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Papers by:

297 "Modelling Economic Policy and Agricultural Development: A General Equilibrium Approach"	Ramon L. Clarete and James A. Roumasset
376 "Growth Without Adjustment: Thailand, 1973-1982"	Shantayanan Devarajan and Hector Sierra
485 "Fiscal Policy, Monetary Targets, and the Price Level in a Centrally Planned Economy: An Application to the Case of China"	Andrew Feltenstein and Ziba Farhadian
745 "Inflow of Foreign Private Capital and National Welfare of Developing Countries: A General Equilibrium Analysis"	M. Hasan Imam
895 "A Short-Run General Equilibrium Model for a Small, Open Economy"	Santiago Levy

These papers contain preliminary findings from research work still in progress and should not be quoted without prior approval of the authors.

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Developing Countries and Applied General Equilibrium

November 15, 1985

The enclosed papers were presented at a one-day symposium on numerical general equilibrium modelling applied to issues facing developing countries. The symposium was sponsored by the Centre for the Study of International Economic Relations and held in the Department of Economics at the University of Western Ontario.

Ramon Clarete (University of Western Ontario) and James Roumasset (University of Maryland) presented a model designed to evaluate the efficiency and equity effects of agricultural policies in developing countries. Trade and taxation policies are also featured in the model, allowing a comparison with agricultural policies regarding their relative efficiency in promoting agricultural development.

Pradeep Mitra (World Bank) delivered a paper by Shantayanan Devarajan (World Bank and Harvard University) and Hector Sierra (World Bank) in which they formulate a dynamic, multisectoral model of the Thai economy to investigate Thailand's rapid rate of growth between 1974 and 1981. The implications of the Thai experience for other oil-importing countries is discussed.

Andrew Feltenstein (World Bank) discussed a study he has made with Ziba Farhadian (International Monetary Fund) in which they apply a monetary model of a centrally planned economy to China. They demonstrate how the use of official price indices may lead to serious misspecification of target levels of key macroeconomic variables.

Hasan Imam's work on private investment in a developing economy attempts to determine the expected extent of such investment and evaluate its welfare implications. The model is applied to India in a computable general equilibrium framework.

Santiago Levy (Boston University) presented a general equilibrium model representative of less developed countries in that it incorporates quantitative restrictions, quota-derived rents, and the possibility of excess capacity in some production sectors. The model is calibrated to a stylized developing country, and simulation experiments are run focusing on the effects of changing quantitative restrictions on imports.

Also presented at the symposium, but not included in this volume, was a paper by Trien Nguyen (University of Waterloo) and John Whalley (University of Western Ontario) entitled "General Equilibrium Analysis of Black Markets in Developing Countries". This paper appeared earlier as a CSIER Working Paper, #8522C.

MODELLING ECONOMIC POLICY AND AGRICULTURAL DEVELOPMENT:

A GENERAL EQUILIBRIUM APPROACH

Ramon L. Clarete and James A. Roumasset

December, 1985

The authors have visiting appointments at the University of Western Ontario and University of Maryland, respectively. We wish to thank A. Blomqvist, P. Mitra, and J. Whalley for their valuable comments to earlier versions of the paper. We alone are responsible for any remaining errors.

Modelling Economic Policy and Agricultural Development: A General Equilibrium Approach

by

Ramon L. Clarete and James A. Roumasset

1. Introduction

Agriculture is an important sector in many developing countries. A substantial portion of the respective gross domestic products of these economies comes from agriculture. A majority of the population are engaged in agricultural activities. Foreign exchange earnings are drawn mainly from exporting primary and semi-processed agricultural products. Agriculture is the main source of food for the whole population, especially for the growing urban poor in these countries.

Agricultural development strategy has passed through a number of phases of fad and fancy. Dissatisfaction with community development schemes, based on the assumption that modern technology had only to be transferred to tradition-oriented peasants, led to the "high input/high payoff" model, which was based on the alternative assumption of efficient farm decision-makers. When the Green Revolution did not live up to expectations, economists and policymakers called for a wide range of interventions including price supports, fertilizer subsidies, supervised credit, crop insurance, and institutional reforms. Once more, the policies did not deliver the anticipated goods.

The current panacea is encapsulated in the familiar slogan, "get the prices right". At present, our level of ignorance about getting agricultural prices right is so great that experts seem unwilling to specify under what conditions agricultural prices should be increased, decreased, or allowed to remain at market clearing levels (Roumasset, 1985). Lest the positive aspects of the privatization initiative be undermined by overly simplistic implementation, it is time to learn from the mistakes of the past and base recommended policy reforms on a more fundamental understanding of how agricultural systems function and interact with other sectors of the economy.

In this paper, we design a general equilibrium model for evaluating the economic impacts of agricultural policies of developing countries. In particular, the policies considered in the model are those intended to increase agricultural output and promote better income distribution, such as price-floors in food production, price-ceilings in food consumption and in the use of agricultural inputs, and irrigation investments. While applied general equilibrium analysis has been used to assess the economic impacts of tariffs, taxes, and other price wedges, the models found in the public economics literature (see, e.g. Scarf and Shoven, 1984) are not well suited to the analysis of price controls and public investments in agriculture.

The consensus among a number of specialists in agricultural development policy is that direct investments in agriculture are a more effective vehicle for economic development than price distortions.[1] While this proposition sounds eminently plausible, these counselors have not proposed an appropriate framework with which to evaluate the efficiency and equity implications of alternative strategies. By incorporating price-fixing policies and irrigation investments into a general equilibrium framework, not only can we evaluate the respective contributions of such policies to agricultural development, but we

[1]See, e.g., the section on agricultural policy in Eicher and Staatz (1984).

can also compare agricultural development strategies that rely on price interventions versus those that shift the supply curve.

The model also incorporates tariffs, export and domestic sales taxes in order to assess their impacts on agriculture and on the economy as a whole, as well as how these policies interact with agricultural policies. Tariffs and export taxes tend to discourage agricultural production by lowering the prices of exportable farm products and by raising the cost of imported inputs in agriculture. Since these policies are imposed to raise revenues, it is interesting to compare their agricultural impacts with those of a domestic sales tax. If agricultural subsidies are in place, another issue is that tariffs and export taxes tend to increase output subsidies but lower those on food consumption and the use of imported agricultural inputs. Since most agricultural subsidies are to compensate agricultural producers for their losses through having tariffs and export taxes, it is also interesting to know whether or not a free trade regime could raise farm production more efficiently than subsidies. Lastly, in the case of a cheap food policy, the question worth looking into is whether or not a free trade regime by encouraging the production of food items, most of which are exportables, could encourage food consumption through lower market prices of food products less costly than food subsidies.

We extend the Shoven-Whalley approach to applied general equilibrium analysis (Shoven and Whalley, 1984; Scarf and Shoven, 1984) to deal with agricultural policy issues in developing countries. In particular, we develop an Arrow-Debreu model of a small-open economy with homegoods, which features trade, domestic tax, exchange rate, and agricultural policies. Such a framework with tariff policies was already developed in Clarete and Roumasset

(1985) and extended to accommodate nontariff trade barriers, rent seeking, and a Harris-Todaro labor market distortion in Clarete and Whalley (1985). We further extend this framework by adding a fixed exchange rate, agricultural price interventions, and irrigation investments. The model is solved using a fixed-point algorithm, such as OCTASOLV (Broadie, 1983).

Existing computable general equilibrium models for analyzing agricultural policies (e.g. deJanvry and Subbarao, 1984; Bautista, 1984; Quizon and Binswanger, 1983; and McCarthy and Taylor, 1978) tend to give up pure microeconomic foundations and typically use the Johansen approach to applied general equilibrium analysis (Johansen, 1960). Insufficiently specified macroeconomic phenomena were appended to the underlying real Walrasian model in deJanvry and Subbarao (1984) and in McCarthy and Taylor (1978). The nonagricultural sectors of the economy were left out in the Quizon-Binswanger model apparently to facilitate the econometric estimation of the model. Except for the McCarthy-Taylor model, these models are solved using Johansen's method.[2]

Models with incomplete microfoundations are sometimes chosen to facilitate econometric estimation or as a management tool to inform

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[2]Concisely, this method is as follows. Consider (1) $F(x) = 0$ to be the complete set of general equilibrium relations, where F represents a set of n functions, x is an m-dimensional vector and 0 is an n-dimensional vector ($m > n$). Then, (2) $Gy = 0$ is obtained by totally differentiating (1) with respect to x. Particularly, G is an n-by-m matrix of the partial derivatives of F with respect to x, and $y = dx$. We assume that $G = [G_1|G_2]$ where G_1 is n-by-n and G_2 is n-by-(m-n); further, we assume that $y = [y_1|y_2]$ where y_1 is the vector of the changes in n endogenous variables (the unknowns) while y_2 is the vector of the changes in (m-n) exogenous variables (the shifters). Thus, (2) can be rewritten as $G_1y_1 + G_2y_2 = 0$. Assuming G_1^{-1} exists, the solution to

policymakers of the policy changes necessary to achieve particular targets. These models are not well-suited to estimating the efficiency costs of alternative policies, however. Our objective is to facilitate a comparison of alternative agricultural development strategies in terms of their economic costs. As such we must preserve complete microfoundations in order to exploit the tools of applied welfare economics.

The general equilibrium treatment of price interventions has been modeled by Imam and Whalley (1982). We extend their approach by featuring the interactions of price controls with trade policies. This is achieved by specifying a small-open economy model, in contrast to the closed-economy Imam-Whalley model. However, we follow the model's treatment of price controls in the case of irrigation water which is regarded as a homegood in our model.

Kehoe and Serra (1983) have modeled price interventions for a large-open economy. An interesting innovation they made was to allow the government to incur a deficit, which was financed with government bond sales to the domestic private sector. However, they did not specify the repayment of public debt, which seems difficult to do in a static framework. In our model, we incorporate price interventions, but in the context of a small-open economy, which may be more appropriate for developing countries. Unlike Kehoe and Serra, however, we specify that the government has a balanced budget in equilibrium, by making the real exchange rate flexible.

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the model is (3) $y_1 = -G_1^{-1}G_2y_2$. deJanvry and Subbarao (1978) used the method by Dixon, Parmenter and Rimmer (1984) of piecewise calculations to minimize the linearlization error in the Johansen approach.

In the following section, we lay down the basic structure of our model. In Section 3 we introduce tariffs, sales taxes, and price controls. In Section 4, we introduce irrigation investments and subsidies. Finally, potential applications and limitations of the model are summed up in Section 5.

2. A Small-Open Economy Model

Consider an economy consisting of N producers, H consumers, and a government. Of the N sectors (producers), some goods are not traded and comprise the set SH. All other goods are fully traded and make up the set ST. The economy is a price taker in its tradables. We denote the exogenous world price vector as $\bar{v}$.

Production is carried out under a decreasing returns to scale technology. Every producer utilizes M variable factors, a sector-specific factor, and intermediate inputs. Denoting X to be the output vector, F to be the M-by-N factor demand matrix and $\bar{Z}$ to be the N-dimensional vector of fixed factors, we describe the N production functions as: $X_j = f_j(F_j;\bar{Z}_j)$, $j=1,\ldots,N$.

Under profit-maximization, one derives the N supply functions,

$$X_j = X_j(w,p;\bar{Z}_j), \qquad j=1,\ldots,N, \tag{1}$$

where w and p are respectively the vectors of factor and producer prices, and the M derived demands for factors in each of the N sectors,

$$F_{ij} = F_{ij}(w,p;\bar{Z}_j), \qquad i=1,\ldots,M;\ j=1,\ldots,N, \tag{2}$$

by taking the respective gradients of the N restricted profit functions. Intermediate inputs are utilized in fixed proportion to production. We denote N square matrix $A = [a_{ij}]$ to be the input-output matrix.

Economic rents are generated because of the presence of sector-specific factors. The respective rents in each sector are given by:

(3) $$\pi_j = p_j X_j - \sum_{i=1}^{N} a_{ij} X_j q_i - \sum_{i=1}^{M} F_{ij} w_i \qquad j=1,\ldots,N,$$

where q is the N-dimensional vector of consumer or user prices. The distribution of these profits is assumed exogenous. This can be done by specifying how $\bar{Z}$ is distributed among consumers. To simplify our exposition, we introduce a set of exogenous share parameters, to be denoted by the H-dimensional vector σ, defining how the aggregate profit in the economy is to be divided.

Consumer preferences are described by H utility functions, each a function of the final demand for goods: $U_h = U_h(C_h)$, h=1,...,H, where U denotes the H-dimensional vector of utility indices and C_h stands for the N-dimensional vector of final demands by consumer h. Under constrained utility maximization,

(4) $$C_{hj} = C_{hj}(q;Y_h) \qquad h=1,\ldots,H;\ j=1,\ldots,N,$$

where Y_h is the income of consumer h. Summing up (4) across all consumers gives the vector of market demand curves, C.

The incomes of consumers come primarily from their endowments in variable and fixed factors. We assume that consumers are exogenously endowed with factors and derive income by selling these resources to firms. There is no tradeoff between leisure and market time in the model. Denoting $\overline{FS}$ to be the H-by-M factor endowment matrix,

$$(5) \qquad Y_h = \sum_{i=1}^{M} w_i \overline{FS}_{ih} + \sigma_h \sum_{j=1}^{N} \pi_j \qquad h=1,\ldots,H.$$

The total supply of factor i in the economy is $\overline{FS}_i = \sum_{i=1}^{H} \overline{FS}_{ih}$.

Although the total supplies of variable factors are fixed, their respective allocations across sectors are endogenous in the model.

Since the world prices of traded goods are fixed, we can define the following Hicksian (Hicks, 1936) composite quantities as in Clarete and Roumasset (1985):

$$(6) \qquad C_T = \sum_{j\in T} \bar{v}_j (C_j + ID_j) \quad \text{and}$$

$$X_T = \sum_{j\in T} \bar{v}_j X_j$$

here ID_j is the total intermediate demand for good j. C_T and X_T are respectively the demand and supply for the composite good. According to the Hicks composite commodity theorem, goods with proportional prices can be aggregated in value terms and treated as one commodity with its own price (Diewert, 1978), to be denoted here as r_T. Accordingly, the vector of domestic prices of tradables is

$p = r_T\bar{v}$.

The application of Hicks aggregation theorem increases the computational efficiency of the algorithm used to calculate equilibrium relative prices.

The theorem allows us to scale each $\bar{v}_j$ with r_T to its corresponding domestic price, p_j. By following this procedure, we solve for the equilibrium values of r_T and of all prices of homegoods. Trade deficit is cleared by adjusting r_T, while the markets for homegoods equilibriate as their prices are modified. Without the use of r_T, we need to solve only for the prices of homegoods. But ironically, this alternative procedure may require a longer time because the endogenous prices must satisfy simultaneously market clearing and trade balance conditions.

The scaling introduced here does leave equilibrium relative prices unchanged. This is apparent in the case of traded goods, where their relative domestic prices is their fixed relative world prices. With homegoods, the equilibrium value of r_T is equal to the ratio of the equilibrium price of any homegood to its equilibrium price in the alternative computational procedure which uses no scaling. Hence, the equilibrium relative prices of any traded to those of any nontraded good, as well as that between any pair of homegoods are invariant to the scaling adopted here. Interestingly, in the special case involving traded goods and one homegood, the numeraire, the change in the equilibrium value of r_T is the real exchange adjustment described by Dornbusch (1973).

Summing up (5) across all consumers and equating the total with aggregate expenditures of consumers, and using (3), and (6), we obtain the following expression of Walras' Law:

$$(7) \qquad \sum_{i=1}^{M} w_i \left(\sum_{j=1}^{N} F_{ij} - \overline{FS}_i \right) + \sum_{j \in SH} p_j (C_j + ID_j - X_j) + r_T (C_T - X_T) = 0.$$

Thus, general equilibrium for this basic formulation of a small-open economy is the set of equilibrium prices of homegoods, factors, and of the composite commodity which clear all markets of homegoods and factors and simultaneously satisfy trade balance.

Note that there are no wedges between producer and consumer prices as well as between domestic and world prices in the model. In the following section, we introduce a government that taxes imports, exports, domestic sales, and imposes price controls on a subset of traded commodities.

3. Price Interventions, Tariff Policies, and Sales Taxes

The government is now added into the model. It imposes price ceilings on consumer and intermediate goods as well as price floors in producing a subset of traded goods. We denote STC to be the subset of traded goods under price ceiling policies and STF as the set of traded goods under price floors in producing a subset of traded goods. An intersection of STC and STF is allowed. Any excess demands arising from these pricing policies are absorbed by the rest of the world. Hence, no rationing is done in response to such policies.

The subsidy cost of price interventions is fully borne by the government. To pay for the subsidy, the government imposes tariffs on imports, and taxes exports and domestic sales. We denote t to be the vector of tariff (or export tax, if negative) rates and tx to be the vector of sales tax rates.

