANK command to change the name of your current databank. Finally, enter the UPDATE command and respond to its questions.

TECHNICAL NOTE

This economy-wide modelling package has four basic components and a number of ancillary utility components. The components are made available by entering EXEC MODELLER or optionally by entering this HOOKUP if EXEC MODELLER has already been entered since the last time the installation accounting programs were run.

EXEC MODELLER is a utility component which will:

1) allocate file sysproc to LIB.CLIST, which contains the modelling commands.

2) create MODEL.TEMP.CNTL, to later contain country and databank version level, and initialize it as empty.

Basic components:

INPUT PROGRAM

Function: add or modify data in the current databank

Invocation: INPUT command, a clist which will:

1) put the country and databank version level in MODEL.TEMP.CNTL if it was empty.

2) create a databank if none existed, via clist CREATE.

3) call the input program.

4) free files.

Subcommands: add, change(or replace), delete, list, inventory.

Help: enter DOCUMENT INPUT, or a "?" while the input program is running.

MODEL PROGRAM

Function: obtain datasets from an existing databank, apply either a general equilibrium or linear programming solutions to them, and optionally record the results in the current databank.

Invocation: MODEL command, a clist which will

1) put the country and databank version level in MODEL.TEMP.CNTL if it was empty.

2) if the country name is new, create and fill country.PARAMS.CNTL and country.NAMES.CNTL with economic specification information given via clist NEWMOD.

4) if desired, create or add to dataset country.OVERS.CNTL which contains overriding dataseries' names to be used in a particular model run.

5) gather modelling-time options, such as which simulation technique to use, whether or not to calibrate, and what level of modelling-time displays to use.

6) invoke the model program.

7) free files.

Subcommands:

before the model begins running: calibrate, step, test, display, comment.

while model is running, if step option was selected: yes, no, step off.

while the model is running, after ATTN or BREAK key is pressed: stop, display, save, step on.

after model finishes: display, save.

Help: enter DOCUMENT MODEL or a ? before the model program starts running.

REPORT PROGRAM

Function: selectively print the contents of a databank at your terminal.

Invocation: REPORT command, a clist which will

1) put the country and databank version level in MODEL.TEMP.CNTL if it was empty.

2) invoke the report program.

3) free files.

Subcommands - all, endogenous, predetermined, exogenous, sector, sector*, factor, factor*, variable variables, linesize, pagelength, pattern, usepattern, listpattern, title, tableheader, pageheader, deletepattern, numbers.

Help: enter DOCUMENT REPORT, or a ? after the report program starts.

UPDATE PROGRAM

Function: interactively alter some exogenous variables in the current databank to reflect the passage of time.

Invocation: UPDATE command, a clist which will

1) put the country and databank version level in MODEL.TEMP.CNTL if it was empty.

2) invoke the update program.

3) free files.

Subcommands - none

Help: enter DOCUMENT UPDATE, or a ? after the update program starts.

Ancillary components:

Enter "COMMANDS" for a list of the other economy-wide model components. Several are specialized clists: The "LCOUNTRY" command invokes the Access Methods Services command LISTC at the catalog index level of vsamprefix.userprefix.countryname. The "DATABANK" command can alter the name of the current dataseries in the dataset country.MODEL.TEMP.CNTL. (List the members of LIB.CLIST for the full test of these clists).

Other commands invoke clists and programs which read, write or manipulate databanks:

MAKECOPY defines a databank (with the same countryname but a different databank version name), then copies the current databank into it, and resets the name of the databank being used.

MOVEDATA allocates a card image dataset and copies the current databank into it, reformatting the VSAM datasets into card images.

INITIAL reads the current databank and alters it. Enter "DOCUMENT INITIAL" to see which dataseries this command creates or changes. This command should be used to set parameter values in a new databank; otherwise the parameter values that you have set may be reset to default values.

WORKLIST and STATS commands do not change the values in any dataseries.

