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FOREIGN AID, ECONOMIC DEVELOPMENT AND INCOME DISTRIBUTION: SOME INFERENCES FROM A CGE MODEL FOR EGYPT

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MRG WORKING PAPER #M8709

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ABSTRACT

This paper examines the sensitivity of quantitative assessments of foreign aid on the level of income and its distribution across income groups to alternative modelling and parametric assumptions. It does so with the use of a computable general equilibrium model for Egypt by subjecting the model to alternative assumptions. Although the results are (as expected) sensitive to the assumptions made, they indicate that at least potentially, as for example, when foreign aid takes an appropriate form and is accompanied by appropriate offsetting policies, it can be a useful tool for achieving development at minimum social cost.

The purpose of this paper is to examine the sensitivity of quantitative assessments of the effects of foreign aid on the level of income and its distribution across income groups to different modelling and parametric assumptions. It does so within an analytical framework that is considerably more general and flexible than that which has typically been used for such purposes. The sensitivity of the results is determined by subjecting a computable general equilibrium (CGE) model of an important foreign aid-receiving country, namely, Egypt, to a series of different simulation experiments.

The presentation is organized as follows: Section I reviews the considerable change in attitude to the efficacy of foreign aid in promoting economic development and an equitable distribution of its benefits; Section II briefly describes the CGE model which has been employed and its flexibility features; Section III outlines the simulation experiments and presents the results; finally, the conclusions are presented in Section IV.

I. Changing Perspectives on the Usefulness of Foreign Aid

Thirty-five years ago there was considerable hope that foreign aid could play a vital role in the economic development of less developed countries (LDCs). This hope was buoyed by the following considerations: (1) LDCs were conceived of as being constrained almost exclusively by the shortage of capital, but to have excess supplies of other resources, namely of labor, or of land or natural resources. (2) Based on the familiar Harrod-Domar model which served as the basis for the early development plans, foreign aid (savings) was viewed as being strictly additive to domestic savings. Given the capital-output ratio, this would imply that any increase in the ratio of foreign aid to GNP would lead to a proportional increase in the rate of economic growth. (3) The foreign aid provided to Europe in the late 1940's under the Marshall Plan was universally acclaimed as being highly successful. (4) Because of the numerous equilibrating mechanisms underlying real world economies, ranging from trade through migration and capital mobility, there was considerable confidence that development, once initiated, could be counted upon also to spread and trickle down to the poor. (5) Likewise, thanks to the development of investment criteria and social cost-benefit analysis, foreign aid, once provided, could be assured of being allocated in an efficient way. (6) Based on the favorable experience in private philanthropy with matching grants and in governmental support programs with conditionality, on the one hand, and the political and other costs associated with desirable policy reforms, on the other hand, foreign aid was even considered to be an indispensible tool for eliciting the desired reforms.

Over the last several decades, however, the case for each of these beneficial effects of foreign aid on development and equitable distribution has been severely challenged, and perhaps even altogether dashed. Two-gap models and other forms of analysis have frequently shown the capital constraint not to be the binding one in the LDCs.[1] Empirical studies have demonstrated that foreign aid frequently serves as a substitute for, rather than a complement to, domestic savings.[2] The analytical paradigm underlying mainstream development economics has been shifting in such a way as to view the classical adjustment mechanisms as being far less equilibrating than had previously been conceived, and in some cases as even being disequilibrating. Most foreign aid allocations have been decided on political rather than economic grounds and allocated without having been subjected to formal social cost-benefit analysis. Finally, rather than inducing desirable reforms, foreign aid seems to have allowed recipients governments to postpone or defeat these reforms.[3]

While many of the findings of deleterious consequences of foreign aid are far from definitive and by no means necessary, in the light of the remarkable shift in attitudes concerning the usefulness of foreign aid in fostering development and equitable distribution, it is hardly surprising that developed countries have drastically lowered their provision of foreign aid in relation to GNP.

Existing studies of the effects of foreign aid have invariably employed one or another of the following methods: (1) case studies, (2) highly aggregated and simplified theoretical models (3) empirically based macroeconomic models of the two-gap variety and (4) development planning models mostly of the programming type.

Not surprisingly, each different type of analysis has emphasized different types of effects and has its own benefits and costs.[4] For example, the case studies tend to be broad in scope but of course lacking in generality.[5] The theoretical studies are rigorous but typically analyze only a single issue, such as the terms of trade, which is not particularly central to the relevant controversies.[6] The macroeconomic, cross-section and planning model studies generally concentrate on a few macroeconomic consequences such as those on savings and the balance of payments.[7]

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 considerable variations within any such type of analysis from one study to the next and to some extent also from one vintage of such analysis to the next. It is for this reason that in the present study, the emphasis is on investigating the sensitivity of the effects of foreign aid to different modelling and behavioral assumptions within a common and rather general modelling framework.

II. The CGE Model of Egypt

Because of its advantage as a practical tool for doing general equilibrium analysis in the realistic context of multiple regions, products and factors in which supplies and demands may be sensitive to relative prices and for capturing distributional effects, the present study uses a computable general equilibrium (CGE) model of Egypt.

Since textbook treatments of CGE models and their advantages and disadvantages are now easily accessible, e.g., Dervis, deMelo and Robinson (1982) and Ginsburgh and Waelbroeck (1981), we proceed directly to a brief outline of the CGE model for Egypt which has been employed in this study.