The domestic price received by producers is given by:

$$(8) \qquad p_j = \begin{cases} \max[\bar{p}_j, r_T \bar{v}_j (1 + t_j)], & \text{if } j \in \text{STF;} \\ p_j, & \text{if } j \in \text{SH; and} \\ r_T \bar{v}_j (1 + t_j), & \text{otherwise,} \end{cases}$$

where $\bar{p}$ is the vector of price floors. The total amount of production subsidy (PS) is:

$$(9) \qquad PS = \sum_{j \in STF} [p_j - r_T \bar{v}_j (1 + t_j)] X_j .$$

The domestic price paid by consumers is given by:

$$(10) \qquad q_j = \begin{cases} \min[\bar{q}_j, r_T \bar{v}_j (1 + t_j)(1 + tx_j)], & \text{if } j \in STC; \\ p_j (1 + tx_j) & \text{if } j \in SH; \text{ and} \\ r_T \bar{v}_j (1 + t_j)(1 + tx_j), & \text{otherwise} \end{cases}$$

where $\bar{q}$ is the vector of price ceilings. The total consumption subsidy (CS) is:

$$(11) \qquad CS = \sum_{j \in STC} [r_T \bar{v}_j (1 + t_j) - (\frac{q_j}{1 + tx_j})](C_j + ID_j).$$

Note the interactions between price intervention and trade policies in the model. By varying the vector t, the policymakers can affect the amount of subsidies. Increasing tariff rates or lowering export tax rates, for example, tends to reduce production subsidies by decreasing the wedge between the floor price and marginal cost. In contrast, the same policy measures tend to increase consumption subsidies by raising the difference between marginal cost and the ceiling price.

The revenues from trade taxes (TR) and from sales taxes (CR) are given by:

$$(12) \quad TR = \sum_{j \in ST} r_T \bar{v}_j t_j (C_j + ID_j - X_j); \text{ and}$$

$$CR = [\sum_{j \in STC} \frac{q_j tx_j}{(1 + tx_j)} + \sum_{j \in SH} p_j tx_j + \sum_{j \in TNC} r_T \bar{v}_j (1 + t_j) tx_j](C_j + ID_j)$$

where TNC denotes the set of traded goods with uncontrolled prices.

The fiscal surplus of the government is defined as:

(13) $$D = TR + CR - CS - PS.$$

We assume that the surplus is given back to consumers in a lump-sum fashion as transfer payments, denoted by TY. We further suppose that the H-dimensional vector of share parameters, ϕ, which describes how TY is to be distributed to all consumers in the model is known.

Accordingly, the income of consumer h is modified to reflect the transfer payment received by him from the government. Equation (5) becomes

(5b) $$Y_h = \sum_{i=1}^{M} w_i \overline{FS}_{ih} + \sigma_h \sum_{j=1}^{N} \pi_j + \phi_h TY, \qquad h=1,\ldots,H.$$

Adding up (5b) across all consumers, equating the result to the total expenditures of consumers in the model, and making use of equations (3), (6), (8) through (13), we obtain the following expression of Walras' Law, the derivation of which is detailed in the Appendix:

(7b) $$\sum_{i=1}^{M} w_i \left(\sum_{j=1}^{N} F_{ij} - \overline{FS}_i \right) + \sum_{j \in SH} p_j (C_j + ID_j - X_j)$$
$$+ r_T (C_T - X_T) + (D - TY) = 0.$$

General equilibrium for this formulation will be the set of factor prices, homegood prices, the real exchange rate, and the transfer payment which clears all markets of factors and homegoods and balances the trade and public sector accounts. Formally, we solve the following simultaneous equation set for w, p_j ($\forall j \in SH$), r_T and TY:

$$(14)\qquad \sum_{j=1}^{N} F_{ij} - \overline{\overline{FS}}_i = 0, \qquad i=1,\ldots,M;$$

$$C_j + ID_j - X_j = 0 \qquad \forall j \in SH;$$

$$C_T - X_T = 0; \text{ and}$$

$$D - TY = 0.$$

4. Irrigation Investments and Subsidies

To introduce irrigation investments, we create a market for irrigation water. Consider now that irrigation water is added as the $(N + 1)^{th}$ sector of the model. Accordingly, we expand the dimension of the N-dimensional price vectors in the model to accommodate the price of irrigation water. We denote IRR to be the set of irrigated sectors (crops)

The use of irrigation water is a derived demand from producing irrigated crops. Formally, the production functions of these crops incorporate irrigation water as an additional input:

$$(15)\qquad X_j = g_j(F_j, WD_j; \bar{Z}_j), \qquad \forall j \in IRR,$$

where g_j is a decreasing-returns-to-scale function and WD_j is the use of irrigation water in the irrigated sector j. In (15), we allow for substitution between WD_j and the variable factors to occur. Under profit maximization, the derived demand for irrigation water is:

$$(16)\qquad WD_j = WD_j(w, p, q_i; \bar{Z}_j), \qquad \forall j \in IRR;\ i=N+1$$

Certainly, water is required by all crops. The difference is that in nonirrigated crops water is provided only by nature. Since the model is non-stochastic, we assume that the amount and distribution of natural (as opposed to irrigation) water are exogenous for the duration of the analysis.

Accordingly, natural water is incorporated in $\bar{Z}_j$. With irrigation, irrigated crops can vary the use of water, using the market of irrigation water, while continuing to utilize the natural water as a fixed input.

We suppose that the production of irrigation water can be represented by a production function which transforms variable factors and a sector-specific factor into water: $WS = f_j(F_j;\bar{Z}_j)$, where f is a decreasing-returns-to-scale function and j denotes irrigation water. Under profit maximization,

$$(17) \qquad WS = WS(p,w;\bar{Z}_j) \qquad\qquad j = \text{irrigation water}$$

which is the supply function of irrigation water. Note that the p vector has as its $(N+1)^{th}$ element the marginal cost of providing irrigation water.

The link between irrigation investments and water provision is channeled through the fixed input, $\bar{Z}_j$, in (17), which represents mostly the fixed capital that irrigation investments underwrite. Irrigation capital in turn may take various forms such as an irrigation dam or a system of canals for distributing irrigation water to various farm plots. An exogenous increase in irrigation investments will expand the stock of irrigation capital and accordingly will shift the supply curve in (17) outward.

The extent of the shift depends upon the nature of irrigation investments. One of the leading irrigation policy issues at present is to determine whether constructing irrigation dams or improving the management of existing irrigation systems will expand more the supply of irrigation water. For our purposes, we assume that the technical information about the relationship between the nature and extent of irrigation investments and the supply of irrigation water can already be provided by engineers.

In order to focus on the tradeoff between investment in irrigation and other policies to increase the available supply of food, one needs to abstract from issues of water management. We assume that any inefficiencies in management are already built into the production function. Subsidies to irrigation are measured as the difference between the charge per unit of water and the long-run marginal cost of delivering water. Since we are abstracting from issues of information and enforcement costs, it does not matter whether the institutional mechanism for water charges is a price per unit or whether quantities of water are centrally determined and farmers charged a lump sum. In either case, farmers are assumed to use water up to the point where the marginal product of water equals the user cost, q_j.

Since water is a homegood, our analysis of the water subsidy follows closely that in Imam and Whalley (1982). Suppose now that $\bar{q}_j$, j = irrigation water, is the price ceiling of irrigation water set by policymakers. Formally, the user price of irrigation water is given by:

$$(18) \qquad q_j = \min([\bar{q}_j, p_j(1 + tx_j)], \qquad j = \text{irrigation water.}$$

Substituting (18) into (16) and summing up the result across all irrigated crops, we get the market demand for irrigation water.

If producers would receive $\bar{q}_j$, then an excess demand for water would arise and could be resolved through rationing. However, this would constrain rather than encourage the use of irrigation water and thus would defeat the purpose of this price ceiling policy.

Hence, producers are subsidized to produce more water to cover the excess demand for it. The endogenous *ad valorem* subsidy rate is:

$s_j = p_j - \frac{q_j}{(1 + tx_j)}$, j = irrigation water. The price p_j in turn is the solution of (18) such that WS is equal to the market demand for irrigation water. The cost of the irrigation program is:

$$(19) \qquad IS = \sum_{j \in IRR} s_j WD_j(q_i, p, w; \bar{Z}_j) + IC, \qquad i = \text{irrigation water.}$$

where IC is the amount of public funds invested in building irrigation systems. Equation (19) is subtracted from (13), modifying the fiscal surplus in the model.

The following excess demand function for irrigation water is added to the equation set in (14) and is to be solved for the marginal cost of irrigation water.

$$(20) \qquad WD_j - WS = 0.$$

5. Potential Applications and Limitations

The general equilibrium model designed here can be used to evaluate the economic impacts of agricultural policies, such as price floors in food production, price ceilings in food consumption and in the use of agricultural inputs, and irrigation investments. We can also use the model to comparebetween two-tier pricing policies and irrigation investments as tools for improving income distribution and food consumption in developing countries. While this comparison was done before (e.g., Barker and Hayami, 1976), the analysis utilized a partial (not a general) equilibrium formulation.

Furthermore, since the model features agricultural as well as trade and tax policies, we can use it to assess the relative efficiencies of these instruments to foster agricultural development. In particular, we can investigate whether or not a free trade regime could raise farm production more efficiently than farm subsidies. Also, we can assess if free trade policy by encouraging the production of food items, most of which are exportables, is a better instrument to encourage food consumption than food subsidies. For those interested in agricultural implications of measures which raise tax revenues, the model can be used to compare the relative waste of tariffs and domestic sales taxes.

The model is also potentially useful in computing constrained optimal values of policy instruments within the control of the policy-making bodies in question, taking the other policy variables as politically fixed. In this case, the analyst solves for the values of the flexible policy instruments that maximize real national income subject to the fixed policy variables. In practice, this analysis may involve the following. Given a finite set of policy options to offset the inefficiency and undesired consequences of politically fixed policy distortions, the analyst uses the model to compare discretely his alternative strategies; the option which gives the largest net increment to real national income is chosen as the second-best agricultural policy.

As is always true in applying abstract models, it is important to bear in mind what phenomena are left out. The model does not incorporate disequilibrium, the process of adjustment, induced investment, or exogenous disturbances that may occur during a period of adjustment. Since the model is deterministic, stochastic weather disturbances which explain to some extent agricultural production are not incorporated. Accordingly, the model should not be used as a predictive tool, except as a point of departure. It has been designed primarily to assess the efficiency and equity consequences of alternative policies, not to predict the actual path of adjustment.

The model also does not attempt to incorporate transaction costs and the forms of economic organization that would be necessary for a more realistic analysis of agricultural policy issues. For example, our treatment of irrigation water as an ordinary commodity with a well-developed market of its own abstracts from property rights problems with regard to natural sources of water and enforcement problems of irrigation fee collections. Hence, our approach here is best regarded as a limited approximation of the actual allocation mechanism for irrigation water. But we believe that it is a natural start for modeling irrigation policy issues.

Appendix

The effective budget constraint of the community is:

$$\sum_{j=1}^{N} q_j C_j - \sum_{h=1}^{H} [\sum_{i=1}^{M} w_i \overline{FS}_{ih} + \sigma_h \sum_{j=1}^{N} \pi_j + \phi_h TY] = 0.$$

Substituting equation (3), the definition of π_j, we get:

$$\sum_{j=1}^{N} q_j C_j - \sum_{i=1}^{M} w_i \overline{FS}_i - \sum_{j=1}^{N} [p_j X_j - \sum_{i=1}^{N} a_{ij} X_j q_i - \sum_{i=1}^{M} w_i F_{ij}] - TY = 0.$$

This simplifies to:

$$\sum_{i=1}^{M} w_i [\sum_{j=1}^{N} F_{ij} - \overline{FS}_i] + \sum_{j\in SH} q_j (C_j + ID_j) - \sum_{j\in SH} p_j X_j$$

$$+ \sum_{j\in STC} q_j (C_j + ID_j) + \sum_{j\in NTC} q_j (C_j + ID_j)$$

$$- \sum_{j\in STF} p_j X_j - \sum_{j\in NTF} p_j X_j - TY = 0.$$

Using equations (8) and (10), the definitions of domestic consumer and producer prices, and adding and subtracting: (a) $r_T \bar{v}_j (1 + t_j)(C_j + ID_j)$, if $j \in STC$, and (b) $r_T \bar{v}_j (1 + t_j) X_j$, if $j \in STF$, we get:

$$\sum_{i=1}^{M} w_i\Big(\sum_{j=1}^{N} F_{ij} - \overline{FS}_i\Big) + \sum_{j\in SH} p_j(C_j + ID_j - X_j)$$

$$+ \sum_{j\in SH} p_j tx_j(C_j + ID_j) + \sum_{j\in ST} r_T \bar{v}_j(C_j + ID_j - X_j)$$

$$+ \sum_{j\in ST} r_T \bar{v}_j t_j(C_j + ID_j - X_j)$$

$$- \sum_{j\in STC} [r_T \bar{v}_j(1 + t_j) - q_j](C_j + ID_j)$$

$$+ \sum_{j\in NTC} r_T \bar{v}_j(1 + t_j)tx_j(C_j + ID_j)$$

$$- \sum_{j\in STF} (p_j - r_T \bar{v}_j(1 + t_j))X_j - TY = 0.$$

Multiplying q_j with $(1 + tx_j)/(1 + tx_j)$ if $j \in STC$ and using (6), the definition of the Hicksian composite good, we get:

$$\sum_{i=1}^{M} w_i\Big(\sum_{j=1}^{N} F_{ij} - \overline{FS}_i\Big) + \sum_{j\in SH} p_j(C_j + ID_j - X_j)$$

$$+ r_T(C_T - X_T) + \sum_{j\in ST} r_T \bar{v}_j t_j(C_j + ID_j - X_j) - \sum_{j\in STC}\Big(r_T \bar{v}_j(1+t_j) - \frac{q_j}{(1+tx_j)}\Big)(C_j + ID_j)$$

$$+ \sum_{j\in STC} \frac{q_j tx_j}{(1+tx_j)}(C_j + ID_j) + \sum_{j\in NTC} r_T \bar{v}_j(1 + t_j)tx_j(C_j + ID_j) + \sum_{j\in SH} p_j tx_j(C_j + ID_j)$$

$$- \sum_{j\in STF} (p_j - r_T \bar{v}_j(1+t_j))X_j - TY = 0.$$

Finally, using (9), (11), (12) and (13), respectively, the definitions of production subsidy, consumption subsidy, tariff revenue, sales tax revenue, and fiscal surplus, we derive equation (7b).

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DRAFT
Comments Welcome

GROWTH WITHOUT ADJUSTMENT:

THAILAND, 1973-1982

by

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Table of Contents

I. INTRODUCTION

Like many other developing countries, Thailand was adversely affected by the increased oil prices and worldwide recession of the seventies. Nevertheless, from 1974 to 1981 the Thai economy grew at an annual rate of 7.3% while its population increased at about 2.4% per year. The implied per capita real income growth of 4.9% per year was among the highest of the middle income oil-importing countries.

Even more remarkable is the fact that this growth rate was achieved with seemingly little adjustment to the dramatic change in world market conditions. For example, the controlled domestic price of oil remained well below the world price and effectively unchanged until 1979. Moreover, some of the policies that were pursued appear with hindsight to have been imprudent. Thailand's export-promotion drive reached its peak in 1975-76 when prices for Thai exports were low and falling; the country borrowed lightly in world capital markets in the early seventies, when interest rates were low, and heavily in the latter half of the decade when rates were high.

Two hypotheses can be suggested to explain this pattern of development. One is that Thailand was effectively insulated from the oil shock of 1973-4 by a series of fortuitous circumstances. The U.S. military presence in southeast Asia enabled Thailand to run a surplus on its foreign transfer account. Thai export prices rose soon after the oil shock. In fact, the country's terms of trade reached an all-time high in 1974. Finally, Thailand was able to expand the area of land under cultivation without any bottlenecks during this period, enabling agriculture--the most important sector in the economy--to continue its rapid growth rate.

The second hypothesis is that Thailand simply postponed the adjustment that was necessary after the oil shock by borrowing from abroad. Indeed, by the early 1980s it became clear that it would not be possible to maintain the high growth rates of the 1970s. The country's external deficits reached almost 8% of GDP in 1981, as compared with 4% in 1975. Commercial lenders were becoming increasingly reluctant to finance these deficits. Reflecting the deteriorating economic outlook, the private sector decreased total fixed capital investment between 1980 and 1982 by 6% on average. The GDP growth rate slowed to 5.5% during this period. In its Fifth Five-Year Plan (1982-86), the Thai government introduced a program of structural adjustment in agriculture, industry, energy, fiscal policy and public administration as well as the explicitly stated aim of reducing current account deficits.

Now, which of these two hypotheses explains Thailand's adjustment experience has important implications for how we view the country's impressive growth rate. If it is the first, then we can say that the Thais were blessed with a certain amount of good fortune and that it would be difficult to transfer the Thai experience to other situations. If, however, the second hypothesis dominates, then we will view Thailand's economic record with some caution as the growth enjoyed by the Thais in 1973-82 may have come at the expense of those saddled with debt-service payments today.