DATABANK ORGANIZATION:

Overview of the INPUT COMMAND:

The INPUT command manages and manipulates the databank for a specified country model. It is anticipated that the model will have already have been specified with the MODEL command before the databank is entered. However, you may create the databank beforehand if you wish to.

The INPUT command has among its subcommands: end, add, change, delete, list and inventory. When you become confused, enter a question mark to see what the command expects next. If you depress the break or attention key, the input command will respond "nothing saved for this record". You may then enter another record. The subcommand to leave the input command is "end".

The input program is an interactive program which gathers information from your terminal and stores it in a consistent format. You enter commands, options and data. The program interprets the commands and stores the data for future use by the modelling program, by the report writing program and by the update program.

Every record has several areas which may or may not be used in different cases. For example, the data area can contain up to one hundred numbers but need not have any. A data series has one required field: name. You should fill as many fields as possible for good documentation.

You should be aware that a dataseries has these fields:

NAME - a character string up to forty characters long.

PERIODICITY - a character string up to ten characters long with a word such as annual or the year of the data series.

TYPE - a character string up to ten characters long used to remind you what this data series is, such as IOTABLE or TIMESERIES.

TITLE - a character string up to seventy characters long.

COMMENT - a character string up to seventy characters long.

DATA - an area which can contain up to one hundred numbers.

Both title and comment areas can contain up to five separate strings. Each string is referenced uniquely by appending its number. Implicitly, title or comment as the name of a field refer to title1 and to comment1, i.e., the first title and the first comment. Title2 is the name of the second title field, comment4 is the name of the fourth comment field.

Individual locations within the data area are named by their offset from the start of the data area in the case of cross-section data and by the year in the case of time series data. The offset or year is followed immediately by a colon to identify it as being different from the data values which follow. For example, 1: 1 2 3 4 5 will place the values one through five as variable values one through five. As another example, 1965: 100 200 300 adds or replaces the values for 1965, 1966 and 1967 with 100, 200 and 300 respectively.

Subcommands of the INPUT command:

END - exit from input program.

ADD - create a new record.

CHANGE - alter an existing data record.

DELETE - mark an existing data record as being deleted.

LIST - type or print all or parts of an existing data record.

INVENTORY - type or print all or parts of all data records.

VERIFY - show any changes made. This will occur unless changed.

NOVERIFY - cease displaying changes made.

Options for LIST and INVENTORY commands:

ALL - print all parts of the record. ALL is the same as including the options TITLE, COMMENTS and DATA together. This will also occur if no options are specified.

TITLES - print all of the five optional title fields.

COMMENTS - print all of the five optional comment fields.

DATA - print all of the data field.

PRINT - direct inventory listing to the batch line printer.

Syntax rules to be followed: (see notes below)

```
ADD      | name | fieldname=contents | number:values | ;
CHANGE   | name | fieldname=contents | number:values | ;
DELETE   | name | fieldname=contents | number:values | ;
```

(where "number" above represents a offset value or a year)

```
LIST      | name | options | ;
INVENTORY   options | ;
```

Note that:

The vertical bars above are not included as part of the command.

All statements end with a semicolon.

All commands must begin on a new line.

An asterisk in the name field refers to the previous name.

If the contents entered contains embedded blanks then it must be delimited by double quotes. (")

The users' manual has an appendix with examples of actual use of the input command.

The MODEL command.

The MODEL COMMAND has two phases. Phase one:

When you enter a country name for which no model has been specified, the MODEL COMMAND will ask you questions to establish the economic characteristics of the model to be solved. This occurs once, when a new model is created. See the Users Manual. Questions are asked for each factor of production and for each output sector. You may assign any name you want to each factor and to each sector. Please assign names less than thirty characters long without embedded blanks. The required variable name which must be in the databank depends on the how you have specified the model. An example may clarify this method. Assume that you have given one of the model sectors the name "nonstaplefood". Further, you have answered yes to two of the model command's questions relating to this sector: "can import prices be different for different users in the nonstaplefood sector" and "can domestic prices be different for different users in the nonstaplefood sector". The answers tell the model that it must find 1) the level of domestic output for the sector, a variable it calls XD, 2) the tax or subsidy rates for the domestic part of the sector, a variable it calls TD, 3) the level of imports for the sector, a variable it calls XM, and 4) the tax or subsidy rates that apply to these imports, a variable it calls TM. Thus, when the model subsequently runs, it will look in tha databank for at least four data series for the sector, called XDNONSTAPLEFOOD, TDNONSTAPLEFOOD, XMNONSTAPLEFOOD and TMNONSTAPLEFOOD. By following this procedure for all the sectors you specify, the model is able to construct matrices of domestic output,

imports and taxes. It then can use these matrices to calculate matrices of prices and input-output coefficients.

Phase two:

When the country model has already been specified, the model command will ask you about conditions relating to the individual model run. You will be asked which version of the data (which databank) to use. This is a feature that allows you to use one version of the data as input to the model, save the model results, and use the saved results as input to a subsequent model run. Note: the original databank (benchmark) is assigned version number 1, so, when you are first using the model, the version number you respond to the question is "1". The model command will next ask you if you want to save the model results in a new databank. You answer yes only in the case of solving a string of model runs, as above.

Another question follows: "do you want to override any data names in this run". This feature allows you to alter a portion of the data used by the model without having to respecify the model or having to change the benchmark data series in the databank. The model will use the data series with the overriding name instead of the data series with the overridden name. As an example, suppose that you want to test the impact of several different levels of subsidies on imported staple foodstuffs. Assume that you have specified the sector with the name "staplefood" and have allowed for imports and taxes(subsidies). The benchmark data series of interest is then called TMSTAPLEFOOD, taxes on imports of staple foodstuffs. Rather than using the input command between model runs to change values in this benchmark series, you may use the input command to add new data series to the databank, called, say, TMSTAPLE-10%, TMSTAPLE-20%, etc. These new data series

contain the literal values you want the model to use. When you use the override feature, then, you enter the name to be overridden as TMSTABLEGOOD and the overriding name as TMSTABLE-107. The model will use the data values found in the series TMSTABLE-107.

Note: If through error you override the same data series more than once, only the last override will take effect.

The next question the model command asks you is whether or not you want a list of all the required data series names.

Lastly, the model command asks you whether you want general equilibrium or linear programming estimation.

Up to this point, pressing the break key will put you back in READY mode as though you had not entered the model command. Beyond this point, when the model program is actually invoked, pressing the break key has a different effect. When you press the break key, the program halts in the middle of a solution. The program will tell you where it stopped. You now have three options: stop, display and save. These may be used in any combination. STOP terminates the model run. DISPLAY types current debugging information at your terminal. SAVE writes all current data values, which will not be solution values if you interrupted the program, into the databank. You may then use either the input command, perhaps with the inventory subcommand, or the report command to view the results.

The REPORT COMMAND allows you to selectively extract data series values from the data bank. The subcommand to leave the report command is "end".

Note: When you press the break or attn key the report program will stop whatever it is doing and expect either another subcommand or "end". You may enter a question mark at any time to see what the report command expects next.

When you ask for a report (using the subcommands listed in the categories below), the report program will assemble the data series, tell you the estimated typing time, and ask you whether or not to actually type the report. You respond either "yes", "no", or "print". In the latter case the report program's output will be printed at your installation's line printer after you leave the report command.

The REPORT program's subcommands are (by category):

A) Selection of which data series to report:

ALL:

ENDOGENOUS;

PREDETERMINED:

EXOGENOUS;

SECTOR sectorname(s);

SECTOR# sectornumber(s);

FACTOR factorname(s);

FACTOR# factornumber(s);

VARIABLE name(s):

Or any combination, followed by a semicolon.

The number signs (#) above refer to the order in which the sectors or factors were entered in the original model specification. The subcommand NUMBERS, described below, will give you a list of these numbers.