The equations of the model are specified in Table 1 below. The general construction of the model and parameter estimates have been designed to be consistent with the 1976 Social Accounting Martix (SAM table) of the Egyptian economy provided by Eckaus, McCarthy and Mohie-Eldin (1978), though modified as described in Nugent and Williams (1984).

Twelve productive sectors are distinguished, four of which are rural ((1) staple food, (2) non-staple food, (3) cotton and (4) other agriculture), and eight of which are urban ((5) food processing, (6) textiles, (7) other manufacturing, (8) construction, (9) crude oil and petroleum products, (10) transport and communications, (11) housing and (12) other services). Also distinguished are six variable factors of production, namely, 3 income level - skill labor classes "lower 60 percent," "next 30 percent," upper 10 percent," in both urban and rural areas, designated as classes 1 through 6, respectively.

As is conventional in CGE models, the specification of the model and the subsequent computation of the model's solutions are divided into a series of blocs. The presentation begins in Section I of Bloc A where the output levels and inputs are determined for a given set of initial conditions consisting of the prices of all commodities and factors of production and the stocks of all fixed factors of production, namely, those of sector-specific capital.

The production functions for the gross output of each sector s, X_s, and that for the value added component of that output V_s are given in equations (1a) and (1b), respectively. The latter is assumed to be of the familiar CES form with respect to the variable and fixed factors, R_s and K_s, respectively;

the former is based on fixed coefficients of input i in sector s, which in turn is disaggregated in equation (2) into two components, the domestically supplied component d_{is} and the imported component m_{ks}. While the a_{is} coefficients are assumed to be technologically fixed within any given period (but flexible over time), the decomposition of these coefficients into their d_{is} and m_{ks} components is assumed to be flexible, depending in part on the relative prices of the two components as indicated in equation (3). The fixity of the input-output coefficients implies also the fixity of the domestic value added-output coefficients d_{vs} defined in equation (4). Section I is completed by the definitions of the total interindustry demands for the domestically supplied and imported inputs by equations (5) and (6).

We move now to Section II. The price index of domestic value added Pvs 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.

Equations (8), (9), (10) and (11) define unit profits, sectoral profits, the sector-specific rate of profit, and the overall average profit rate, respectively. 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).

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 of the whole economy. 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 investment, 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_{C_c}, as weighted averages of their component price indexes, the weights being the base period quantity shares.

Equation (21) consists of the profit-maximizing demand functions for variable inputs. Each such function has been derived by maximizing profits, i.e., equation (9), subject to the constraint of the CES production function, with the sector-specific capital stock assumed to be fixed in the short run at $\bar{K}_s$. The advantage of these functional forms is not only their generality but also their ease-of-estimation. Specifically, one can assume the technical efficiency parameter, γ_s, to be equal to unity and the distribution parameters α_{rs} and $(1 - \alpha_{rs})$ to be approximated by 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_{rk} is, of course, related to the elasticity of substitution σ_{rk} by $\sigma = 1/1-\rho$.

Equation (22) generates the sector and skill-specific demand for labor. By setting the values of $h_{cs} = 0$ 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 is imposed.

Equation (23) aggregates these demands across sectors. Equation (24) states that the aggregate supply of each variable resource type c is considered to be fixed in any period. Alternatively, however, this assumption can be relaxed by using the variable labor supply function given by equation (24a) which allows the labor supply of class c to respond to changes in its real wage rate, its real income and/or its real wage relative to that of a relevant alternative wage rate, e.g., the urban wage relative to the rural wage of unskilled labor.

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. As an alternative specification, the "Lewis case," we specify the wage rate of unskilled labor to be set exogenously, with excess supply prevailing in the market for that skill type.

Bloc B and Section IV of Table 1 begins by generating the disposable incomes of the variable factors, i.e., of the six household types c = 1...6, 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, 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 the model.

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 (30) 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, Powell and Williams (1977)], although quite demanding in terms of data, and estimation technique (requiring the imposition of constraints across equations). In the case of the Egyptian SAM, however, values of the required parameters can be

Table 1

Specification of the Egyptian CGE Model

Bloc A

I. Production Relationships

Production Function for Gross Output

$$(1a)\quad X_s = \text{Min}\left(\frac{V_s}{d_{vs}},\ \frac{X_{1s}+M_{1s}}{a_{1s}} \ldots \frac{X_{is}+M_{ks}}{a_{is}} \ldots \frac{X_{ns}+M_{us}}{a_{ns}}\right)$$

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

Production Function for Value Added

$$(1b)\quad V_s = \gamma_s \left[\alpha_{rs} R_s^{-\rho_{rks}} + (1-\alpha_{rs})\bar{K}_s^{-\rho_{rks}}\right]^{-v/\rho_{rks}}$$

for each s.

Fixity of Input-Output Coefficients

$$(2)\quad \bar{a}_{is} = \frac{X_{is}+M_{ks}}{X_s} = \frac{X_{is}}{X_s} + \frac{M_{ks}}{X_s} = d_{is} + m_{ks}$$

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

Substitution between Imported and Domestic Input Components

$$(3)\quad \frac{m_{ks}}{d_{is}} = \frac{\bar{m}^0_{ks}}{\bar{d}^0_{is}} \left(\frac{Pd_{is}}{Pm_{ks}}\right)^{\sigma_{mds}}$$

for each k,s.