In this paper we present a quantitative framework with which the relative importance of the different hypotheses may be assessed. We develop a dynamic, multisector model of the Thai economy and use it, in the first instance, to "track" the actual path of various macroeconomic variables during the period 1973-82. Next, we perform counterfactual experiments with the model. We ask how the economy would have performed without the service payments from U.S. military bases, or with lower export prices or with limits to the availability of arable land. We also look at how the economy would have evolved had it been spared both the favorable shocks listed above and the unfavorable oil shocks. Turning to the second hypothesis, we look at the impact of a different profile of foreign borrowing than the one actually followed. We examine a trajectory of foreign borrowing that minimizes the post-1982 debt-service obligations. Alternatively, we determine the borrowing and investment paths that maximize the capital stock in 1982. As both of these differ from the actual trajectory, they strengthen the notion that the borrowing strategy adopted by Thailand was by no means optimal. Finally, we ask whether changing the composition of investment — as opposed to its level — over the ten-year period would have left the Thais with a stronger economy in 1982.

The plan of the paper is as follows. In Section 2, we describe the major developments in the Thai economy in the period 1973-82. Section 3 is an heuristic description of the model; the equations of the model are in the appendix. In Section 4, after showing how the model tracks the behavior of various macroeconomic variables, we present the results of the counterfactual experiments. Section 5, the conclusion, draws together the lessons we have learned from this exercise for adjustment in oil-importing countries in general and for economic policy in Thailand in particular.

II. ADJUSTMENT EXPERIENCE OF THAILAND

A. Antecedents and Institutional Framework, 1960-73

Thailand's economic policy in the last quarter century has been characterized by a reliance on private economic activity and limited government intervention. The underlying philosophy was clearly expressed in the First National Development Plan (1961-1966):

> "..[T]he key note of the public development program is...the encouragement of economic growth in the private sector, and the resources of government will be mainly directed to projects, both in the agricultural and non-agricultural sectors of the economy, which have this objective in view."

The emphasis on private sector growth, political stability, and a generally favorable investment climate, all may be included among the factors that contributed to the rapid economic growth of the postwar period. In the years from 1960 to 1973, Thailand's GDP increased at an average 7.8% per year. The growth rate of per-capita income, 4.6% per year, was one of the highest among developing countries.

Rapid growth in agriculture and rising exports supported the growth in the rest of the economy. Value added in agriculture grew at an annual rate of 5.2%, while the volume of exports grew at 7.2% per year during the period 1960-1973.

In agriculture, the availability of additional land allowed expansion of traditional subsistence production, and helped to absorb a growing labor force. It also facilitated a rapid diversification of new cash crops, which was the mainstay of the rapid growth of agricultural exports. Most of the growth of agricultural production in this period can be explained by the expansion of land under cultivation, which occurred at a rate of about 4% p. a. until the early 1970s. The expansion of cultivated area included both increasing the size of existing holdings, and creating new farm units which facilitated the absorption of labor. Public investment was restricted to infrastructure and support facilities which aided the efficiency of the market. In the agricultural sector, this has led to a reduction in transportation and handling cost, and to a corresponding increase in the share accruing to the farmer. The market system traditionally provided credit, information and extension services to many farmers in the absence of such services from the public sector.[1/]

The manufacturing sector also became an important source of growth and employment during this period, growing at an annual rate of 8.3%. The accelerating importance of this sector as a source of employment is reflected in the following figures: in 1960, the agricultural sector employed 82% of the labor force while the manufacturing sector (including mining) employed only 3.6%, less than commerce (5.76%), and services (4.8%). By early 1973, the agricultural sector employed 67.3% of the labor force, and the manufacturing sector was second with 10%.[2/] A surge in domestic demand, together with import substitution were important factors contributing to growth in this sector.

1/ See, for example, Thailand, Income Growth and Poverty Alleviation. World Bank, June 20, 1980.

2/ Thailand Population Census 1960, and Labor Force Survey 1973.

B. External Shocks, 1973-81

Like many other developing countries in the 1970s, Thailand relied upon imported oil and petroleum products to meet most of its energy requirements. The quadrupling of the oil prices in 1973-74, therefore, sent Thailand's import bill climbing. The initial balance of payments effect was cushioned by high export prices (as compared to their 1971-73 levels.) In addition, the high transfer and service account earnings from U.S. bases continued throughout the period 1973-75. Inflation was also controlled successfully, having fallen from 24% in 1974 after the oil shock to about 4% in 1975.

The terms of trade were not so favorable after 1975. Export prices actually dropped 2.74% in the year 1975-76, and increased at an average 8.6% p.a. between 1977 and 1981. Meanwhile, import prices steadily increased reaching an average growth of 12.1% p.a. in the period 1977-81. The difference in the growth rates represented a 24% deterioration in the terms of trade between 1975 and 1981.

The reduced impact of the oil price shock allowed Thai authorities to focus on attaining historical growth rates of output. However, the continuous deterioration in the terms of trade after 1975 and an increase of real interest rates in 1979-81 implied a larger shock for Thailand. In the next sub-section we shall examine the direction of adjustment and growth followed in the period after the first oil shock.

C. Modes of Adjustment

That Thailand was spared the full impact of the oil-related shocks is reflected in the objectives of the Fourth Development Plan (1977-81). One of the main goals of the Plan was to "... revitalize the economy in order to ensure a higher and sustainable rate of output, investment and employment expansion during 1977 and 1978." After 1975 the main concern of the Thai authorities shifted towards restoring the high growth of the 1960s as a means of achieving the objectives of the Plan. The specific target set for GDP growth during this period (1977-81) was 7% per annum, which compares favorably with the level of the 1960s. The target growth rates of salient variables are given in Table 1.

Table 1: PROJECTED GROWTH RATES IN FOURTH DEVELOPMENT PLAN, 1977-1981

Value Added In	Average Annual Growth Rate
Agriculture	5.0
Industry	9.6
Merchandise Exports	14.0
Volume	7.5
Price	6.1
Merchandise Imports	11.5
Volume	6.1
Price	5.0
Investment	7.2
Government Expenditures	11.2

We now consider the types of adjustment undertaken by Thailand in the 1970s, which can then be compared with the above-mentioned projected targets. Most of the adjustment was carried out through additional foreign borrowing and export expansion.

(i) Foreign Borrowing

The particular time profile of financing which follow distinguishes Thailand from most other developing countries. While many developing countries borrowed heavily in the early 1970s -- as real interest rates were low and global liquidity high -- Thailand's growth in external debt was modest during the first half of the 1970s. This was due to several factors, including a commodity price boom which cushioned Thailand's balance of payments effects arising from the increase in oil prices. After 1975, however, many oil importing countries had undertaken major adjustment measures to offset the impact of the first oil shock, and responded to the substantial rise in interest rates--which began in 1978--by reducing the rate of increase in the growth of their external debt. By contrast, Thailand's external borrowing accelerated during this period, with nominal growth rates of medium and long-term debt at almost 50% in 1979 and 1980, coinciding with record high nominal and real interest rates. As a result, the ratio of debt to GDP more than doubled from less than 10% in 1974, to about 20% in 1981. Short-term debt also expanded rapidly since 1975, reaching US$2.78 billion at the end of 1981.

This rapid foreign borrowing financed the increased level of spending after 1975, which reflected the intention of the Thai government to attain higher growth rates of output, as expressed in the Fourth Development Plan. Consolidated public expenditures, a comprehensive measure of government activity in Thailand, grew at a rapid pace between FY77 and FY82, tripling in terms of current prices, doubling in terms of constant (1976) prices.1/ The average rate of growth of public expenditures was about 18% p. a. between FY77 and FY81, which is considerably larger than the minimum 11.2% projected in the Plan. The current account deficit, which averaged less than 2% of GDP for the period 1960-75, reached more than B (Bhat) 40 billion (8% of GDP) in 1979. The (total) public sector deficit surpassed B 30 billion (6% of GDP) in the same year. Inflation increased from 4% in 1975 and 1976, to 8% in 1977.

Adding to domestic expansionary policies were several factors that contributed to the deterioration of the current account. As we mentioned above, export price indices declined in nominal terms, while import prices continued to grow after 1975, yielding a considerable deterioration in terms of trade. At the same time, surpluses on the saving and transfer accounts suddenly diminished by a total of B 4.5 billion (US$200 million), largely as a result of the reduced U.S. military presence in the region. 2/

1/ Consolidated public expenditures in Thailand consist of recurrent and capital expenditures of general government and state enterprises, which differs from the conventional national accounts approach. The latter does not include the recurrent costs of state enterprises.

2/ A phased withdrawal of the American presence began in 1969, as conditions in Southeast Asia began to change. By late July 1976, the last of the American air and naval units had departed (see e.g. Bunge (1981)).

While there was a rapid increase in the budget deficit of the private and public sectors, no measures were taken to increase revenues: energy and other key goods, such as cement, remained underpriced. It was not until 1979 that a major oil price increase was effected (40%). Until then, the lower domestic price of energy implied only a relatively small reduction in energy use as a result of higher international oil prices. The demand for energy grew 1.8 times faster than GDP in the 1960s, and it slowed only to 1.3 times faster in the 1970s. Government taxes on energy products were in fact reduced, and subsidies were paid to refiners at various times. As a consequence, most of the impact of rising energy prices was absorbed in the current account and public sector deficits.

Government policies oriented towards maintaining historical growth rates of output implied larger expenditures in public investment in 1975. Growth in central government expenditures, however, was not matched by a similar growth in revenues, resulting in large budget deficits. Total government revenues as a share of GDP stagnated at about 13%, and taxes at a little more than 12%, both down marginally from their shares in 1970-75. Despite a rapid decline in the relative importance of taxes on international trade, indirect taxes remained the mainstay of Thailand's tax system.

(ii) Export Expansion

The resurgence in the demand for exports--after the recession of 1973-1974 resulted in a substantial increase in the growth of agricultural and manufactured exports. In addition, several domestic policies were adopted to promote exports. Export taxes, which represented 3.7% of total exports in 1975, were reduced to an average 1.89% of total exports over the period 1976-81, and to 0.84% in 1982. A domestic sales quota on rice that was linked to the amount exported was suspended.[1/] Export industries, in particular those which were facing production problems such as textiles and sugar industries, received substantial assistane from the Bank of Thailand through lending through the commercial banks under concessionary terms. Also, the repayment period for concessionary export credits was extended to enable traditional exporters to expand markets by granting longer credit terms to buyers.

Table 2: STRUCTURE OF MERCHANDISE EXPORTS
(in %)

	1970	1982
Agriculture	71.0	64.0
Nonagriculture Primary	15.0	7.0
Total Primary	86.0	71.0
Manufactures	14.0	29.0
Total Merchandise Exports	100.0	100.0

Source: NESDB and BOT.

1/ This policy had to be replaced by some measures to slowdown rice shipments abroad after the country had been badly hit by a widespread drought (see Bank of Thailand Annual Economic Report 1977).

The combined effect of these policies and the increased demand had a positive effect on Thailand's export performance. During the period 1974-81 merchandise exports subtantially outperformed both GDP and import growth in real terms and thus reversed the pattern of the 1960s: exports of goods recorded 11.3% p.a. average volume increase, 1.6 times higher than GDP growth, 1.7 times higher than merchandise import growth, and well above the volume targets set in the Plan (7.5% p.a.). As a result of this growth, merchandise exports increased substantially as a share of GDP in the last decade (see Table A.1 in Appendix A); two-fifths of the change was due to traditional exports (agriculture and other primary commodities), and three-fifths to the expansion of manufactured exports. The structure of exports underwent considerable changes in the 1970s. While agricultural goods still played a mayor role in the late 1970s (64% of merchandise exports), manufactured exports have emerged as an important contributor (Table 2). In 1970, Thailand held a share of 0.4% of total manufactured exports by developing countries; in 1979, this share rose to 2%. These figures show Thailand's positive response to continuously strong demand for its traditional exports, and its effectiveness in penetrating new markets with manufactured exports.

In addition to increasing exports and borrowing from abroad, oil importing countries have pursued three other tools of adjustment: import substitution, investment slowdown and resource mobilization ([Mitra [1984]). In Thailand's case, use of these other modes was light and, in some instances, in the opposite direction.

(iii) Import Substitution

While the levels of protection in Thailand were substantially increased over the period 1974-78,[1/] these levels are relatively low compared with other developing countries. In the last decade, merchandise import volumes grew at 6.6% p.a., marginally lower than GDP and lower than exports. This figure compares favorably with the 6.1% volume growth projected in the Plan. The share of imports in GDP at current prices, however, increased considerably from 19.5% in 1970, to 27.7% in 1979 due to unfavorable developments in import prices, especially oil prices. The increased oil prices had an effect not only in the volume growth of imports, but also on its composition. Before the first oil price shock, oil imports accounted for only 10% of total import value. This proportion increased to about 20% after the price shock.

(iv) Investment Slowdown

While some countries adjusted to the oil shock by slowing down their investment program, Thailand actually accelerated hers. When it became evident in mid-1976 that Thailand's balance of payments had improved considerably, that domestic prices had not increased by much, and that public expenditures during the first half of 1976 could not be disbursed as rapidly as planned, the Bank of Thailand switched to an

1/ Protection increased from an average nominal level of 35% in 1974, to 51% in 1978 for products with low import competition (less than 10% of domestic production) and from 25% to 36% for import competing goods. Effective tariff rates increased from 39.7% in 1974 to 99.6% in 1978 for non-import competing goods, and from 44.8% to 85.9% for import competing goods.

easy money policy to induce credit expansion by financial institutions. The objective of the credit expansion was to encourage more investment by private enterprises, mainly through the reduction of short-term interest rates and the bank rate. Starting in mid-1976, the Bank of Thailand bought treasury bills on tender each week at increasingly higher prices. In addition, the Bank announced in 1976 a reduction in its basic interest rate charged on loans to commercial banks from 10% to 9% per annum.

This, coupled with the generally favorable environment brought about by the policies of the mid-1970s, led to an increase in investment activities in both the public and private sectors. In 1977 public and private fixed capital investment increased considerably, yielding a record 32.8% increase in real gross fixed investment. The share of fixed investment in GDP also increased from 21.7% to 25.3% between 1976, and 1977. The number of investment applications received by the Board of Investment increased from 111 in 1975, and 119 in 1976, to 264 in 1977.

However, investment activities fluctuated during the period 1977-81. In 1977 it increased 9.5% in real terms, but also declined as much as 2.3% in 1979-80, mainly due to a slowdown in the agro-processing industries as Thailand was affected by unfavorable weather. The average increase of fixed capital investment for the period 1977-81 was 4.2% p.a., which is lower than the one projected in the Plan (7.2% p.a. in real terms).

(v) Resource Mobilization

The majority of resource mobilization in Thailand occurs in the private sector, which has typically generated savings to the tune of about 19% of GDP, and has invested roughly comparable amounts. Private savings exceeded private investment demand throughout the period 1960-79, and were available to finance part of the investment in the public sector. By contrast, the public sector spent more resources than it generated during the 1970s, as public saving fell short of public investment. With the exception of the years 1974 and 1975 when the government pursued a restrictive fiscal policy in response to the first oil shock, the public sector saving-investment gap was close to, or above, 5% of GDP. Since 1978, this gap has rapidly increased.

The surpluses generated by the private sector were channeled to finance the public sector deficits via transfers through the banking system. However, between 1977 and 1979, public sector foreign borrowing increased substantially, substituting for the substantial drops in the public saving rate, while public investment remained approximately unchanged as a share of GDP. From the mid-1970s onward, public foreign borrowing rapidly increased from 0.5% of GDP in FY75 to almost 4% in FY80, and financing an increasing share of the growing public sector deficits.

This broad picture of the Thai economy from 1974 to 1982 would not be complete without a description of the distributional aspects of the adjustment experience. In the next subsection, we look at the consequences of rapid economic growth for povery alleviation and the distribution between urban and rural incomes.

(d) Some Distributional Aspects

In the area of poverty alleviation too, Thailand has a good record. Household income data[1/] indicate that the benefits of rapid growth have been enjoyed by large segments of the population, and the incidence of poverty has been cut in half over the last two decades: the overall incidence of poverty was reduced from about 57% in the early 1960s, to about 31% by the middle 1970s, and from 61% to 35% in the rural sector.

Agricultural growth has had a profound influence on overall economic performance and therefore on rural and urban incomes. Although the structure of domestic production has changed over time, with manufacturing and financial services gaining in their share, agriculture has remained the single most important sector. In 1980, an estimated three-fourths of the labor force remained in agriculture, a share which was surpassed only by six other middle-income oil-importing countries (MIOIC), and virtually the same proportion as in 1960 (Table 3). Another indicator of the effect that a drought-induced slowdown in the rate of growth of agriculture in 1979 had on other

1/ Some of the data in this section comes from WDR 1982, and the WB report Income Growth and Poverty Alleviation in Thailand, June 20, 1980.

Table 3 LABOR FORCE AND URBANIZATION

	Share of labor force in agriculture (%) 1960	1980	Growth of labor force (%p.a.) 1970-80	Share of urban in total population (%) 1960	1980
Thailand	84	76	2.9	13	14
Indonesia	75	58	2.1	15	20
Philippines	61	46	2.4	30	36
Korea	66	34	2.8	28	55
Malaysia	63	50	3.0	25	29
Middle income oil importing	59	42	2.2	37	50

Source: World Bank, World Development Report, 1982

sectors of the economy. In 1980, after an impressive growth of 10% during the seventies, the manufacturing sector saw the lowest growth for the past 15 years, mainly as a result of slow growth in agro-processing industries. 1/ Additionally, agricultural incomes have been a major component in domestic demand, which we already established as an important source of industrial growth. In short, the good overall performance in poverty alleviation is mainly the reflection of a sustained rise in rural incomes experienced during the period 1963-79.