Note: Some combinations can result in a null set.

b) Setting linesize and pagelength:

LINELENGTH nnn;

PAGELENGTH nnn;

It may happen that the report table that you are requesting may extend beyond the maximum linelength of your terminal. This means that the line of data, as it is being typed, will "wrap around". You may specify a linelength larger than your terminal's. In this case, the first, (lefthandside), portion of the table will be printed followed subsequently by the rest of the table. To see the complete table you must separate the paper and place the pieces side by side.

If you do not alter the linelength the linelength will be 132 (nnn=132) characters.

The PAGELENGTH parameter is initially set at 999 (nnn=999) lines. You may reset the pagelength to a smaller value, such as 50 or 60 lines, if you want to.

c) Pattern feature:

PATTERN name "contents";

USEPATTERN patternname optionaladditionaldataseries;

LISTPATTERNS;

The PATTERN subcommand allows you to save a table request, that is, any combination of subcommands from parts A and B above, under any name you choose. Then, rather than restating the table request, you can enter USEPATTERN patternname, where patternname is a set of subcommands that you have previously chosen and given a name to with the PATTERN subcommand. You can add to the contents of pattern name by entering more table request information after the patternname and before the semicolon.

LISTPATTERNS will type all currently existing pattern names and their associated contents.

Note 1: The "contents" of the pattern must be enclosed by quotation marks (").

Note 2: If you create a pattern with the same name as a previous pattern only the most recent pattern will exist.

Note 3: Pattern names should be less than forty characters long and contain no embedded blanks.

Note 4: Patterns are not associated with a particular country model. The same pattern is available even though you are using the report command on a country model other than the one for which the pattern was created.

d) Adding your comments to the report:

TITLE "comment";

TABLEHEADER "comment";

PAGEHEADER "comment";

Each of these subcommands allows you to include your comments on the report program's output.

The TITLE will be typed at the beginning of the report.

The TABLEHEADER will be typed at the beginning of each table, along with the title, if included.

The PAGEHEADER will be typed at the beginning, and again (with the title and tableheader) if the pagelength limit is exceeded.

Note: The comment must be enclosed in quotation marks.

e) Type numbers which correspond to each variable:

NUMBERS:

This subcommand will type a list of numbers which you can use to refer to sectors, factors and variables rather than using their names.

THE ERROR COMMAND

You may get into a situation in which the modelling commands are unable to proceed. This can, generally, arise in the following two circumstances :

1) One of the modelling programs finds it cannot continue and generates a "severe error" message. The standard action in this case is to:

a) dump the current status of all variables to a disk dataset for debugging purposes.

b) close and release any databanks being used by the program.

c) stop the program and return to T.S.O. READY mode to await next modelling command.

It may be that the program cannot close the databanks successfully. You will find out when the next modelling command attempts to use the "damaged" databanks. You will get an error message stating "dataset not properly closed".

The second circumstance is when

2) The command list (CLIST) which sets up the environment for one of the modelling programs is abnormally interrupted. This can, in some cases, occur after you have depressed the BREAK or ATTN key on the terminal.

Usually it happens during a pattern of events unforseen by the programmer (Chuck Williams, 213-741-8548).

You will recognize this circumstance by the presence of contradictory error message, such as "DATASET NOT CLOSED,

WAS NOT OPEN" in conjunction with "DATASET OPEN, WAS NOT CLOSED".

The ERROR command should be used in these two circumstances and whenever unexplained actions occur. The command tries to close and release databanks that were "damaged".

Note that these are some situations in which the only way to successfully recover from an error is to LOGOFF, thereby making sure that datasets and databanks are released.

Try the ERROR command now. It can't hurt your databanks or anything else, and you will see how it works.

The INITIAL command.

This command is optionally used after a new databank is created. A new databank can be created by the "CDEL command for a new country model, by the INPUT command, by the MAKECOPY or MOVEDATA commands, or by the UPDATE command, which uses the MOVEDATA command.