Domestic Value Added Per Unit of Gross Output

$$(4)\quad d_{vs} = (1 - \sum_i a_{is}) = (1 - \sum_i d_{is} - \sum_k m_{ks})$$

for each s = 1,...,12

Interindustry Demand for Domestically Produced Commodity i

$$(5)\quad X_i^I = \sum_s X_{is}$$

for each i = 1,...,12

Interindustry Demand for Imported Commodity k

$$(6)\quad M_k^I = \sum_s M_{ks}$$

for each k = 1,...,12

II Price and Profit Relationships

Effective Price of Value Added

$$(7)\quad Pv_s = \frac{P_s - \sum_i d_{is}Pd_{is} - \sum_k m_{ks}Pm_{ks}}{1 - \sum_i d_{is} - \sum_k m_{ks}} = \frac{P_s^*}{d_{rs}}$$

for each s.

Unit Profits	(8) $\pi_s = Pv_s d_{vs} - \sum_i r_{cs} Pr_{cs}$ for each s.
Sectoral Profits	(9) $\Pi_s = \pi_s X_s = Pv_s d_{vs} X_s - \sum_c R_{cs} Pr_c = Pv_s d_{vs} X_s - R_s Pr_s$ for each s.
Sectoral Profit Rate	(10) $\pi_s^r = (\Pi_s/\bar{K}_s)$ for each s, s = 1,...,12
Average Prifit Rate	(11) $\pi_{ave}^r = \sum_s \Pi_s / \sum_s \bar{K}_s$
Sector-Specific Price Index of Variable Resource Input	(12) $Pr_s = \sum_c b_{cs}^0 Pr_c$ for each s.
Purchasers' Prices of Domestically Produced	(13) $Pd_{ij} = P_s(1+\overline{td}_{ij})$ for each i,j.
Purchasers' 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) $\bar{P} = \sum_s e_s^0\ Pv_s$
Price Index of Domestic Investment Goods	(16) $Pd_I = \sum_i f_i^0\ Pd_{i\Pi}$
Price Index of Imported Investment Goods	(17) $Pm_I = \sum_k g_k^0\ Pm_{k\Pi}$
Price Deflator for Investment	(18) $P_I = \theta^0 Pd_I + (1-\theta^0) Pm_I$
Commodity-Specific Consumption Price	(19) $P_{C_{ic}} = \mu_{ic}^1\ Pd_{ic} + \mu_{kc}^2\ Pm_{kc}$ for each i and each c.
Aggregate Consumption Price Deflator for Household Class c	(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)

$$R_s^D = \left[\frac{(1-\alpha_{rs})\bar{K}_s^{-\rho_{rk}} P_{rs}^{\rho/\rho+1}}{Pv_s^{\rho/\rho+1}\gamma_s^{\rho/\rho+1}\alpha_{rs}^{\rho/\rho+1} - \alpha_{rs}P_{rs}^{\rho/\rho+1}} \right]^{-1/\rho}$$

for each s.

Demand Function for Variable Resource Type c (22)

$$R_{cs}^D = R_s^D \Sigma h_{cs}^0 \left(\frac{Pr_s}{Pr_c} \right)^{\sigma_{r_c r_s}}, \quad \text{for each c and s}$$

Aggregate Demand for Variable Resource Type c (23)

$$R_c^D = \sum_s R_{cs}^D \quad \text{for each c.}$$

Fixed Aggregate Supply of Variable Resource (Labor) Type c (24)

$$R_c^S = \bar{R}_c^S \quad \text{for each c.}$$

Variable Supply of Labor Type c (24a)

$$R_c^S = R_{co}^S \left[\frac{\frac{W_{co}Pr_c}{P_{C_c}}}{\frac{Pr_{co}}{P_{C_{co}}}} \right]^{\eta_{Pr_c}} \left[\frac{Y_c/P_{C_c}}{Y_{co}/P_{C_{co}}} \right]^{\eta_{y_{cd}}} \left[\frac{Pr_c/Pr_{co}}{Pr_j/Pr_{jo}} \right]^{\eta_{Pr_{co}}}$$

Full Employment Equilibrium (25

$$R_c^S = R_c^D \quad \text{for each c.}$$

<u>Bloc B</u>

IV. Factor Income Generation and Expenditure Allocation

Disposable Income of Household Class c (26)

$$Y_c = (1-\bar{t}y_c)\, Pr_c R_c^D + \sum_h \overline{TR}_{hc}$$

for each c, where $h = c_1,\ldots,c_6,\Pi,G,F$

Disposable Income of the Enterprise Sector (27)

$$Y_\Pi = (1-\bar{t}_\Pi)\sum_s \Pi_s + \Sigma\, \overline{TR}_{h\Pi}$$

where $h = c_1,\ldots,c_6,\Pi,G,F$

Disposable Income of The Government Sector (28)