1/ See e.g., Thailand: Managing Resources for Structural Adjustment, August 31, 1981, for support of this claim. Manufacturing production growth recovered in 1981 (6.4%) but remained below historical levels.

The rise in rural incomes, in turn, was due to several interrelated factors, the most important of which was the continuous expansion of land under cultivation. Land expanded at about 3% p.a. during the period 1960-79, absorbing the increase in rural population (3% p.a. in the 1960s, and 2.5% p.a. in the 1970s), and allowing average holdings size to increase. The expansion of land was facilitated by, first, the availability of land, and by the expansion of transport and communication infrastructure which provided farmers access to new land, and--through the market structure--to national and international markets. The expansion of land was also facilitated by the control of malaria in the North and North-East parts of the country, which permitted sedentary cultivation of large tracts of land.

Other important factors that contributed to higher rural incomes were diversification into higher-value crops, and rising crop prices. A key factor in promoting diversification were improved linkages with external markets, and increasing the share of wholesale prices received by producers. By providing seeds, information, and outlets, merchants and traders were able to introduce new crops with profitable external markets, such as sugar, cassava, and maize in the Center, maize in the North, and kenaf, maize, and cassava in the North-East.

The rise in the relative price of most agricultural products (except rubber), also explains part of the growth in rural incomes. The increases occurred at different sites for different crops, but the agriculture-non-agriculture terms of trade stood at 113 in 1976, compared to 100 in 1962. 1/

A final factor explaining the rapid rise in rural incomes has been the increasing participation of rural households in the modern sector, where incomes tend to be higher. A significant proportion of rural incomes derived from money wages rather than self-employment. Agricultural households diversified their sources of income and by 1975 22% of agricultural households' income was earned from non-agricultural activities such as agro-industries, trade, commerce, construction, and public service. 2/

Despite all this, at least one quarter of the population did not share sufficiently in the benefits of growth to rise above the absolute poverty level. Poverty remains largely a rural phenomenon and it is unevenly distributed around the country. Most people below the poverty line are farmers engaged in rainfed agriculture, living in the North and North-East parts of the country. 3/ These regions account for 56% of Thailand's population in 1980, and 45% of regional GDP is derived from agriculture, compared with a national average of 26%.

1/ See e.g., Income Growth and Poverty in Thailand, p.13. The accessibility of external markets for several crops, however, allowed farmers to switch among upland crops in response to relative price changes, and they probably did better than indicated by the terms of trade index.

2/ See e.g. ibid., p.13

3/ See e.g. ibid., p.19

Rural workers in the South present another exception to the general trend in rising rural incomes. Unlike other regions, the South was (and still is) heavily dependent on a single cash crop, rubber. Despite relatively large areas of unexploited land, agricultural expansion and diversification have been slow. The South is physically distant from the rest of the country, and the communications network has been much slower in developing. In addition, rubber prices declined in the late 1960s and early 1970s, and the region was less able to diversify production away from reliance on rubber as a cash crop.

Not surprisingly, there is a concentration of wealth in the Center part of Thailand, and the capital city of Bangkok, which expanded rapidly in the 1970s. 1/

These diverse regional and agricultural development patterns occurred in response to differences in the comparative advantage of each region, which have in turn been influenced by factors such as government policies in the rural sector, and the particular economic and social system in Thailand.

Among these factors, the emphasis on the private sector has been a leading contributor to the rates of growth experienced by the different rural areas and, as a result, to the raising of large numbers

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1/ In 1970, Bangkok had a population of 3.2 million, which increased to 4 million in 1978. Migration into Bangkok was 70,000 in 1973; 60,000 in 1974; 67,000 in 1975; and 92,000 in 1976. The 1970 census indicates that some 35% of Bangkok's population was born outside Bangkok (National Statistical Office, Survey of Migration in Bangkok Metropolis, annual publication, 1974-77).

of the rural population above the poverty line. The market economy encouraged farmers to change their production patterns to profitable cash crops, and the marketing system absorbed and disposed of large agricultural surpluses to domestic and export markets, while returning to the farmers a large percentage of wholesale prices. The market system also provided credit, information, and extension services to many farmers in the absence of such services from public institutions.

The main contribution of public policies was in increasing the efficiency of the market system through the provision and maintenance of economic infrastructure, such as communications and roads. Definite poverty-alleviation programs were not considered until the Fourth Development Plan (1977-81), which included explicit anti-poverty objectives as part of its development strategy. The anti-poverty program set out in that plan, however, recognized the leading role of the private sector in reducing poverty, and reinforced the government's role of providing support and an appropiate economic framework.

Other government policies had mixed results in terms of their impact on growth and poverty alleviation. It has been argued, for example, that the policy of maintaining low rice prices for urban consumers through export taxes, reserve requirements and the export premium has acted to the detriment of most rural areas.[1/] These policies lowered incomes received by farmers producing and selling rice, and reduced the incentive for subsistence farmers to produce marketable

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1/ See e.g. op.cit., p.30-31

surpluses of rice. Since rice is essentially the wage good, maintaining low rice prices has kept modern sector wage rates low, and reduced the real earnings of rural laborers in alternative employment. It has also been argued[1/] that public policies promoted regional disparities. The Center and Bangkok were the main beneficiaries of public investment, irrigation works, and the availability of subsidized agricultural credit.

Significant shifts took place in the functional distribution of public spending between FY77 and FY82. Expenditure on industry, mining, energy, transportation and communications, which in FY77 accounted for 38.5% of the total, increased its share to 46.4% in FY82. In contrast, the share of public spending on agriculture, education, and other services dropped from 33.3% of total public expenditure in FY77, to 26.9% in FY82. Health expenditure, in particular, expanded at a very low rate (2.3%) in real terms during the Fourth Plan period. However, a normative conclusion without further analysis is precluded by the fact that these shifts were the consequence of a number of exogenous factors (especially in the energy sector), as well as explicit domestic policies. [2/]

1/ See e.g., WB report No. 4085-TH, Thailand: Perspectives for Financial Reform.

2/ See report Managing Public Resources for Structural Adjustment, Table 4.5, for data on the growth and structure of consolidated public expenditure, as well as for a description of influential factors on expenditure decisions.

In general, then, Thailand's track record in poverty alleviation and income distribution has been impressive, all the more so given the emphasis on the private sector and economic growth in the government's policies. That agriculture was the engine of growth in the Thai economy certainly contributed to removing the gap between urban and rural incomes. Migration patterns and rural households' participation in urban employment also helped in counteracting any urban bias in public investment. Just as with adjustment to oil shocks, therefore, Thailand's performance in improving the distribution of income appears to have been achieved without an explicitly stated set of policies aimed in that direction. Rather, the particular development strategy pursued seems to have contributed to the twin goals of equity and growth--during a period when other countriees were having difficulty making progress with either objective.

The question of how this curiously successful pattern of development was achieved, however, remains unanswered. We turn therefore to a description of the multisector model of the Thai economy that will be used to assess the importance--in quantitative terms--of the various factors that we have in this section suggested as having contributed to Thailand's economic performance in the period 1973-82.

III. THE MODEL

A variant of the model developed by Mitra and Tendulkar [1985] for their study of the Indian economy, the model to be presented here is a reflection of (i) the issues we wish to address; (ii) characteristics of the Thai economy; and (iii) the data available. As for (i), we are concerned with an entire economy's adjustment. Hence, ours is a general equilibrium model which takes explicit account of the equality between a country's income and expenditure. The model is disaggregated into six sectors so that changes in the structure of production may be simulated. With four categories of labor and six household types in the model, the impact of policies on distribution can be observed. Finally, as investment and foreign borrowing feature heavily in our discussion of Thailand's response to the oil shocks, the model is dynamic. Different periods are linked through investment, which augments the capital stock, and foreign borrowing, which adds to external debt and hence to future debt-service payments.

Turning to aspects of the model that reflect the Thai economy, we note two in particular. First, in the agricultural sector, we include land as a separate factor of production. This enables us to perform counterfactual experiments on the availability of land which, as we noted earlier, is said to have played a major role in Thailand's economic growth.

Secondly, we model labor markets such that for two categories of labor--urban white collar and rural workers--the wage is parametrically fixed. Thus, there can be unemployment in these categories. When there is unemployment in rural labor, it "spills over" into the informal urban labor market where a flexible wage equates supply and demand. In this way, we attempt to capture the phenomenon of rural households competing for jobs in the urban sector. Similarly, we allow unemployed white collar workers to cascade downwards to the urban blue collar market which also is cleared by a flexible wage.

Concerning (iii), as there are fairly good data on income distribution in Thailand, our model is specified so that we can account for the variations in incomes of six different categories of households.

We turn now to an heuristic description of the model. A complete list of the model's equations is given in Appendix A. Appendix B is an account of the data sources used to estimate the model's parameters.

A. Model Dimensions

The production side of the model distinguishes six different product markets: (1) Agriculture, (2) Consumer goods, (3) Capital goods (including construction), (4) Intermediate Goods, (5) Public Infrastructure, and (6) Services. The disaggregation follows agriculture-industry-services lines. Industry is disaggregated by sources of demand, (2), (3) and (4), to capture the differential impact of policies on different parts of the industrial sector. Infrastructure (e.g. irrigation, roads) is singled out to isolate possible bottlenecks to expansion of traded goods sectors necessary for adjustment. There is an investment producing sector, referred to as the Capital-goods sector, whose output is used as investment goods in all the sectors.

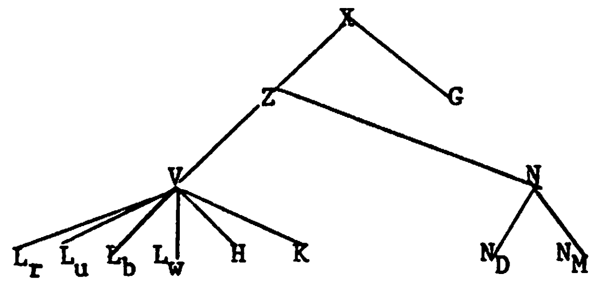
There are four basic factors of production: labor, capital, infrastructure and land. The Agriculture sector is the only one using land. Labor is further disaggregated into four categories: informal rural, informal urban, blue collar and white collar. Capital and infrastructure are sector-specific and immobile across sectors.

Households are classified into six categories: own account rural and urban households, informal urban and rural households, blue collar, and white collar. (Table A.5 shows how factor incomes are allocated to each of these categories). Households demand the output of the six production sectors.

There are four sources of savings: households, firms, government and foreign savings. The total savings from all sources adjust to the given levels of investment. Firms are distinguished from other institutions, but grouped all into one account. Government represents one agent in the economy as does the rest of the world.

B. Production and Factor Demand

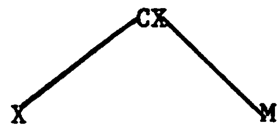
In all sectors, the production structure is represented by a nested CES tree as follows:



Output X is a function of L_r (informal rural labor), L_r (informal urban labor), L_b (blue-collar labor), L_w (white-collar labor), land H (in the Agriculture sector only), capital K, N_D (domestically produced intermediate goods from all sectors other than 5), N_M (imported intermediate goods from all sectors other than 5) and G (the flow of infrastructure, i.e., output of sector 5 going into the sector in question).

Four types of labor combine with capital and land to produce value added. N_D is a fixed-proportions bundle of non-sector 5 domestically produced intermediates; similarly, N_M is a fixed-proportions bundle of non-sector 5 imported intermediates. There is substitution between N_D and N_M; their aggregate, N combines with value added to produce Z. Infrastructural services which are publicly provided are identified separately and combine with Z to produce output, X.

In Sector 3 (capital goods), there is an extra layer at the top of the tree as follows:



Thus imported final goods (M) are less than perfect substitutes for the domestically produced variety (X); final output (CX) is considered to be a CES aggregate of the two.

The CES equations implied by the structure above plus the assumption of cost minimization behaviour permit the derivation of implicit demand equations for Z, G, M, D, K, L_{ℓ} , N. The list of demand equations for these variables is given by equations in Appendix A.

C. Employment and Wage Determination

While detailed examination of wage levels and structures in Thailand is hampered by the scarcity of wage surveys data, some important features of the labor market can be characterized. The government is a major employer in the economy, particularly of better-educated employees in higher-status jobs, accounting in 1981 for approximately 70% of all white collar workers. By comparison, it employed only 19% of blue collar labor in the same year. It is therefore not surprising to find government wage and employment policies to have a substantial impact on the labor market, with the government white collar wage being the prime determinant of the average white collar wage.

Another important characteristic is the substantial difference between formal and informal sector wages, suggesting that formal labor markets do not operate competitively. Rather, job rationing may be predominant.[1/] If this view is correct, the expansion of the labor force can be absorbed in the informal sector with the wage adjusting to clear the market.

At the same time, as we discussed before, there is evidence of high seasonal elasticities of labor supply in rural areas, which may be interpreted to reflect an abundant reserve of "underemployed" labor. We have also discussed the large seasonal fluctuations in agricultural employment, which are in turn caused by changes in the demand of labor over the year.

Taking all these considerations into account, we distinguish in the model four different labor types:

(i) Rural Labor

(ii) Informal Urban Labor

(iii) Blue Collar Labor

(iv) White Collar Labor

The rural category — which includes all rural workers — is only employed by the Agricultural sector. We assume that the rural real wage is fixed and that there is job rationing for this type of labor. The informal urban wage is perfectly flexible and moves to clear the market. This type of labor is employed by all sectors with all informal urban workers getting the same wage rate. The blue and white collar workers are employed by all sectors and by the government. It is

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1/ This view is supported by several studies. See e.g., Sussangkarn [1983] from which many of the observations in this sub-section are taken.

assumed that the blue collar wage is flexible and moves to clear the market. The government and the private sector pay the same wage rate to blue collar workers. The real wages of white collar workers, however, are assumed to be fixed, with job rationing characterizing this type of labor. The government and the private sector also pay the same wage rates to white collar workers.

The following "spillover" mechanism is assumed for the labor market:

$$
\begin{aligned}
L_r - U_r &= \textstyle\sum_i L_{r,i} \\
L_u + \lambda_r U_r &= \textstyle\sum_i L_{u,i} \\
L_b + \lambda_w U_w &= \textstyle\sum_i L_{b,i} + L_b^G \\
L_w - U_w &= \textstyle\sum_i L_{w,i} + L_w^G
\end{aligned}
$$

where (L_r, L_u, L_b, L_w) represent the (exogenously given) available supply of rural informal, urban, blue collar and white collar labor, respectively. The variables $(L_{r,i}, L_{u,i}, L_{b,i}, L_{w,i})$ represent the demand for the different labor types by the i-th sector, and (L_b^G, L_w^G) the government demand for blue collar and white collar labor, respectively. The variables (U_r, U_w) denote the amount of unemployed rural and white collar labor, respectively. The parameters (λ_r, λ_w) represent the percentage of unemployed rural and white collar labor who find jobs as informal urban and blue collar workers, respectively. The informal urban and blue collar wages move to clear the corresponding labor markets.

The absorption of migrant workers into the Bangkok economy is supported by a complex of formal and informal networks to provide job information and placement. According to a labor survey,[1/] about 60% of those migrant who came to work either had a job or a promise of a job before moving. Relatives, friends and acquaintances were the principal sources of job information, with employment agencies a much smaller but still significant factor. In the model, therefore, we assume that λ_r is responsive to differentials between the cost-adjusted informal urban real wage, and the the rural real wage.

For white collar labor we fix λ_w at 0.4, which means we assume that 40% of the unemployed white collar workers find jobs as blue collar workers, independently of the wage differentials between the two labor categories. The value represents an arbitrary, but we think reasonable, estimate as there are no data to corroborate this figure.

D. Income Generation and Final Demands

The production system distinguishes four categories of income, viz., (1) income from labor (2) land income, (3) capital income, and (4) income from implicit government subsidies on publicly provided infrastructure. To this must be added unearned income, comprising such items as (a) interest on national debt, (b) domestic current transfers, (c)

1/ See Apichot Chamratrithirong, Recent Migrants in Bangkok Metropolis: A Follow-Up Study of Migrants Adjustment, Assimilation and Integration. Mahidol University, Institute for Population and Social Research, November 1979.

net factor income from abroad and (d) net current transfers from the rest of the world.

Final demands comprise private consumption, public consumption, exports and investment. Household incomes are mapped into private consumption via a savings function. Private consumption demand for the output of the six production sectors is generated by a linear expenditure system for each of the rural and urban households, and are functions of prices and incomes. Public consumption of each sector's output is exogenous. Export demand is a function of world demand as well as the ratio of export prices to those of substitutes in international markets. Investment demand is almost entirely directed at Sector 3 (capital goods, including construction).

Thailand had significant final good imports in sectors 1, 2 and 3 during the period of analysis. For these sectors domestic production feeds all sources of final demand except consumption. It is assumed that domestic production and final good imports are imperfect substitutes in consumption and combine in a CES fashion to satisfy consumer demand in Sectors 1, 2 and 3.