The function of the INITIAL command is to place standard values ("default" values) for parameter dataseries into the current databank. As most of the parameters are elasticities, most of the default values are set to unity. The use of this command is recommended for a new country model in that the INITIAL command will save you the time spent in entering the required parameter dataseries' values with the INPUT command. There is one caveat: the default values may not be the values you want. You should use this INITIAL command immediately after the new databank is created. Then, if the databank has incorrect values placed in it with this command, you can use the DELETE command to get rid of the databank and start over.

NOTE: If you interrupt the INITIAL command with the ATTN or break key the databank may be partially initialized. That is, not all parameter dataseries will be set to default values.

NOTE: If your current databank already has values for the parameter dataseries, these values will be overwritten and possibly changed by the INITIAL command.

The WORKLIST command

This command is optionally used after a new country model has been specified with the MODEL command. The WORKLIST command will type a worksheet with the names of required exogenous and predetermined variables on it, accompanied by spaces for the required dataseries values. You may then fill in the space and use the worksheet when you enter dataseries values into your beginning (benchmark) databank with the INPUT command.

Use of the WORKLIST command is recommended, in that firstly it will tell you what data is required and secondly will ensure that you get the data values in the correct place when you use the INPUT command. The worksheet, however, may take a while to type, and if your model has many sectors or factors you may have to use some cut and paste techniques (on a college, not graduate, level, to put it together.

If you stop the WORKLIST command while it is typing by pressing the ATTN or break key no harm will be done. But, if you enter the WORKLIST command again, it will start from the beginning, not from where you stopped it before.

The WORKLIST command has only one subcommand, LINESIZE. The linesize of your terminal determines how many pages, if any, the worksheet will span across. If you do not enter a new linesize when the WORKLIST command asks you to, a linesize of 132 characters is assumed.

NOTE: It may be that not all required exogenous and predetermined dataseries are present on the worksheet. The presence or absence of a

ew parameters is determined by which MODEL options you select to run on.

The LIST command.

This command will list the names of all databanks which have been created for the country that you are modelling. The country name used is the name which you entered as the response to the question "enter country name" when you began the session.

An alternative method of obtaining this information is to enter the LISTC command of T.S.C., which will list all the dataset names. You can identify the databanks by the presence of the country name.

The STATS command.

You can use this command to obtain the values of the control variables in the databank that you are currently using.

The command can also be used to get a list of changes in a databank since a given date. To do this, enter the date when the STATS program asks you for it. The command will then look through the databank currently being used, and compare your SINCE date with the "date_changed" field on every dataseries. If the dataseries was altered on or since the date you request, its name and contents will be typed at your terminal.

Note that if the databank being used is new or just added, no "SINCE" date will be found, as the "date_changed" field will be blank.

THE DELETE COMMAND

This command is used to delete a databank.

When you delete a databank there is no way to recover its contents except if you have entered the:

1) MAKECOPY command, which will reproduce a databank in another databank with a different name.

2) MOVEDATA command, which can copy a databank to a card-image dataset which may later be restored by the MOVEDATA command with the "TOVSAM" option (enter DOCUMENT MOVEDATA for more information)

Enter the modelling command LCOUNTRY to determine the databank versions which currently exist for the country you are modelling.

Deleting all databanks and datasets for a country model:

1) Enter the LISTC command of T.S.C.
2) Note all entries that have the country name in them.
3) Use the DELETE command of T.S.O. to delete these entries.

The DATABANK Command

The DATABANK command is used to alter the name of the current databank. You may want to do this if you are updating, that is, changing some erroneous values in your current databank, with the UPDATE command. To do, enter the command DATABANK. After it tells you which databank you are currently using, if you want to change databanks, enter the new name. Otherwise, enter the name of the current databank.

THE MAKECOPY COMMAND

This command is used, automatically, when sequential simulation is requested with the "RUN" command.

The MAKECOPY command creates a new databank and copies an existing databank into it. The process may take several minutes of clock time. You can use this command to make a copy of your databank for redundancy or testing purposes by entering "MAKECOPY". You will be asked for a new databank version name, which will then be the databank used unless you change the current databank name with the DATABANK command.