$$Y_G = \sum_i \sum_s \overline{td}_{is}(Pd_{is}-\overline{td}_{is})X_{is}$$
$$+ \sum_k \sum_s \overline{tm}_{ks}(Pm_{ks}-\overline{tm}_{ks})M_{ks}$$
$$+ \sum_i \sum_c \overline{td}_{ic}(Pd_{ic}-\overline{td}_{ic})Cd_{ic}$$
$$+ \sum_i \overline{td}_{iG}(Pd_{iG}-\overline{td}_{iG})Cd_{iG}$$
$$+ \sum_i \overline{td}_{i}(Pd_{i}-\overline{td}_{i})Id_{i}$$
$$+ \sum_k \overline{tm}_{k\Pi}(Pm_{k\Pi}-\overline{tm}_{k\Pi})Im_{k}$$
$$+ \sum_k \sum_c \overline{tm}_{kc}(Pm_{kc}-\overline{tm}_{kc})Cm_{kc}$$
$$+ \sum_k \overline{tm}_{kG}(Pm_{kG}-\overline{tm}_{kG})Cm_{kG}$$
$$+ \sum_i \overline{td}_{iE}(Pd_{iE}-\overline{td}_{iE})E_{i}$$
$$+ \sum_c \overline{ty}_c Pr_c R_c^D + \sum_s \overline{t\pi}\Pi_s + \Sigma_h \overline{TR}_{hG}$$

Sectoral Exports (29)

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

for each i.

Consumption Expenditure 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 and each c.

(30a)

$$C_c = C_{co} + c\,\frac{Y_c}{P_{c_c}} + d(IR_t - IR_o)$$

Consumption Breakdown into Domestic and Imported Components (31)

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

Import Component of Comsumption of Class k by Household Type c (32)

$$Cm_{kc} = \left[\frac{m_{kc}/d_{ic}}{1+(m_{kc}/d_{ic})}\right] C_{ic} \text{ for each k and c.}$$

Domestic Component of Consumption of Class i By Household Class c (33)

$$Cd_{ic} = (C_{ic} - Cm_{kc})$$

Government Consumption and Breakdown into Domestic and Imported Components (34)

$$Cd_{iG} = \overline{Cd}_{iG}$$

(35)

$$Cm_{kG} = Cm_{kG}$$

V. Savings, Investment and Trade Balances

Housefold Savings (36)

$$S_c = Y_c - \sum_i P_{Cic} C_{ic} \quad \text{for each c.}$$

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)

$$S = \sum_c S_c + S_G + S_f + \overline{S}_\pi$$

Real Investment (41)

$$I = S/P_i$$

Investment Function (41a)

$$I = I_o \left(\frac{GDP_t}{GDP_o}\right)^{\varepsilon_{GDP}} \left(\frac{IR_t}{IR_o}\right)^{\varepsilon_{IR}}$$

Nominal Imports	(42)	$MN = \sum_s \sum_k M^I_{ks}\overline{Pm}_{wk}\overline{Pfe} + \sum_c \sum_k Cm_{kc}\overline{Pm}_{wk}\overline{Pfe} + \sum_k Cm_{kG}\overline{Pm}_{w,}\overline{Pfe} + \sum_k Im_{k\Pi}\overline{Pm}_{wk}\overline{Pfe}$
Nominal Exports	(43)	$EN = \sum_i E_i pd_{iE}$
Investment Breakdown by Commodity	(44)	$I_i = \overline{a}_{iI}I$
Domestically Produced Investment Goods	(45)	$Id_i = d_{iI}I_i \left(\frac{Pm_{k\pi}}{pd_{i\pi}} \right)^{\sigma_{iI}}$
Imported Investment	(46)	$Im_k = I_i - Id_i$

VI. Commodity Balances

Aggregate Demand for Domestically Produced Commodity i	(47)	$X^D_s = \sum_s X_{is} + E_i + \sum_c Cd_{ic} + Cd_{iG} + Id_i$
Aggregate Supply of Demand Equilibrium	(48)	$X^D_s = X^S_s$ 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)	$M = \sum_k M_k$

obtained easily if one is to assume that workers in the lowest skill groups, i.e., the lowest 60 percent of the rural and urban 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} can therefore be regarded as being out of discretionary income, i.e., that amount of income above the subsistence level. Equation (30a) is an alternative (Keynesian-neo-classical) function for generating aggregate consumption. In this case, the commodity breakdown is accomplished by a modified version of (30) in which the term in brackets is replaced by C_c as generated by equation (30a). 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 balance. Equations (36)-(39) define savings of the household sectors, S_c, of the enterprise sector, S_π, of the government sector, S_G, and of the foreign sector, $\bar{S}_f$, 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, $\bar{S}_f$, is exogenous. Equation (39) requires that solutions for imports and exports, both evaluated in nominal terms, are consistent with the exogenous $\bar{S}_f$. 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. An alternative is to use the independent investment demand function (41a). In either case, as in the case of the input-output coefficients, aggregate investment, I, is broken down into specific investment goods, I_i, and then subsequently into the domestic and imported components, Id_i and Im_k, in equations (44), (45) and (46).

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.

III. Some Simulation Experiments of the Effects of Foreign Aid with the CGE Model for Egypt

In this section we demonstrate the potential usefulness of CGE models for evaluating the effects of different levels of foreign savings and related policies under alternative assumptions concerning behavioral relationships, functional forms and parameter values. We do so by presenting and analysing the results of several types of simulation experiments with respect to the Egyptian CGE model.

The parameters and nature of each of the several hundred simulation runs conducted on the static version of the model are defined in Table 2. The different simulations reflect different assumptions about (a) the level of foreign savings (Sf), (b) the supplies of labor of the different region and income-skill groups, (c) the consumption functions of these region and income-skill classes, (d) the investment function, and (e) the parameters of the sectoral production functions which indeed play such an important role in generating the factor demands and hence the incomes of the different income-skill classes.