E. Trade

The trade side incorporates price-responsive export and import relationships. The derived demand for both intermediate and final imports depends on the level of output and the import price to the user relative to that of the domestically produced variety, where appropriate. Similarly, exports depend on the state of demand in the rest of the world (world income) and export prices relative to that of substitutes. Import prices are given, so that the country is small in the relevant market. By contrast, the country is assumed to be able to vary its export sales by changing its export prices. In any event, the model is equipped to simulate the effects of tariffs and subsidies.

F. Market Clearing

Gross output in each of the six sectors must equal the sum of final demand, intermediate demand and changes in stocks. Since each of these components is either exogenous or price-responsive, the market clearing conditions determine prices.

The allocation of public infrastructures for intermediate use in each of the production sectors is fixed by policy, while production and final demand are price-responsive. Intermediate users are typically not charged the market price for infrastructure. This allows an exploration of the effects of changing the rates of implicit subsidy on public infrastructure as well as of the policy-determined allocations to intermediate users.

G. Investment and Savings

Investment is equal to the sum of household, government and foreign savings. The relation between household incomes and consumption determines household savings. Government savings are the difference between government income and expenditure. Foreign savings are exogenously specified in most runs of the model. However, in some experiments, we fix investment exogenously and allow foreign savings to adjust. The "tracking" experiments described in the next section are all "investment driven."

H. Government

The sum of tax and tariff revenue, the return on public infrastructure and other income, less the value of government consumption equals government saving. This is the government's budget constraint but it does not need separate formulation, since, by Walras' Law, it follows from the other equations of the system.

I. Dynamics

The model system solves for an equilibrium in each time period, taken to be a year. The solutions in future periods depend on past policies through their impact on investment and foreign savings, and hence on future capital stocks and external debt.

The model is thus solved year by year. Capital and debt accumulate according to the exogenous investment and net foreign borrowing, there is technological progress, and the exogenous variables are updated. In updating the capital stock, the first step is to determine the allocation of investment output among the capital stocks of the six different sectors. The second is to update the private capital stocks based on this allocation and allowing for depreciation. The third is to allocate the output of new infrastructure.

The breakdown of investment by sector of origin is given by base year input output data; it typically comes entirely from Sector 3. Its breakdown by sector of destination is taken from national accounts data for the base year. These proportions are maintained for all periods.

IV. EXPERIMENTS

A. Calibrating the Model and Tracking History

The model described in the last section will be used later to examine alternative patterns of adjustment for Thailand for the years 1974 to 1982. For this reason, it is important to get the model to reproduce what is already known for the Thai economy for this period. In addition, it will serve as a test of how reasonable our model is as an application to Thailand. Here we follow the standard procedure for computable general equilibrium models by first "calibrating" the model so that the base year is reproduced exactly, and then, by updating some exogenous parameters, getting the model to track what is known for the years following the base. In our case, the base period is 1973.

It is clear that a perfect matching of historical data is almost impossible since, in the first place, we are not sure that the real world behaves in the same way as the model predicts, and, second, independent estimates for many of the parameters and variables in our model do not exist. For example, we do not have values for the elasticities of substitution in the CES functions, nor values for the year-to-year variation of sector-specific tax rates.

Instead, we follow the common practice among modellers of selecting the value of some of the parameters for which data are not available on the basis of how well they improve the tracking of the system. This is similar to how parameters are estimated by econometric techniques to minimize the sum of squared errors although in our case, there are many more degrees of freedom.

The official historical figures of Thailand for some key variables are presented in Table 4. The solution path obtained by the updating of parameters is shown in Table 5. The model reproduces quite well what happened in Thailand during the period 1974 to 1982. The model's estimate for GDP and investment growth shows basically the same trend as in the national account estimates. The model-generated path of private consumption was consistently below the actual one, although the discrepancy is small.

The model had difficulty reproducing the export boom of 1977, when the volume of exports grew 40% with respect to 1973 levels. As we mentioned before, the boom was mainly due to an increase in demand for Thailand's primary exports, such as rice, and the implementation of several export promotion policies by the government, such as the reduction in the quotas imposed on rice exporters. These policies are difficult to replicate given the structure of the model. Consequently, exports in the model after 1977 are considerably lower than the actual figures. The path, nevertheless, follows the basic trend as the historical figures. The amount of imports in the model was adjusted in such a way so as to have the trade balance follow historical estimates.

B. Alternative Patterns of Adjustment

Having ascertained that the model reproduces Thailand's actual pattern of development, we now turn to some counterfactual experiments. As stated in Section 1, we will attempt to assess quantitatively two hypotheses about Thailand's rapid growth without

Figure 1

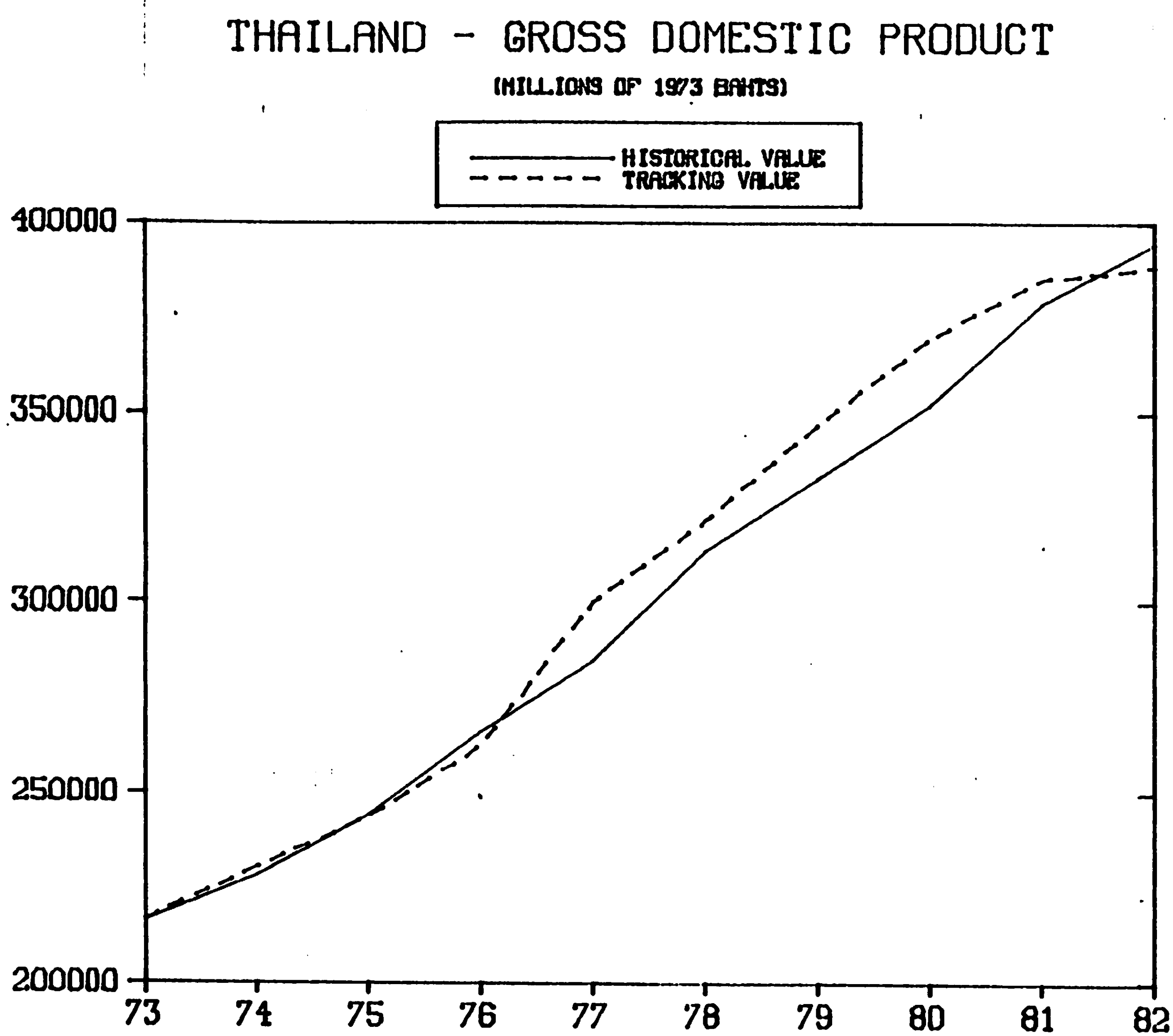

THAILAND - GROSS DOMESTIC PRODUCT
(MILLIONS OF 1973 BAHTS)
HISTORICAL VALUE
TRACKING VALUE
400000
350000
300000
250000
200000
73
74
75
76
77
78
79
80
81
82

Figure 2

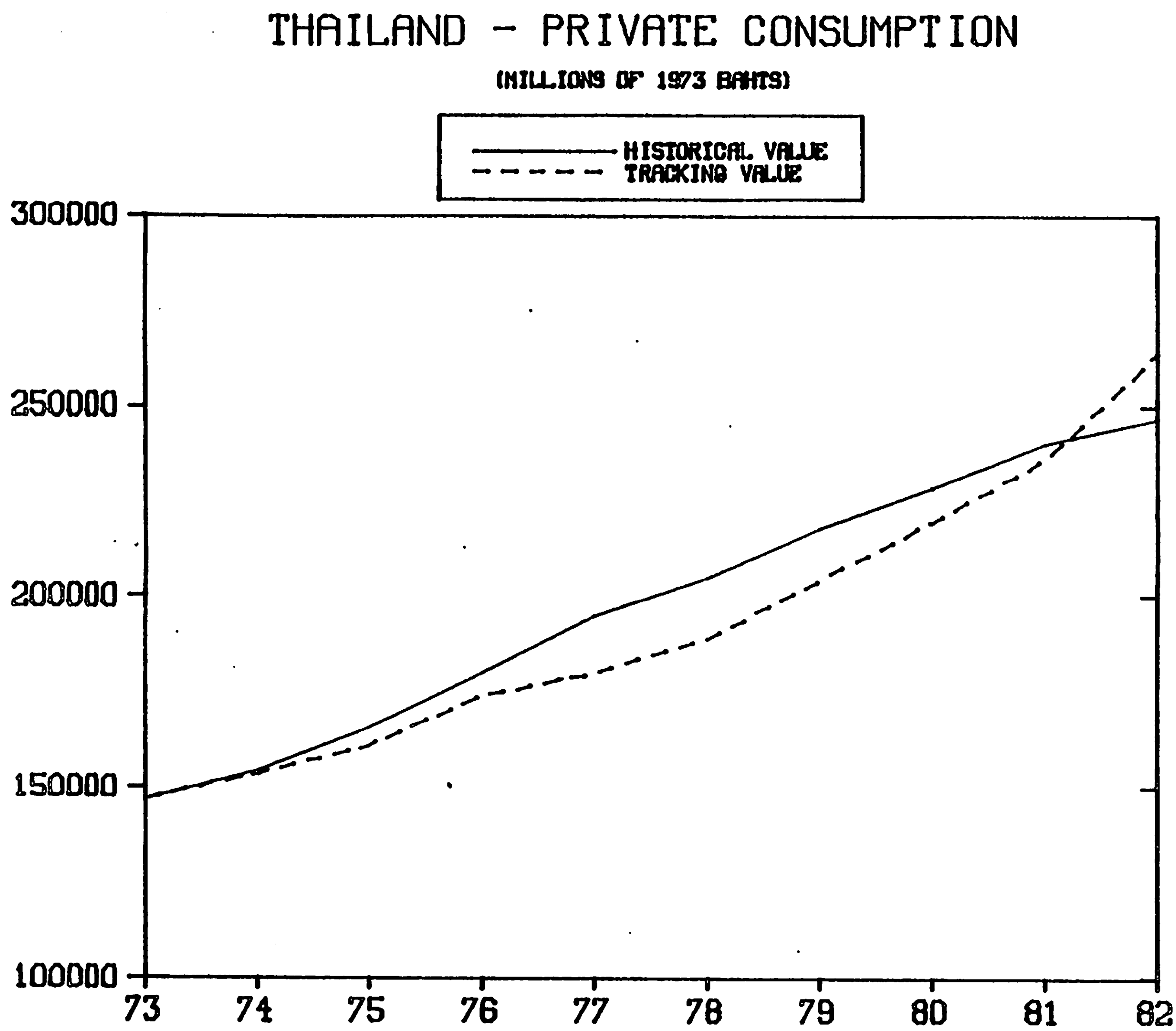

THAILAND - PRIVATE CONSUMPTION
(MILLIONS OF 1973 BAHTS)
HISTORICAL VALUE
TRACKING VALUE
300000
250000
200000
150000
100000
73
74
75
76
77
78
79
80
81
82

Figure 3

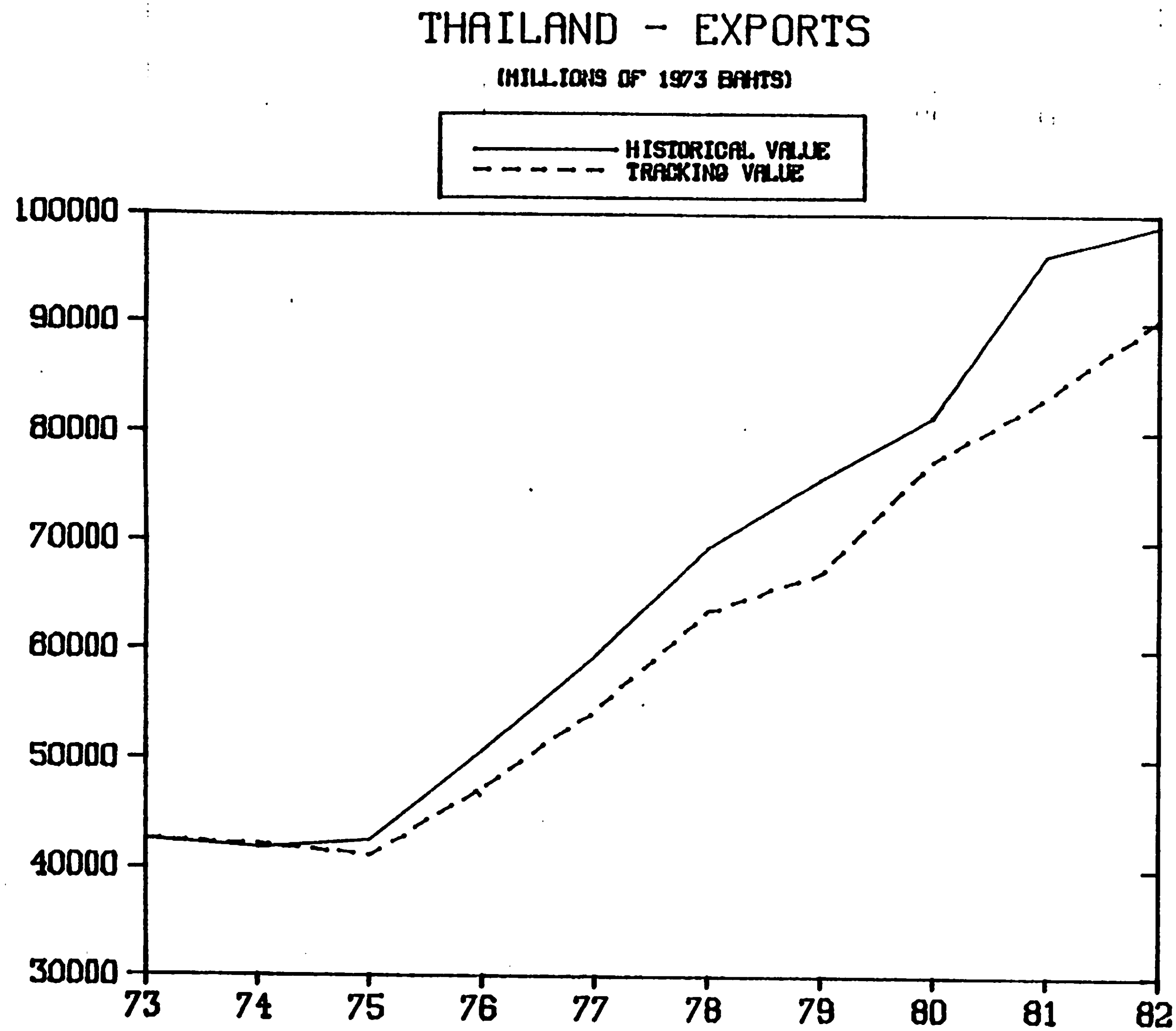

THAILAND - EXPORTS
(MILLIONS OF 1973 BAHTS)
HISTORICAL VALUE
TRACKING VALUE
100000
90000
80000
70000
60000
50000
40000
30000
73
74
75
76
77
78
79
80
81
82