You cannot copy over an existing databank; an error message will appear if you try.

THE MOVEDATA COMMAND

You may want to make a copy of your databank(s) which can be stored on tape or cards. The copy could be a backup or a databank which will not be used for a while.

The MOVEDATA command makes a copy of a databank, copying it from a direct-access databank to a sequential card-image dataset on disk. It can also copy the sequential card-image dataset into a databank. The action taken depends on your answer to the command's question: "ENTER TOTSO or TOVSAM"

An answer of "TOTSO" will cause a card-image copy to be created with a dataset name identicated to that of the data bank with the exception that a qualifier of "TSO" is added before the databank version name. The databank can then be moved to tape or cards using, perhaps, the IBM IEHMOVE or IEBGENER utility program. Ask your computer installation representatives for details.

An answer of "TOVSAM" will copy a sequential disk dataset which follows the modelling naming conventions to a direct-access file. The process is slow and may take several minutes of clock time. When it is completed, you can use the databank as you would any other databank.

Note: You will get an error message and the databank will not be moved if the target (dataset being moved to) already exists. Enter "DOCUMENT TECH" for an explanation.

Model simulation instructions and experience:

After the model user has specified functional relationships that yield plausible results for the base year of data values the user can run simulations of various AID policy alternatives. The model user should have a clear idea of the relevant alternative ways in which external assistance would be used and of the accompanying policy changes that might be rendered on the part of recipient country policies as a result of the granting of such assistance. The model provides many entry points for policy changes and combinations of entry points may have to be utilized either to describe a given use of external assistance or to include the effects of accompanying policy changes. Note, however, that if many parameters are altered at once, the user is likely to find it more difficult to isolate the effects of each individual parameter change. The entry points of aid effects and policy changes can be in virtually any of the model's components as we have described them, the factor markets, the product markets, product demand generation and factor demand generation within periods or in the intertemporal updating and allocation models between periods. To introduce such aid-use and policy experiments, the user must change the appropriate parameters of external data read by each of these areas through the data management program mentioned in user task 1 Section xx. The new data is then used by either or both of the estimation modes to solve the model. Some of the external data available to the

used for simulation are: Tax and subsidy coefficients for each input to the productive process. Tax and subsidy coefficients for each sectoral output. A vector of exogenous final demand components which can be used to simulate different levels of goverment demand. A vector of exogenous factor supply components which can be used to simulate the effect of a different quantity supplied of a scarce factor, such as skilled labor. A vector of factor supply constraints used to relax or tighten supplies of capital or labor. A vector of product supplies which can be added to the endogenous model supply before product prices are adjusted. This allows the simulation of transfers of products such as staple foodstuffs from abroad. Vectors of tariff levels, subsidy levels and quota levels which can be altered for each product which is imported. Vectors of export subsidies and taxes for products which are exported. Allocations of capital to sectors with fixed capital stocks can be made between periods, and thus the effects of external assistance uses that affect capital and productive capacity over time can be simulated more realistically than in the usual static two-gap type models. In addition, any of the equation coefficients can be altered. For example, the technological shift parameter can be changed in a sectoral production function. The model considers the coefficients it uses as external data and thus any of the behavioral relationships can be changed between model runs. The policy control data series listed above enter the model

in the following way. When the model is stated as a computer program it becomes a sequence of individual operations. As an example, one of these operations is the determination of household consumption demand for one commodity output given a set of prices and incomes set previously, and the consumption function. The operation consists of multiplying the function coefficients times the variable values and adding the result. As each coefficient and value are multiplied, the data policy vectors for consumer income subsidy and for consumer income tax, if supplied by the user, are examined. The intermediate result is scaled upwards or downwards according to the tax or subsidy value. This method gives the model user the flexibility of altering and guiding the solution at almost every point in the model.

For our simulation experiments we have set the values of all parameters and elasticities to one, with the exception of the dataseries sigracapr, which we set to one half.