While the alternatives identified cover only a tiny fraction of the sensitivity tests that could be performed, they include many of the changes which a priori could be considered to make the most difference in the results, including the domestic savings and investment functions, and the demand and supply functions for labor. As noted in Table 2, the effect of foreign saving in Tables 3 and 4 below can be assessed most directly by comparing the results of any column and odd-numbered row which pertains to the base level of Sf (654 million Egyptian pounds at 1976 prices) with that in the even-numbered row entries immediately below it, the even-numbered rows containing the results for the case in which Sf is 10 pecent higher (719.4 million Egyptian pounds).

Because both the development planner's interest and the two-gap models have traditionally focussed on the effects of foreign savings on GDP and gross investment (I), in Table 3 at least, we concentrate on the effect of Sf on these variables.

We begin in entry A1, i.e., Row 1, Column A, with what we call the base version of the model, namely, a version of the model with the following options: fixed labor supply, no investment function (implying that investment is entirely savings-determined), the linear consumption function, i.e., equation (30a) in Table 1, for determining aggregate real consumption, the breakdown of aggregate consumption expenditures being determined by the linear expenditure system LES (a modified version of equation (30) in Table 1 above), and the base level of Sf. The corresponding simulation in which all the other assumptions are identical but the level of Sf is 10 percent higher, i.e., 719.4, instead of 654, million Egyptian pounds is labelled A2. By comparing the solution values of run A2 with the values of the corresponding variables of A1, which are given in rows 1 and 2 under Column A of Table 2, one can determine the effects of the higher level of foreign savings on all variables in the system.

By comparing the solution values for GDP and I of run A1 with those of run A2 given in the first two rows of column A in Table 3, one can see that GDP is raised by 6 and I by 58 as a result of the increased Sf of 65.4. Since Sd = (1 - Sf), it can readily be seen that the estimate of the coefficient of Sf on Sd implied by these estimates is -.113 or considerably below the empirical estimates obtained by Weisskopf (1972b) and Griffin and Enos (1970). Since this result derives from one particular and untested set of modelling assumptions, we in no way mean to suggest that our estimate is more realistic. Indeed, the main purpose of the sensitivity experiments is to draw at least moderately upon the considerable flexibility of the modeling package so as to determine how these results would be affected by alternative assumptions about closing rules, functional forms and parameter values.

Without going into many examples, it should be obvious from the results of Table 3 that the results reveal considerable sensitivity to the assumptions concerning the modeling of labor supply, consumption, investment and the parameters of the production function. For example, with respect to the effects on gross investment I that result from the simulated increase in Sf of 65.4, the increases vary from 0 in all such comparisons in column E to 160 in A11-A12. The zero gains in I obtained from column E are, of course, immediately attributable to the assumption of column E that real investment is exogenously set at the base level. Since this particular case would seem to be especially artificial, it can perhaps be ignored for the purpose of identifying a realistic range for such an effect. The next lowest increases of I (of between 2 and 8) which are registered by comparing the results of simulation runs D1 and D2 and those of runs D17 and D18 can also be ruled out for essentially the same reason.[8] Likewise, the largest increases which occur rather frequently in column A of between 111 and 160 are also rather unrealis-

Table 2

Characterization of the Alternative Simulation Runs

Foreign Savings Options:

Base: The observed level of 654 million Egyptians pounds. Results given in odd-numbered rows

+ 10: The observed level plus 10 percent = 719.4 million Egyptian pounds. Results given in even numbered Rows.

Labor Supply Options:

Fixed: The labor supply of each region and income distributional group is fixed at the level observed in the base year. Results given in Rows 1-2.

Variable: The labor supply of each region and sector is variable and computed with the use of equation (24a). Results given in Rows 3-16.

Lewis-Fixed: The labor supply of labor class 1 is computed via equation (24a). The labor supplies of all other sectors are fixed. Results given in Rows 17-30.

Lewis-Variable: The labor supply of labor class 4 is set arbitrarily high and those of the other classes are computed via equation (24a). Results given in Rows 31-46.

Consumption Function options:

Linear Consumption Function: Consumption computed as in equation (30a). Results given in Columns A-E.

Extended Linear Expenditure System: Consumption computed via equation (30). Results given in Column F.

Investment Function Options:

None; i.e., investment automatically assumes the value given by aggregate savings (investment is savings-determined). Results given in Columns A and F.

Full Investment Function: Gross investment computed according to equation (41a). Results given in Column B.

Investment Function Insensitive to GDP: Gross investment computed according to equation (41a) but with $\varepsilon_{GDP} = 0$. Result given in Column C.

Investment Function Insensitive to Interest Rate: Gross investment computed according to equation (41a) but with $\varepsilon_{IR} = 0$. Results given in Column D.

Exogenous Investment: Gross investment is set equal to its observed base year value of 1589 million Egyptian pounds. Results given in Column E.

Table 2 (Continued)

Production Function Parameter Value Options

$\underline{\alpha_i}$, the share of labor in value added in sector i = the value observed in the base year

α_i + 10 = the base value of α_i plus 10 percent. Results given in Rows 5, 6, 19, 20, 33, 34.

$\underline{\gamma_i}$, technical efficiency parameter = the value observed in the base year.

γ_i + 5 = the base value of γ_i plus 10 percent. Results given in Rows 7, 8, 21, 22, 35, 36.