Figure 4

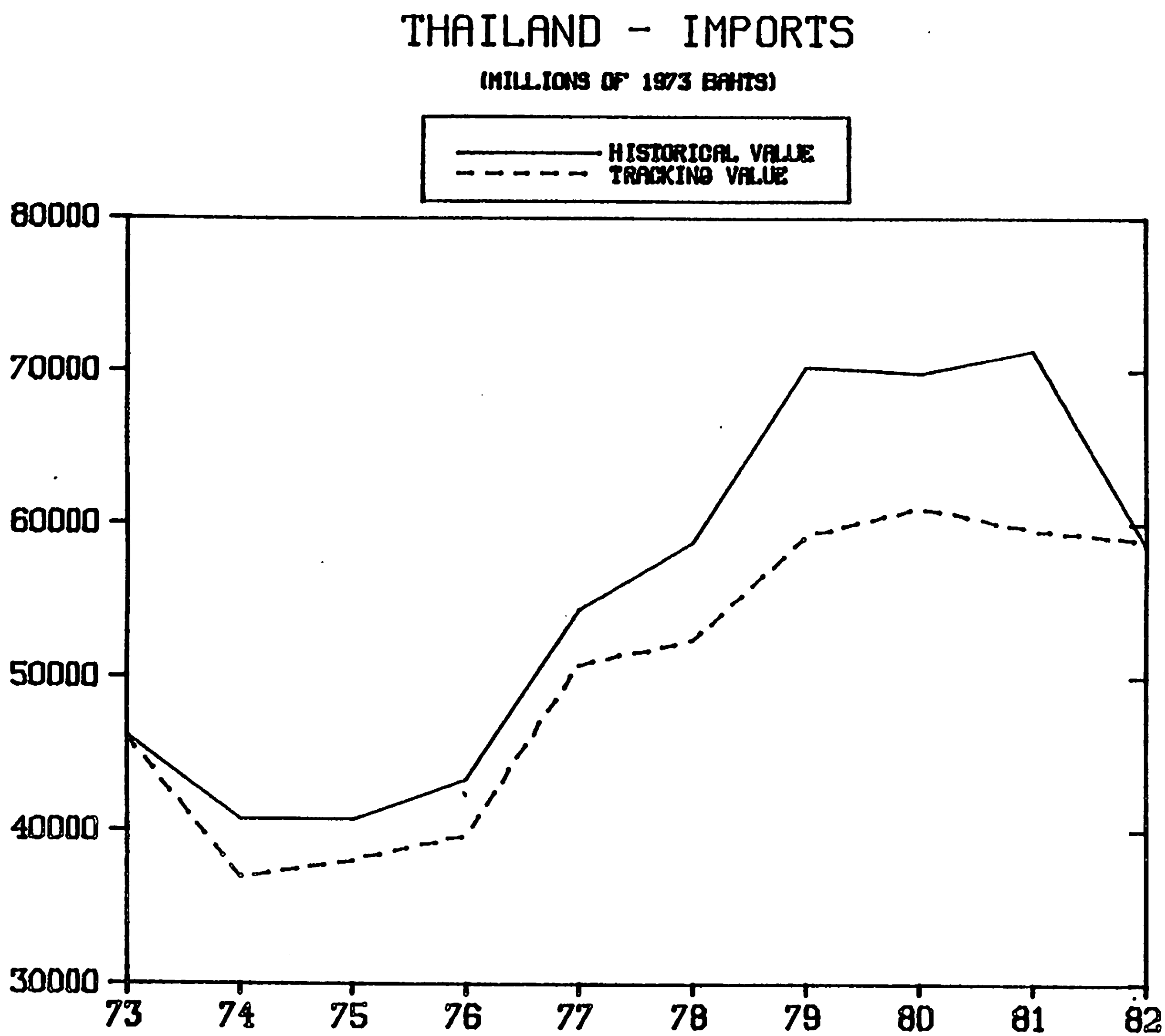
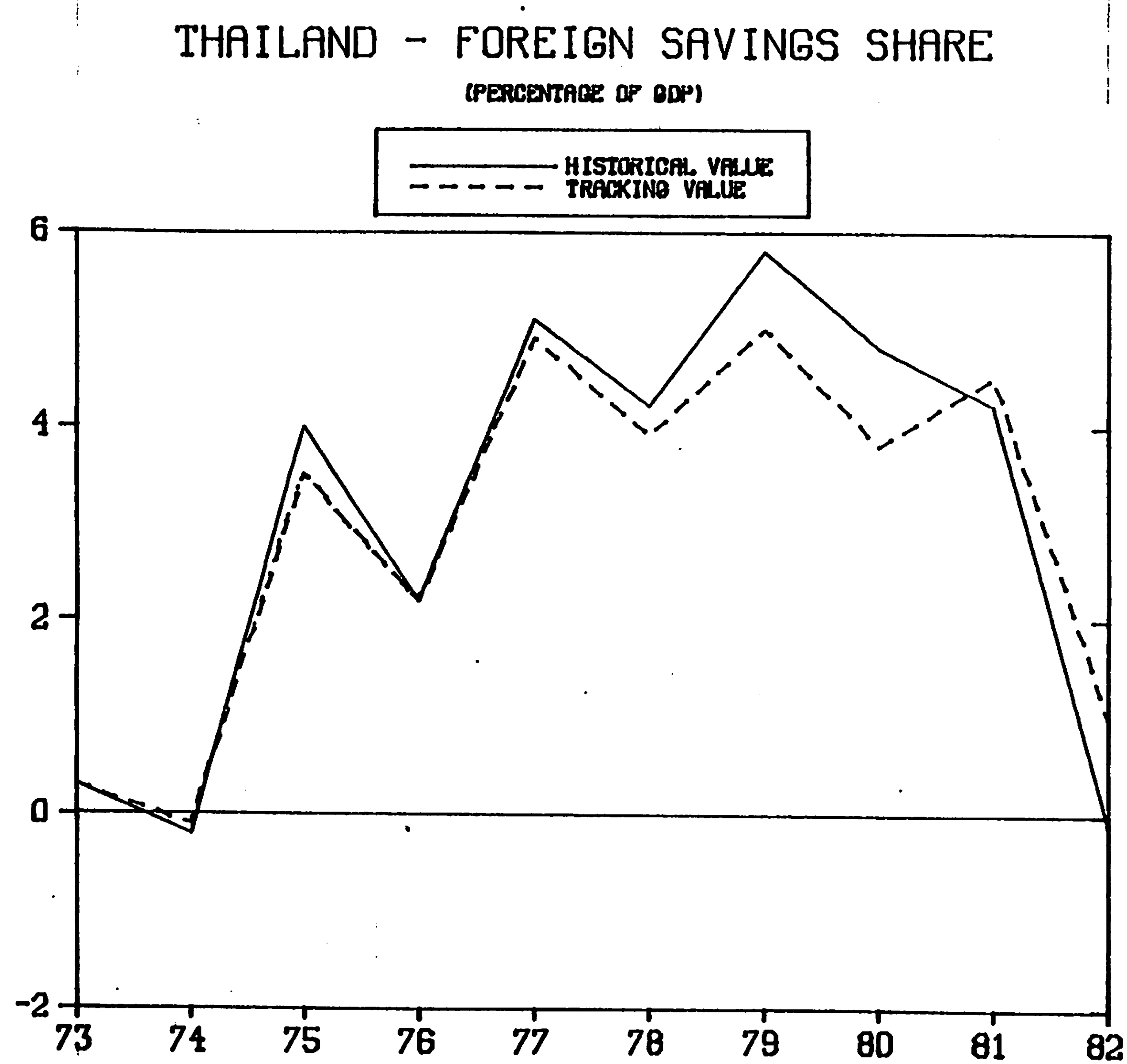

THAILAND - IMPORTS
(MILLIONS OF 1973 BAHTS)
HISTORICAL VALUE
TRACKING VALUE
80000
70000
60000
50000
40000
30000
73
74
75
76
77
78
79
80
81
82

Figure 5


THAILAND - FOREIGN SAVINGS SHARE
(PERCENTAGE OF GDP)
HISTORICAL VALUE
TRACKING VALUE
6
4
2
0
-2
73
74
75
76
77
78
79
80
81
82

adjustment to the external shocks of the 1970s. The first is that Thailand was insulated from the shocks by a series of fortuitous circumstances and therefore did not need to adjust; the second is that Thailand borrowed in world capital markets and thereby deferred adjustment.

Evidence for the first view is offered by the facts that (i) Thailand continued to receive service payments from U.S. military bases until 1976; (ii) export prices peaked in 1974; and (iii) farmers were able to expand the area of land under cultivation without any constraints during the entire period. We measure the contribution of each of these phenomena to Thai economic growth in the 1970s. Specifically, we ask the following questions: What would Thailand's performance have been if:

(i) There had been no transfers from U.S. bases?

(ii) Export prices had not peaked in 1974 but instead had followed their historical trend?

(iii) There had been no increase in the amount of land under cultivation?

We consider each of these questions <u>seriatim</u>.

The transfers from U.S. military bases in southeast Asia represented a significant, although declining, contribution to foreign inflows into Thailand during the period 1973-76 (Table 4).

We simulate the effects of eliminating these transfers by reducing foreign transfers and, hence, the current account deficit sustained in the years 1973-76. This means that exports increase and

Table 4

Year	Transfers from U.S. military bases (in millions of 1973 bahts)
1973	4223
1974	2884
1975	2165
1976	600

Source: Bank of Thailand.

imports decrease with respect to the historical base run (Table 5). The extra exports came at the expense of consumption and investment; GDP is only slightly affected by this loss in foreign transfers. The reason for this is that, with fixed capital stocks and full employment in two categories of labor, gross output is essentially supply-determined in the model. The effect of a drop in foreign transfers leads mainly to a reallocation of demand from foreign to domestic sources. Moreover, consumption is hurt more than investment because it was assumed that the service payments accrued directly to households. However, the lower household income implies lower savings and therefore less investment in this "savings-driven" model. It is interesting to note that, despite the short-term reduction in investment, the economy's long-term health is not badly affected: by 1977, GDP recovers to its historical level.

Concerning changes in the pattern of output, we note that consumer goods output is actually higher than in the base run in the first year of the shortfall in foreign transfers. Declining demand for

Table 5: EXPERIMENT - NO SERVICE PAYMENTS FROM U.S. MILITARY BASES
(Percentage change from base run)

	1973	1974	1975	1976
Exports	8.0	3.2	2.4	0.6
Imports	-7.3	-3.2	-2.3	-0.6
Consumption	-4.1	-2.1	-1.9	-0.6
Investment	-4.1	-1.5	-1.5	-0.4
GDP	-1.0	-0.6	-0.6	-0.2
Outputs of				
Agriculture	-1.2	-1.0	-0.8	-0.3
Cons. goods	0.5	-0.4	0.0	0.0
Capital goods	-3.7	-1.7	-1.3	-0.3
Interm. goods	-0.6	-0.5	-0.5	-0.2
Pub. Infrast.	-3.0	-1.4	-1.0	-0.3
Services	-1.4	-1.1	-0.9	-0.3

capital goods and infrastructure releases resources (labor) which is now put to other uses. This leads to an increase in exports, most of which were consumer goods in 1973. Evidently, this export boom is sufficient to counteract the loss in domestic demand and results in a net increase in output. Similarly, the intermediate goods sector suffers less than other sectors because it produces an import substitute. In the wake of declining imports, this sector registers an increase in demand that dampens the effect of an overall decline in economic activity brought about by the elimination of transfers from the military bases.1/

1/ Infact, the good N_D that compete with imports as intermediate inputs are in fact an aggregate of several sectors' output, but sector 4's (intermediate goods) weight is by far the greatest.

It is interesting to note that although output in each sector (except consumer goods) is lower than in the base run, value added is actually higher in the first year and more or less keeps pace with historical levels subsequently. With a decline in the real wages of two labor groups, all sectors increase employment thereby increasing value added. However, the reduction in imports--which are mainly intermediate goods--is sufficiently acute that despite the higher value added the net result is a decline in gross output.

Changes in relative prices mirror the changes in the sectoral pattern of output described above. While the level of domestic prices is lower, the price of nontradeables falls more than those of tradeables signalling the real exchange rate depreciation that is required to sustain a smaller current account deficit.

Finally, the distributional impact of the loss of foreign transfers can also be explained by the changes in the production mix. Households that rely on employment in the services and capital goods sectors for their income (mainly blue collar and casual urban workers) are hurt more than those that depend on the agriculture, consumer goods and intermediate goods sectors (rural and white collar workers).

To summarize this experiment, the transfers from U.S. military bases permitted Thailand to sustain a slightly higher growth rate in the early years. They enabled the economy to purchase more imports which, given their complementary role in production, resulted in a higher level of output. Nevertheless, the lasting effects of this "windfall" appear to be minimal. Although the lower investment levels without transfers would have led to lower levels of capital stock, the reduced real wage would have resulted in higher employment (given pools of unemployed labor). Thus value added would have been maintained and the post-1976 economy would have been the same.

We now address the second question, namely, the impact of the surge in export prices in 1974-75. The international price of Thailand's agricultural exports rose by 30% in 1974, by another 6.2% in 1975 and fell by 6.2% in 1976 before embarking on a trajectory of steady growth thereafter. We simulate the effects on the economy if the world price followed instead a smooth growth path in the 1973-76 period of 8.6% annual growth (the geometric average of the 1973 and 1976 levels). The results indicate that the lower agricultural export prices have only a slight effect on the economy's performance in 1974 and 1975, and virtually no effect on the long-run path (Table 6). Not surprisingly, the largest impact is on the volume of exports. Imports are also lower in order to maintain the same current account as in the base year. Reflecting the small drop in overall economic activity, domestic savings and hence investment is lower. Finally, the fall in agricultural prices lowers domestic food prices. This, in turn, permits a decline in wages, making other exports more competitive. Thus, while agricultural exports suffer badly in this experiment, all other exports are higher than in the base run.

The last experiment in this sequence is the one in which the growth of arable land is halted. Recall that land is a factor of production in the agricultural sector. In the base run, the supply of this

Table 6: EXPERIMENT - SLOWER GROWTH IN AGRICULTURAL EXPORT PRICES, 1974-75
(Percentage change from the base run)

	1974	1975
Exports	-1.4	-5.0
Imports	-1.4	-3.1
Consumption	-0.5	-1.0
Investment	-0.9	-2.5
GDP	-0.4	-1.8
Exports of: (share of exports in output in parentheses)		
Agriculture (.05)	-20.7	-16.3
Cons. goods (.27)	2.0	4.0
Capital goods (.02)	1.0	1.9
Interm. goods (.09)	1.3	2.8
Services (.17)	1.1	2.6

factor is assumed to grow at 4% per annum; in the present experiment this figure drops to zero. Despite its draconian feature, this counterfactual yields very little difference from the base run. GDP is imperceptibly lower in the first few years. In 1982, the final year, when the cumulative effect of the reduction in land would be most noticeable, GDP is only 1.6% lower than in the base run. The reason for this is that land is but one factor in agriculture, accounting for less than 6% of value added in that sector. As its supply shrinks and price rises, farmers substitute away from land to labor and capital. Although we assume an elasticity of substitution between land and other factors of 0.9, the ready availability of agricultural labor at a parametrically fixed wage induces a fair amount of substitution.[1/] In the terminal year, the price of land is 48% higher than in the base run; yet, the price of agricultural output is only 2.9% higher.

In sum, the three "positive" shocks that accompanied the large negative shock of oil price increases made only a minor contribution to Thailand's economic performance in the 1973-82 period. Of the three, the service payments from U.S. military bases seem to have been the most important, with the 1973-74 export price boom second and the expansion of arable land the least significant. It is reasonable to ask, however, whether the negative shocks had an equally mild impact. That is, was the effect of the oil price rise on Thailand also so slight that it was, in fact, counteracted by these positive shocks? The answer is no. An experiment in which import prices grew at pre-1973 rates (9% instead of 15% per annum) and all three favorable events were eliminated, reveals that the net effect on Thailand was negative.[2/] In the absence of both types of shocks, the Thai economy would have grown considerably faster with real GDP in the terminal year being almost 14% higher than its actual value (Table 7). The lower import prices permitted more imports to enter the economy which, given their complementary role in

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1/ This elasticity of substitution is a prime candidate for sensitivity analysis with the model.

2/ Except for the elimination of transfers from U.S. bases, we assume the foreign capital inflow remains unchanged in this counterfactual. Hence, we are assuming that Thailand's foreign borrowing would have been the same in the absence of the two oil shocks. Since Thailand did not borrow from special oil facilities, this is not an unreasonable assumption.

production, enhanced output. In addition, higher imports raised tariff revenues which, in turn, gave a boost to government savings and investment. Thus, it cannot be concluded that Thailand's combination of positive and negative shocks cancelled each other, making adjustment unnecessary. We consider, therefore, the second explanation for Thailand's adjustment-free growth path namely, that Thailand borrowed in world capital markets and postponed the necessary adjustment.

There are many ways to test the hypothesis that Thailand deferred adjustment by borrowing abroad. It is plain that lower levels of borrowing would have led to lower growth rates in the 1973-82 period, and a lower terminal debt in 1982. However, this does not mean that the borrowing was imprudent. The Thais may simply have been exploiting intertemporal arbitrage possibilities offered by international capital markets. The optimal level of borrowing would depend, inter alia, on the rate of return to capital in Thailand, world market interest rates and the social rate of time preference. Here, we attempt a particular test of the proposition that Thailand "overborrowed" in the 1973-82 period. We ask[1/]: could the actual capital stock in 1982 have been achieved with a lower debt? Specifically, we adjust the time profile of investment and borrowing to minimize the post-1982 debt-service obligations, keeping the terminal capital stock fixed at its 1982 level.