$\underline{v_i}$, the economies of scale parameter = 1 in all sectors, i.e., signifying constant returns to scale.

v_i = .9 in all sectors, i.e., decreasing returns to scale. Results given in Rows 9, 10, 23, 24, 37, 38.

v_i = 1.2 in sector 7, i.e., economies of scale, otherwise = 1.0. Results given in Rows 11, 12, 25, 26, 39, 40.

$\underline{\sigma}_{rk}$, the elasticity of substitution in production between capital and labor services = .5 in all sectors.

σ = .4 in all sectors. Results given in Rows 13, 14, 27. 28, 41, 42.

σ = .6 in all sectors. Results given in Rows 15, 16, 29, 30, 43, 44.

σ = .4 in urban sectors, = .6 in rural sectors. Results given in Rows 45, 46.

Note: All the equation numbers referred to are those given in Table 1.

Table 3

Sensitivity Analysis of the Effects on Gross Domestic Product (GDP) and Gross Investment (I) of Different Levels of Foreign Savings to Alternative Sets of Assumptions

Row	A		B		C		D		E		F	
	GDP	I	GDP	I	GDP	I	GDP	I	GDP	I	GDP	I
1	6583	1589	6583	1589	6583	1589	6583	1589	6583	1589	6583	1589
2	6589	1647	6590	1631	6590	1631	6590	1591	6590	1589	6589	1621
3	6584	1590	6584	1590	6584	1590	6585	1591	6585	1589	6592	1597
4	6673	1711	6683	1687	6685	1681	6710	1620	6722	1589	6684	1687
5	6515	1552	6513	1558	6511	1562						
6	6605	1672	6613	1653	6614	1652						
7	6752	1674	6756	1663	6761	1653						
8	6843	1799	6858	1765	6865	1750						
9	6148	1313	6132	1366	6121	1400						
10	6226	1424	6219	1447	6211	1473						
11	6661	1588	6678	1622	6680	1616						
12	6770	1748	6780	1720	6784	1709						
13	6568	1581	6568	1582	6567	1583						
14	6650	1697	6658	1674	6660	1670						
15	6592	1592	6593	1592	6593	1591						
16	6687	1717	6698	1693	6702	1687						
17	6581	1590	6580	1590	6580	1590	6581	1588	6581	1589	6582	1589
18	6603	1644	6606	1630	6611	1616	6614	1596	6615	1589	6617	1606
19	6407	1437	6400	1472	6396	1486						
20	6432	1481	6427	1503	6424	1515						
21	6831	1756	6838	1727	6842	1716						
22	6852	1820	6863	1777	6869	1759						
23	6443	1588	6445	1578	6443	1588						
24	6459	1653	6464	1625	6463	1634						
25	6606	1562	6604	1571	6604	1570						
26	6630	1608	6631	1606	6638	1604						
27	6415	1427	6407	1465	6404	1479						
28	6435	1475	6429	1499	6427	1510						
29	6697	1707	6703	1682	6705	1674						
30	6722	1766	6732	1727	6734	1718						
31	6581	1588	6580	1589	6589	1596	6580	1590	6580	1589	6580	1589
32	6718	1621	6733	1589	6787	1697	6673	1711	6685	1687	6688	1681
33	6530	1555	6527	1560	6525	1564						
34	6624	1676	6634	1657	6635	1654						
35	6728	1669	6734	1658	6739	1649						
36	6824	1791	6842	1762	6850	1748						
37	6122	1308	6103	1361	6089	1397						
38	6204	1420	6196	1443	6186	1471						
39	6675	1626	6677	1622	6680	1610						
40	6774	1749	6786	1722	6792	1710						
41	6593	1587	6593	1588	6593	1587						
42	6680	1704	6690	1682	6693	1675						
43	6571	1590	6572	1589	6571	1590						
44	6671	1716	6684	1691	6688	1696						
45	6677	1384	6577	1572							6600	1371
46	6776	1477	6689	1665							6704	1443

Notes: All figures are in millions of Egyptian pounds at 1976 prices For explanation of modelling assumptions and perameter values see Table 2 and text. Blank entries indicate simulation not performed.

tic since these results are generated under the assumptions (a) that investment is entirely savings-determined, and (b) that other rather favorable circumstances prevail, such as that the labor supply is rather variable, economies of scale prevail in the investment goods sector, and/or the elasticity of substitution in production is relatively high.

Excluding these extreme cases leaves us with a more realistic range of increases in I of from 17 between runs F25 and F26 to 106 between runs B13 and B14 and between runs B43 and B44. Most of the alternative increases are in the still narrower range of 44-102. If these results are at all representative, they suggest that it is not impossible that domestic savings can be increased by foreign saving[9] rather than decreased by such savings as the increasingly pessimistic interpretations of empirical evidence on the two-gap model would have us believe. Not surprisingly, the largest increases in I are obtained when the labor supply is most variable, when savings play a dominant role in the determination of investment, and when the production function assumptions are such that fairly sizeable increases in real GDP are obtained.

While the range of absolute increases in real GDP associated with the ten percent increase in Sf is also rather large, varying from lows of 6 or 7 between the corresponding entries of rows 1 and 2 to a high of 153 between E31 and E32, in terms of percentage changes the range is rather narrow, namely from 0.1 percent to 2.3 percent. The vast majority of such estimates, moreover, is between 0.3 percent and 1.7 percent. While these increases are certainly far from overwhelming, they are not zero as much of the two-gap literature has assumed them to be, and in absolute terms they are not inconsequential.

Similar tables could be constructed from the results of the comparable runs for all other endogenous variables in the model, such as the sectoral levels of output, employment, imports, exports and so on. Given our focus on income distribution and the apparantly disappointing experience of foreign aid in that respect which was referred to in Section I above, in Table 4 we present the simulation results for one simple and convenient indicator of income inequality appropriate to the case in which there are very few income groups (making the computation of Gini or Theil coefficients rather meaningless). Bearing in mind also the general equilibrium character of the model wherein the burden of adjustment is on wage rates rather than on the levels of employment, our measure of income inequality is the ratio of the real wage[10] of the highest income group, class 3 "urban upper 10 percent," to that index of the lowest income group, class 4 "rural lower 60 percent."

Once again, the results show a fair amount of sensitivity to the alternative parameter values. Note that in the table as a whole, the ratio of the two wage rate indexes varies from a low of .524 in C23 to a high of 1.340 in A20. While the former indicates a substantial decrease in the real wage rate differential between these two groups relative to that of the base run, the latter ratio indicates a substantial widening of the wage differentials, again relative to the base run, i.e., what actually transpired according to the 1976 Egyptian SAM.

By reflecting on the characteristics (assumptions) of these runs which yield the extreme values of these relative wage rate indexes, it becomes easy to understand how these results arise.

Given our primary objective of measuring the effects of external assistance, we once again concentrate on comparisons with respect to the different levels of foreign assistance represented by the value of the ratio in a particular column of an odd-numbered row with that of the corresponding cell of the even-numbered row immediately below it. As the reader can easily see, such comparisons show that an increased level of foreign savings almost invariably raises the degree of income inequality. The reason for this derives from the fact that the investment goods sectors, sectors 7 and 8, "other

Table 4

Index of Income Inequality: Ratio of the Real Wage Rate of the Highest Income Group in the Urban Sector to that of the Lowest Income Group in the Rural Sector for Alternative Assumptions About Levels of Foreign Savings, Functional Forms and Parameter Values

	A	B	C	D	E	F
1	.961	.962	.961	.962	.961	.959
2	1.025	1.016	1.015	.987	.986	1.004
3	.061	.961	.961	.961	.961	.960
4	.985	.979	.977	.961	.953	.980
5	.954	.955	.955			
6	.976	.972	.971			
7	.976	.974	.971			
8	1.001	.993	.989			
9	.934	.947	.955			
10	1.102	.962	.969			
11	1.018	.979	.978			
12	1.005	.998	.995			
13	.944	.945	.946			
14	.966	.960	.960			
15	.977	.977	.977			
16	1.004	.997	.995			
17	.949	.950	.950	.950	.950	.960
18	1.085	1.089	1.045	1.097	1.098	1.100
19	1.176	1.167	1.164			
20	1.340	1.334	1.331			
21	.795	.802	.806			
22	.914	.923	.928			
23	.525	.526	.524			
24	.603	.607	.606			
25	1.067	1.065	1.065			
26	1.218	1.219	1.219			
27	1.203	1.197	1.195			
28	1.324	1.321	1.320			
29	.711	.719	.721			
30	.858	.871	.873			
31	.948	.948	.948	.948	.948	.950
32	.987	.986	.986	.985	.984	.988
33	.994	.994	.994			
34	1.033	1.033	1.033			
35	.909	.909	.909			
36	.946	.946	.946			
37	.854	.855	.857			
38	.886	.887	.888			
39	.977	.977	.977			
40	1.919	1.017	1.017			
41	1.004	1.004	1.005			
42	1.040	1.039	1.039			
43	.901	.901	.901			
44	.944	.944	.988			
45	1.030	1.032	1.032			1.157
46	1.045	1.050	1.050			1.144

Footnotes: [1]Odd numbered rows pertain to the base level of foreign savings, i.e., 654 million Egyptian pounds. Even numbered rows assume a 10 percent higher level of foreign savings, i.e., 719.4 million Egyptian pounds.

[2]For explanation of other rows and column numbers see Table 2.

industry" and "construction," the demand for, and hence the output of, which are increased by virtue of the sizeable increases in real gross investment induced by the additional foreign savings, (according to the Egyptian SAM utilized in these simulations) employ only urban workers. The increase in the demand for urban labor, even if most of it were in the form of the lowest skilled class for that region, has the effect of raising the real wage rates of urban labor relative to those of rural labor and hence also the inequality index employed here. The only exceptions to this rule occur between the cells of row 45 and the corresponding ones of row 46. The difference in these cases is attributable to the fact that the elasticity of substitution (σ_{rk}) is assumed to be considerably lower in these sectors (i.e., all urban sectors) than in the rural sectors, requiring a greater reduction (or less of an increase) in the real wages of urban labor in order to increase employment and hence output in these sectors than in the rural ones.

While the results of Table 3 seemed to offer grounds for greater optimism with respect to the effects of foreign savings on both income and investment and hence the rate of growth of income, the results of Table 4 indicate that, unless certain offsetting policies or programs are adopted, increased levels of foreign savings would have the effect of increasing the degree of income inequality. These results, of course, call attention to the need for specific programs and policies for offsetting the inequality-increasing effect of higher Sf.