1/ For an alternative test, which reaches the same conclusion, see Kharas and Shishido [1985].

Table 7: EXPERIMENT: NO SHOCKS
(Percentage Change from the Base Run)

	1974	1975	1976	1977	1978	1979
Exports	16.0	4.0	1.5	3.0	5.6	8.9
Imports	47.0	41.3	41.5	41.5	40.4	49.7
Consumption	9.5	9.5	4.5	7.9	10.6	14.1
Investment	23.4	19.8	12.1	13.5	18.3	24.6
GDP	3.0	5.2	0.9	4.1	6.9	9.9

	1980	1981	1982
Exports	13.2	13.8	13.4
Imports	68.0	70.1	55.6
Consumption	17.7	20.5	17.9
Investment	31.8	34.4	29.9
GDP	12.1	15.1	17.9

The computational costs of optimizing our six-sector nonlinear model over nine time periods would be prohibitive. Therefore, we employ an approximation technique developed by Sierra (for details, see Sierra and Condon [1985]). This technique begins with the observation that the two variables that drive an optimal borrowing strategy are investment and foreign savings. Of course, these two variables are connected, their connection being expressed by the CGE model. Thus, for a given external and policy environment, there exists a unique relationship between different levels of investment and levels of foreign savings. Sierra and Condon [1985] estimate this relationship using a polynominal approximation. They "shock" the CGE model with different values of foreign savings and fit a fourth order polynominal to the resulting values of investment. This equation is then grafted onto the debt module. This smaller model can be optimized over nine years at very low cost. Moreover, as Sierra and Condon show, the approximation is a good one and the resulting optimal path does not deviate significantly from the "true" optimum.

Our experiment reveals that the investment path that minimizes post-1982 debt-service obligations differs substantially from the historical one, as shown by a comparison between the dashed and solid lines in Figure 6. The optimal profile also squares with intuition: Thailand should have invested and borrowed more than it did in the early years, when interest rates were low, and much less in the later years, when rates were at an all-time high. The terminal debt is 28% lower than its historical value. Clearly, the 1982 capital stock could have been achieved with a much lower debt-burden by shifting the profile of investment and borrowing.

The above experiment determines the optimal borrowing path when there is perfect foresight of the trajectory of interest rates. Now, few people in 1973 could have predicted the erratic behavior of interest rates in the second half of the 1970s. Hence, the deviation of the investment path from the optimal one could have been due to poor prediction of interest rates as well as sub-optimal borrowing. To distinguish between these two, we also compute the optimal path if interest rates had stayed at their 1973 levels. This myopic path, given by the dotted line in Figure 6, also differs substantially from the historical one. Thus, even if Thai policymakers had expected the low interest rates of 1973 to persist, they should have been following a different path from the one followed. Indeed, the myopic path more closely resembles the perfect foresight one. This gives rise to the conjecture that to achieve a given capital stock, if minimizing debt-service obligations is the objective, then a period of rapid borrowing should be followed by one of lower borrowing. It has been shown that foreign borrowing is associated with appreciation of the real exchange rate in developing countries (Ghanem and Kharas [1985]). A higher real exchange rate makes it more difficult to meet debt-service obligations. Thus, the slowdown in borrowing is needed to enable relative prices to adjust to meet debt-service payments.

An alternative question to ask is, "given its debt in 1982, could Thailand have altered its profile of borrowing and investment to achieve a higher capital stock in 1982?" As Figure 7 shows, the optimal borrowing path would differ from the historical one. The resulting pattern reflects the optimizing model's attempt to trade-off depreciation (which try to push investment into the later years) with high interest rates in 1979-1982 (which would push it to the early years). The resulting terminal capital stock, however, is only slightly higher. Thus, for a given volume of terminal debt, Thailand could not have done much better by adjusting its profile of foreign borrowing. This strengthens the notion that it was the country's investment and

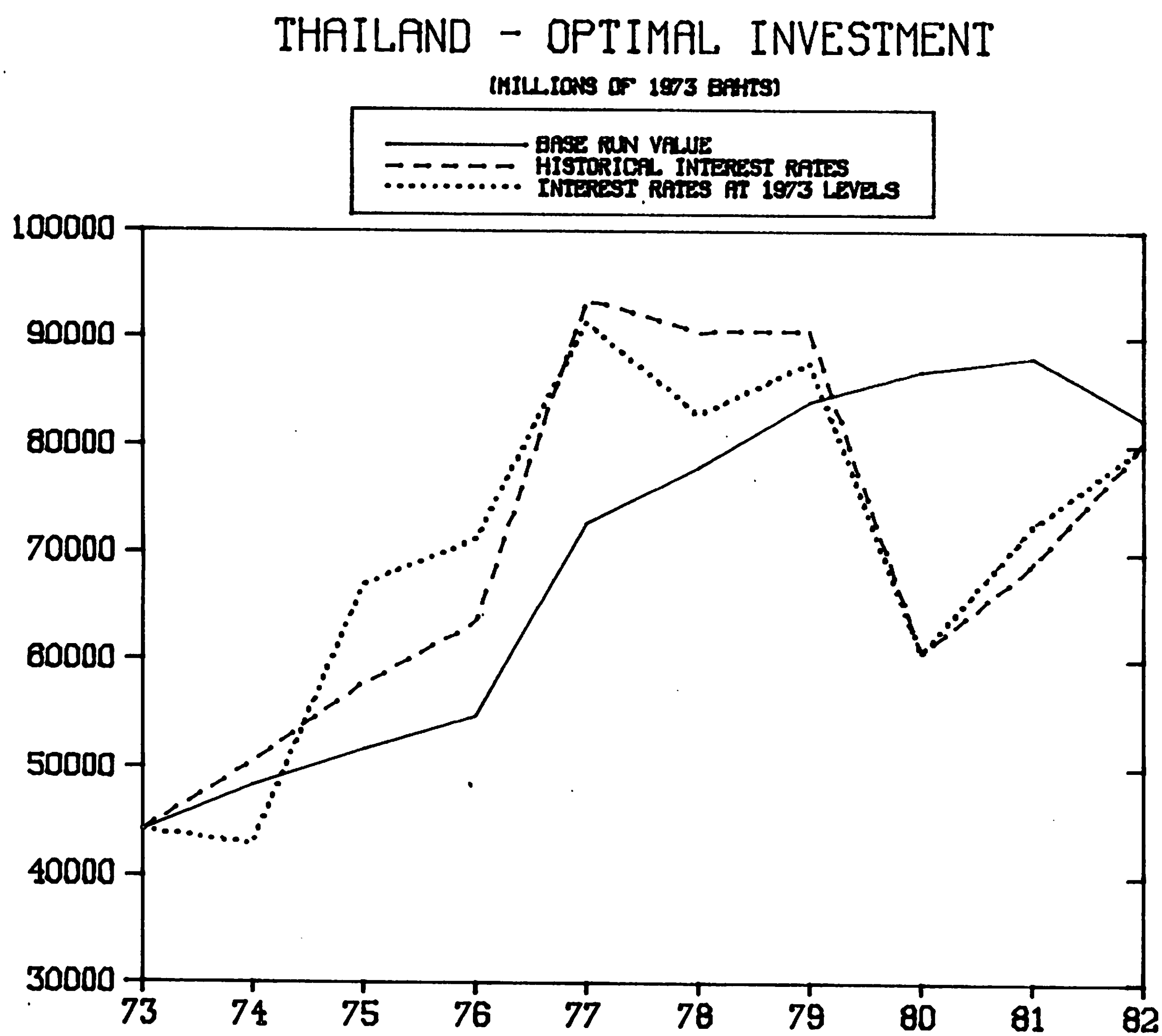
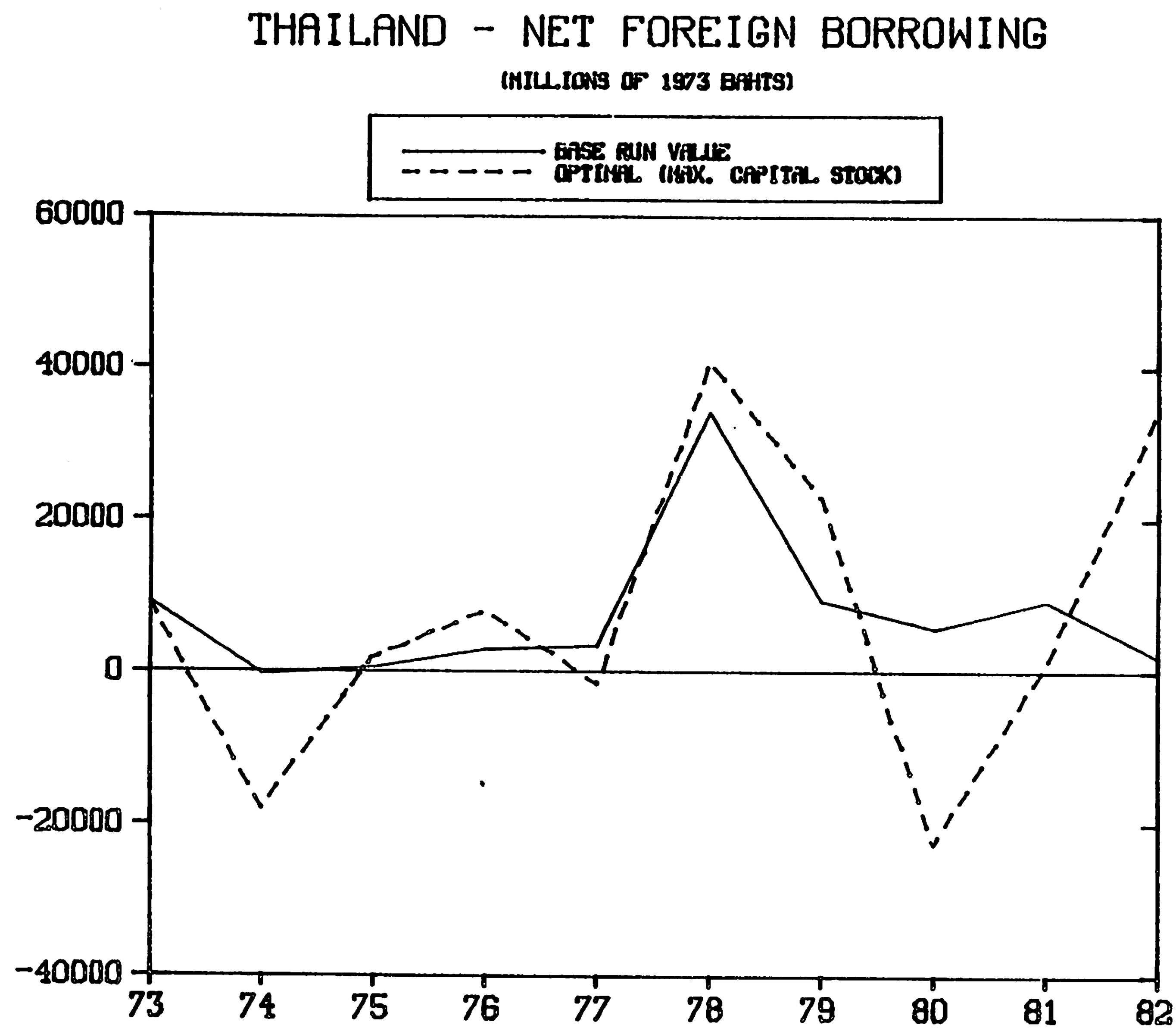

THAILAND - OPTIMAL INVESTMENT
(MILLIONS OF 1973 BAHTS)
BASE RUN VALUE
HISTORICAL INTEREST RATES
INTEREST RATES AT 1973 LEVELS
100000
90000
80000
70000
60000
50000
40000
30000
73
74
75
76
77
78
79
80
81
82

Figure 7


THAILAND - NET FOREIGN BORROWING
(MILLIONS OF 1973 BAHTS)
BASE RUN VALUE
OPTIMAL (MAX. CAPITAL STOCK)
60000
40000
20000
0
-20000
-40000
73
74
75
76
77
78
79
80
81
82

borrowing strategies taken together, rather than its investment strategy given it debt strategy, that was suboptimal.

In the class of experiments just discussed, we have attempted to alter the intertemporal allocation of borrowing and investment. We have kept the intersectoral allocation of investment resources constant at their 1974 levels. That is, while the volume of investment may vary, we assume the share going to each sector is the same in every year as it was in 1974. We now relax this assumption. We allow investment by sector of destination to vary according to the profitability of capital in the sector. This profitability is defined as the return to capital services in a sector (i.e., value added less payments to labor and land) divided by the capital stock.1/ If x_i is the profitability in sector i in relation to the economy-wide average, then y_i, the share of investment going to sector i, is given by

$$y_i = 1 - e^{-\lambda x_i} \qquad (1)$$

Where λ is a damping parameter reflecting how rapidly investment responds to rate of return differentials. (λ is defined so that $\Sigma y_i = 1$).

We perform the following experiment. For the same volume of investment in each year, we allow its intersectoral allocation to be determined by (1). Thus, we are asking: "how would the economy have

1/ With fixed, sector-specific capital stocks within a period, this value will in general not be equal across sectors. Moreover, it would signal the scarcity of capital resources in a sector.

behaved if investible resources were allowed to flow to where capital was scarcest?"1/

The results of this experiment are quite dramatic. There is a clear and significant shift of resources towards the tradeables sector, particularly agriculture and consumer goods. As a result, exports are higher and imports lower than in the base run (Table 8). The need for foreign borrowing is correspondingly reduced, and the economy's terminal year debt is only 25% of its historical level.

Table 8: EXPERIMENT - CHANGE IN ALLOCATION OF INVESTMENT
(Percentage changes from base run)

Year	Exports	Imports
1974	0	0
1975	0.6	-0.4
1976	0.8	-0.5
1977	1.7	-1.5
1978	2.8	-2.5
1979	3.4	-2.8
1980	3.6	-2.9
1981	3.8	-2.9
1982	7.4	-6.2

The structure of output reflects this shift towards tradeables. While all output is higher in the terminal year, that of agriculture and consumer goods exceeds base run values by twice as much as the others (Table 9).

1/ Note that the "closure rule" in this experiment is different from that in all other experiments reported in this paper. By fixing total investment, we allow foreign savings to be endogenous.

Table 9: EXPERIMENT: CHANGE IN ALLOCATION OF INVESTMENT
(Percentage change from base run)

	Output in Terminal Year (1982)
Sector	
Agriculture	10.3
Consumer Goods	8.7
Capital Goods	4.0
Intermediate Goods	4.1
Public Infrastructure	3.1
Services	3.2
	Utility in Terminal Year
Household Group	
Own Account Rural	4.5
Own Account Urban	1.8
Casual Rural	6.2
Casual Urban	2.8
Blue Collar	2.9
White Collar	0.3

As for equity considerations, since consumer demand in our model is based on static utility-maximizing behavior, we can calculate the impact of this (or any) experiment on the utility of each of the six consumer groups. The outcome in this particular case is that while everybody's utility is increased, the rural and poor households benefit proportionately more. This is of course due to the fact that their welfare is closely tied to the faster growing tradeables sector, while white collar workers, for example, are linked with the production of nontradeables.

Thus, by changing the mix of investments, Thailand could have significantly lowered its foreign debt, without affecting the overall volume of investment. This would have increased welfare and improved the distribution of income in the country. The direction in which the mix should have been altered was not determined by some complicated intertemporal optimizing problem. Rather, it was signalled by the current return to capital services in the various sectors.1/ To be sure, these results should be treated with some caution. The assumption made in the base run that the mix of investments remained what it was in 1973 is clearly a strong one, although a necessary one given the lack of data for any other year. It is not surprising, therefore, that allowing this mix to change will have dramatic effects. If the mix had changed in reality towards tradeables, then some of the gains registered by our experiment would already have been captured by Thailand. Nevertheless the magnitude of the change elicited by allowing the intersectoral allocation of investment to respond to differentials in profitability indicates that some gains were likely.

1/ This approach assumes investors are myopic insofar as they look at the current return to capital rather than the future profitability of their investments.

V. CONCLUSION

Thailand's adjustment experience has been characterized by rapid economic growth without much adjustment to the 1973 oil price increase and ensuing worldwide recession. Looking more closely, we find that the country benefitted from several favorable "shocks" and borrowed heavily in world capital markets during the 1973-82 period. In this paper we have attempted to assess that experience in a quantitative framework. Using a six-sector general equilibrium model of the Thai economy (which tracked the behavior of several key variables reasonably well), we showed that the favorable external circumstances contributed little to Thailand's economic growth in the 1973-82 period. Moreover, they did not mitigate the need for adjustment. The harm done by higher import prices in the 1970's outweighed the beneficial effects of these favorable shocks. Turning to the foreign borrowing, we find considerable evidence that Thailand's borrowing strategy was not optimal. We showed that Thailand could have achieved the same 1982 capital stock with less debt had it adjusted its profile of borrowing over the decade. Finally, taking the level of investment as given, we showed that significant gains could have been achieved had the composition of investment been allowed to respond to the profitability of capital in each sector. This would have resulted in a shift of resources towards the tradeables sector, a much lower foreign debt and a more equitable distribution.