The reader should be reminded, however, that increased intergroup inequality in real wage rates need not imply overall increased income inequality among households both because intragroup income inequality may be reduced by fuller employment of those in that income class as a whole and because fuller employment of the low income surplus labor group may well allow household incomes of this class to be increased substantially even without increases in wage rates. Likewise, even if the increased real wage inequality result would carry over to inequality in real disposable income, as indeed our results (not shown) indicate that it does, increased income inequality need not imply decreased absolute income or increased poverty among the poorest group (the lowest income group in the rural sector, income class 4). Indeed, the results for real disposable income of the rural poor (not shown) demonstrate that this is not the case. Real disposable income of the lowest income group, invariably increases, though generally only modestly, with increased external assistance.

IV. Conclusions and Suggestions for Further Research

The primary intention of the preceding section is to illustrate the potential usefulness of CGE models in analysing the actual or potential effect of foreign assistance. While all of the simulations with the model described above have pertained to the static model, i.e., are those of the comparative static type, dynamic experiments could also be performed. In this respect, one could easily follow the differential effects of the different levels of Sf successively through one or more different future periods. For example, any higher levels of investment made possible by higher levels of Sf could be used to increase the sector-specific capital stocks in the next period and then the comparative static experiments could be undertaken once again. Likewise, the values of various other exogenous variables and parameters could be updated so as to make them more realistic to the expected future conditions with and/or without the effects of extra foreign aid of the previous periods.

Because in principle the dynamic effects of higher levels of foreign savings could be positive or negative, depending on the relative importance of the capital-enhancing effects, on the one hand, and the distortion-increasing ones on the other hand, simulations of this sort could be of great help in identifying the degree of sensitivity of the results to alternative assumptions about the underlying parameter values, etc. As such, the CGE results could be essential in the identification of priorities in statistics gathering and empirical estimation.

Another important use of the model could be investigating the effects of alternative forms which Sf might take, such as education (and hence changing the mix of workers between the three different skill classes in each region), and/or projects which would affect parameters in the production function of specific sectors. So too, the model could be advantageous in investigating the effects of accompanying policy reforms. Indeed, in some of our own thus far unreported experiments along these lines we have found that such policies can be of considerable help in offsetting the otherwise unwanted effects of foreign assistance, such as those on income distribution.

Before concluding this exposition of our simulation experiments, it should be emphasized that the results presented only begin to take advantage of all the flexibility provided in the modelling system. Our experience goes well beyond the results reported. In certain cases the outcomes explain why certain other combinations of assumptions were not reported in the sensitivity analysis runs provided in Table 3. For example, the reason why results are not presented for another column, say column G, which would have combined an investment function as in the column E runs with the ELES consumption-savings functions used in the runs of column F was that the results were found to be identical to those of column F. This is the case because, with the ELES option in force no form of savings is sensitive to the interest rate. Hence, savings are determined independent of this interest rate, implying that, if investment, which according to equation (41a) is sensitive to both GDP and interest rate, should be different from savings, the interest rate (which is affected only by savings-investment disequilibrium) would adjust in such a way as to equate investment with savings. Therefore, any interest rate-sensitive investment function is redundant when the ELES option is in effect. On the other hand, with both the ELES savings function and an investment function which is not sensitive to interest rate in operation simultaneously, savings and investment will normally be inconsistent and convergent solutions cannot be achieved. This explains why no results are presented for this case. Another valuable benefit provided by simulation experiments of this sort, therefore, is to help the user understand the economics of the system by forcing the user to come up with explanations for why solutions are not affected by certain changes or why in certain situations equilibrium solutions cannot be obtained.

Besides these primarily methodological lessons, one cannot help but conclude with also a substantive message concerning the effects of foreign aid. While the generally disappointing experience with foreign aid programs and projects, and the possibilities of harmful aid-induced biases of various sorts cannot and should not be denied, the results, nevertheless, show that, when aid is properly designed, managed and implemented and the unwanted effects such as greater income inequality or increased capital intensity are accompanied by policies designed to offset these effects, foreign aid remains a potentially useful tool for assisting LDCs in achieving their development objectives at minimum social cost.

Footnotes

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[1]See, e.g., Chenery and Strout (1966) Landau (1971), and Weisskopf (1972a, 1972b).

[2]Among the most important studies of this type are Houthakker (1965), Griffin (1970), Griffin and Enos (1970).

[3]See especially Bauer (1981) and Tendler (1975).

[4]One should also bear in mind that foreign aid may take many different forms, each form possibly giving rise to different kinds of effects. For a relatively comprehensive but outdated textbook analysis see Mikesell (1968).

[5]For a nice example of the case study approach as well as numerous references to other case studies see Tendler (1975).

[6]This kind of an issue has a rich tradition in economics. For a recent and especially relevant example see Chichilnisky (1980).

[7]See, e.g., Adelman and Robinson (1978), Dervis, de Melo and Robinson (1982) and de Melo (1982).

[8]I is virtually exogenous in these cases since from equations (41a), with the elasticity of investment with respect to the interest rate set to zero, it can be influenced only by the rate of change in GDP which, because of the fixed labor supply and other assumptions of these cases, is minimal, i.e., 0.1 percent.

[9]This result pertains to the static results only. If the foreign aid takes the form of loans, future net savings may be reduced, thereby giving the present value of the net saving stream an ambiguous sign.

[10]The real wage rates are the nominal wage rates divided by the class-specific price indexes.

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