What lessons can be drawn from this exercise for adjustment in other oil-importing countries? First, it is likely that favorable, temporary shocks do little to counteract the need for adjustment to a permanent change in the external environment. Second, while borrowing abroad does postpone adjustment, the tendency to overborrow can be quite costly. In general, it appears as if a period of rapid increase in foreign debt should be followed by a period of decreased borrowing to facilitate debt-service payments. Third, an ambitious investment program may not be inconsistent with adjustment. As we demonstrated, the mix of investments, rather than the volume, can play a crucial role in determining the outcome for the economy.

As for implications for Thai economic policy, there is no question that the economy turned in an impressive performance during the 1970s. However, this was at a cost of sizeable debt-service payments and slower growth in the following decade. We showed that the economy would have been better off with a different time profile of foreign borrowing and a different sectoral allocation of investment. In the latter case, moreover, the signals for a better investment allocation were given by the intersectoral returns to capital. Thus, policy makers in Thailand may wish to promote an environment where investible resources can flow easily to where their current profitability is highest. This leads not just to faster growth but — because it is the tradeables sector that will attract this investment — also to lower borrowing and improved income distribution.

Appendix A

Equations of the Thailand Model

Table A.1: Production Equations

Sectors 1,2,4,5,6

$$(1) \qquad X = (\alpha_G B_G)^{\frac{\sigma_X}{\sigma_X - 1}} G \, P_X^{-\sigma_X} A^{1-\sigma_X} \left((AP_X)^{1-\sigma_X} - \alpha_Z^{\sigma_X} P_Z^{1-\sigma_X}\right)^{\frac{\sigma_X}{1-\sigma_X}}$$

$$(2) \qquad Z = X A^{\sigma_X - 1} \left(\frac{\alpha_Z P_X}{P_Z(1+t_X)}\right)^{\sigma_X}$$

$$(3) \qquad P_G = A^{\frac{\sigma_X - 1}{\sigma_X}} P_X \alpha_G \left(\frac{X}{G}\right)^{\frac{1}{\sigma_X}} / (1+t_X)$$

$$(4) \qquad V = Z \left(\frac{\alpha_V P_Z}{P_V}\right)^{\sigma_Z}$$

$$(5) \qquad N = Z \left(\frac{\alpha_N P_Z}{P_N}\right)^{\sigma_Z}$$

$$(6) \qquad P_Z = \left(\alpha_V^{\sigma_Z} P_V^{1-\sigma_Z} + \alpha_N^{\sigma_Z} P_N^{1-\sigma_Z}\right)^{\frac{1}{1-\sigma_Z}}$$

(9) $$P_N = \left[\alpha_{N_D}^{\sigma_N} P_{N_D}^{1-\sigma_N} + \alpha_{N_M}^{\sigma_N} P_{N_M}^{1-\sigma_N}\right]^{\frac{1}{1-\sigma_N}}$$

(7) $$N_D = N \left(\frac{\alpha_{N_D} P_N}{P_{N_D}}\right)^{\sigma_N}$$

(8) $$N_M = N \left(\frac{\sigma_{N_M} P_N}{P_{N_M}}\right)^{\sigma_N}$$

(10) $$P_{N_D} = \sum_{j \neq 5} a_{ji} P_{Xj} (1 + t_{N_{D_j}})$$ where i is the using sector

(11) $$P_{N_M} = \sum_{j \neq 5} m_{ji} P_{Mj} (1 + t_{N_{M_j}})$$ where i is the using sector

(12) $$K = V\, B_K^{\sigma_V - 1} \left(\frac{\alpha_K P_V}{P_K}\right)^{\sigma_V}$$

(13) $$L_\ell = V\, B_\ell^{\sigma_V - 1} \left(\frac{\alpha_{L_\ell} P_V}{P_{L_\ell}}\right)^{\sigma_V} \qquad \ell = r,u,b,w$$

(14) $$H = V\, B_H^{\sigma_V - 1} \left(\frac{\alpha_H P_V}{P_H}\right)^{\sigma_V}$$

(15) $$P_V V = P_K K + P_H H + \textstyle\sum_\ell P_{L_\ell} L_\ell$$

Sector 3

Since Sector 3 has significant quantities of almost-finished imports, M, it is necessary to add the following equations:

$$(16) \qquad X = (CX) \left(\frac{\alpha_X P_{CX}}{P_X}\right)^{\sigma_C}$$

$$(17) \qquad M = (CX) \left(\frac{\alpha_M P_{CX}}{P_M(1 + t_{FM})}\right)^{\sigma_C}$$

$$(18) \qquad P_{CX} = \left[\alpha_X^{\sigma_C} P_X^{1 - \sigma_C} + \alpha_M^{\sigma_C} (P_M (1 + t_{FM}))^{1 - \sigma_C}\right]^{\frac{1}{1 - \sigma_C}}$$

The supply of infrastructure, G, fixed, supply of output X is given by (1) as a function of the output price, P_X, input price, P_Z and G, where

A : rate of Hicks-neutral technical progress

B_j: rate of factor j-augmenting technical progress

σ_X: elasticity of substitution between Z and G.

Equation (2) expresses the demand for Z.., while equation (3) calculates the shadow price of G to the sector. Equations (4) and (5) are the demand equations for V and N, while (6) expresses P_Z in terms of the prices of its constituent inputs, P_V and P_N, where σ_Z = elasticity of substitution betweeen V and N. Equations (7) and (8) are demand functions for N_D and N_M, while (9) expresses P_N in terms of the prices of N_D and N_M. Equations (10) and (11) define P_{N_D} and P_{N_M} as weighted averages of their component prices, with the weights being the input-output coefficients making up those aggregates. Equations (12) and (14) are the demands for K and H, while (13) is the demand for labor type i (informal rural and urban, blue collar and white collar). Equation (15) determines the price of value added.

Table A.2: Income Generation and Household Consumption

The following types of income are identified by the model:

(1) $$Y^L = \sum_\ell P^L_\ell L_\ell$$: labor (private)

(2) $$Y^L_G = \sum_\ell P^G_\ell L^G_\ell$$: labor (government)

(3) $$Y^K = \sum_i (P_{G_i} G_i + P_{K_i} K_i)(1 - t^P)$$: profit

(4) $$Y^H = (1 - t^P) \quad P_H H$$: land

(5) $$Y^L_R = \overline{Y}^L_R$$: transfers

Household Incomes and Consumption

(6) $$R^W = \bar{R}^W$$

(7) $$Y_L^H = \sum_{i=1}^{6} Y_i^L + e\, R^W + Y_R^L + Y_G^L + \mu_H Y_T^H$$

($\mu_H = 1$ for Own Account rural households and zero otherwise)

(8) $$Y_K^P = \sum_{i=1}^{6} Y_i^K (1 - t^K_{\ i})$$

(9) $$T_L^H = t_L^H\, Y_L^H$$

(10) $$T_K^H = t_K^H\, Y_K^H$$

(11) $$P_i C_i = P_i Y_i^{CL} + \beta_i^{CL} (C_L^H - \sum_j P_j Y_j^{CL})$$

Table A.3: System Constraints

Material Balances

Final demand equals the sum of private and public consumption and gross fixed investment:

(1) $$FD_i = C_i + FI_i + GOV_i$$

The sum of domestic production and imports must equal the sum of final and intermediate demands, export demand and changes in stocks.

$$(2) \quad X_i = FD_i + \sum_{j=1}^{6} a_{ij} ND_j + E_i + \Delta S_i \quad (i = 1,2,4,6)$$

$$CX_i = FD_i + \sum_{j=1}^{6} a_{ij} ND_j + E_i + \Delta S_i \quad (i = 3)$$

$$X_i = FD_i + \sum_{i=1} G_i + \Delta S_i \qquad (i = 5)$$

Exports are a downward sloping function of export prices relative to prices of international competitors, as well as incomes in the rest of the world.

$$(3) \quad E_i = XVOL_i \left(\frac{eP^*_{I_i}}{P_{E_i}}\right)^{\varepsilon_i} \qquad (i = 1,2,3,4)$$

where e is the base year nominal exchange rate and asterisks signify international export prices. Export prices differ from output prices by export taxes:

$$(4) \quad P_{E_i} = P_{X_i} (1 + t_{E_i}) \qquad (i = 1,2,3,4)$$

The flow of infrastructural services to intermediate users is controlled by the government:

$$(5) \quad G_i = \bar{G}_i \quad (i = 1....6)$$

Changes in stocks are given:

$$(6) \quad \Delta S_i = \Delta S_i \qquad (i = 1....6)$$

Public consumption demand for each sector is given:

$$(7) \quad GOV_i = GOV_i \qquad (i = 1....6)$$

Fixed investment demand for each sector is a fixed proportion of total fixed investment:

$$(8) \quad FI_i = \gamma_i \sum_{i=1}^{6} FI_i \qquad (\sum_{i=1}^{6} \gamma_i = 1)$$

The amount of land is fixed

$$(9) \quad H = \bar{H}$$

The stock of capital in each sector, employment in each sector i are given in each period.

$$(10) \quad K_i = \bar{K}_i \qquad (i = 2....6)$$

Wages of informal rural labor and white collar labor are indexed to a CPI:

$$(11) \quad (\frac{w_i}{CPI}) = \lambda\alpha_i \qquad (i = r,w)$$

where $\lambda\ (\leq 1)$ capture the degree of indexation and α_i is the real wage in the base period.

The CPI is an average of consumer price indexes weighted by total private consumption by sector (C_i):

$$(12)\ CPI = \textstyle\sum_i P_{C_i} C_i \ / \ C_i$$

Import prices are internationally given:

$$(13)\ P_{Mj} = eP^{*}_{Mj}$$

where asterisks signify international import prices.

The economy's balance of payments constraint is given by

$$(14)\ eF = \sum_{i=1}^{6} [P_{M_i} M_i + \sum_j m_{ji} P_{Mj} NM_i$$

$$- P_{o_i} (1 + t_{E_i}) \cdot E_i] - NCT - NFI$$

NCT : net current transfers from the rest of the world

NFI : net factor income from the rest of the world

The savings investment equality is

$$(15)\ S + Fe + S_G = \sum_i P_{o_i} \Delta S_i + \sum_{i=1}^{6} P_{C_i} FI_i$$

where S_G is government savings, the difference between government revenue (REV) and expenditure (PUBEXP).

$$(16)\ REV = \sum_{i=1}^{6} \left| \sum_{j=1}^{6} a_{ji}\, P_{o_j}\, t_{ND_j}\, N_{D_i} + \sum_{j=1}^{6} m_{ji}\, P_{M_j}\, t_{NM_j}\, N_{M_i} + t_{E_i}\, E_i + \frac{t_{X_i}}{1 + t_{X_i}} P_{X_i} X_i + (P_{G_i} - P_{c_5}) G_i \right|$$

$$+ t_p\, P_H\, H + t_{p_i}\, \Sigma\, P_K\, K_i + t_{FM_3}\, e P^*_{M_3}\, M_3 + T^H_L$$

Thus, government revenue is the sum of tax revenue on intermediates and final goods, tariff revenue on intermediates and, where applicable, exports and final imports, revenue from excise taxes, wage and capital income, and income from infrastructure.

$$(17)\quad PUBEXP = \bar{Y}^L_R + \bar{R}^G + \Sigma_\ell P^G_\ell L^G_\ell + \sum_{i=1}^{6} P_{C_i}\, GOV_i$$

the sum of interest on the national debt, transfers to households, payments to government labor, and the value of government consumption.

Thus, government savings

$$(18)\quad S_G = REV - PUBEXP$$

Finally, total investment is determined in exogenously.

Table A.4: Labor Market Structure

(1) $L_r - U_r = \sum_i L_{r,i}$

(2) $L_u + \lambda_r U_r = \sum_i L_{u,i}$

(3) $L_b + \lambda_w U_w = \sum_i L_{b,i} + L_b^G$

(4) $L_w - U_w = \sum_i L_{w,i} + L_w^G$

(5) $\lambda_r = 1 - \exp(w_r - \phi\, w_u)$

(6) $\lambda_w = 0.4$

Table A.5: The Debt Module

Let D_t be the (total) stock of debt in period t, and NFB_t net foreign borrowing. Then:

$$D_t = D_{t-1} + NFB_t$$

where we have:

$$NFB_t = CA_t + I_t + \Delta R_t - DFI_t$$

CA = current account deficit

I = interest payments

ΔR = change in reserves

DFI = direct foreign investment

Given CA_t (from base run path), I_t, and ΔR_t (obtained from data), the value of DFI_t (direct foreign investment) is residually obtained so that NFB_t reproduces historical data.

All data have to be expressed in base year local currency. Therefore, historical debt data (given in current dollars) were deflated by the U.S. GDP deflator and multiplied by the dollar exchange rate in the base year (obtained from International Financial Statistics, IMF).

There is a different maturity structure for official and private medium-term debt as well as for short-term debt. It is assumed in the experiments that additional borrowing is split between medium- (official and private), and short-term debt according to the proportions in the base run path.

For experiments, we need to know how additional borrowing in year t affects the stream of service payments (and hence the current account deficit) in future years. We assume that the interest rate, grace period and maturity period for additional borrowing in any year are the same as those the country faced for actual borrowing in that year. Moreover, we assume that the stream of service payments to repay a given loan is constant across the years in which the payments are made. Thus, if the country borrows NFB in year 0 at an interest rate r, with a grace period g and a maturity period m, then it pays rNFB during years $(1,2,\ldots,g)$. For the remaining m-g years, 1/ the

1/ Note that we assume the maturity period of a loan includes the grace period.

country pays a constant service payment S per year. The present value of this stream should equal NFB (the outstanding debt at year g):

$$\sum_{t=g+1}^{m} \frac{S_t}{(1+r)} = NFB$$

or,

$$S = \frac{r(1+r)^{m-g}}{(1+r)^{m-g-1}} NFB$$

To compute the allocation of S between interest and amortization, we note that the indebtedness follows the difference equation:

$$D_t = (1+r) D_{t-1} - S$$

or,

$$D_t = (1+r)^t D_o - \sum_{t=0}^{t-1} (1+r)^{\tau} S$$

Thus the interest payment on this additional debt at time t is

$$I_t = rD_t = r(1+r)^t D_o - [(1+r)^t - 1] S .$$

The amortization payment at time t, A_t, then is the difference between S and I_t.

Now, the actual service payment at t. S_t, is the sum of service payments on debt contracted at different years in the past. Hence,

$$S_t = \sum_{k=0}^{t-1} a_k^t NFB_k + \hat{S}_t$$

where

$$a_k^t = \begin{cases} r_k & \text{if} \quad t - k < g_k \\ \dfrac{r_k (1 + r_k)^{m_k - g_k}}{(1 + r_k)^{m_k - g_k} - 1} & \text{if} \quad m_k > t - k > g_k + 1 \\ 0 & \text{if} \quad t - k > m_k \end{cases}$$

Similarly, the interest payment at t, I_t, is given by the sum of the interest payments on debt contracted earlier:

$$I_t = \sum_{k=0}^{t-1} \left(\gamma_k^t \, NFB_k \, (1 + \gamma_k^t)^{t-1-k} - S_k((1 + \gamma_k^t)^{t-1-k} - 1) \right) + \hat{I}_t$$

where

$$\gamma_k^t = \begin{cases} r_k & \text{if } t - k < m_k \\ 0 & \text{if } t - k > m_k \end{cases}$$

The elements $\hat{S}_t$, $\hat{I}_t$ are parameters that are obtained residually so that the values of S_t, I_t are equal to historical values.

Appendix B

Organization of the Data and Data Sources

This Appendix discusses the basic data requirements underlying the sequential CGE model for Thailand presented in this paper. The data is organized in the form of a Social Accounting Matrix (SAM), which essentially describes the principal flows in an economy at a particular point in time.[1/] The matrix for 1973, at its most aggregate level, is shown in Table A.1.

The figures in each column of the matrix in Table A.1 represent payments to the row, and those in each row receipts from columns. Thus, for example, column 1 pays the total cost of production to factors (GDP at factor cost: 180,920 m. baht) which, added to indirect taxes paid to the government (21,986 m. baht), and to supply of imports (46,069 m. baht) gives the total supply of commodities on the domestic market (248,975 m. baht). This sum is in turn equal to the total demand of commodities in row 1 from households (private consumption: 147,134 m. baht), the government (8,342 m. baht), the consolidated capital account (total investment: 51,711 m. baht), and from the rest of the world (exports: 41,788 m. baht).

The data used in building the SAM were taken from the National Accounts and all other data were adjusted to its magnitudes. The main

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1/ See eg. G. Pyatt, Roe A. and Associates: Social Accounting for Developmenmt Planning, Cambridge University Press 1977.

data sources for disaggregating the National Account figures are the following:

1) National Accounts of Thailand (NA), 1973-82. Published by the office of the Prime Minister.

2) The Basic Input-Output Matrix of Thailand (I-O), 1975. Published by National Economic and Social Development Board (NESDB).

3) The Labor Force Survey (LFS), 1973-82. Published by the National Statistical Office of Thailand (NSO).

4) Annual Economic Report (AER), 1973-82. Published by the Bank of Thailand.

5) A Social Accounting Matrix for Thailand (SAMT), 1975. Published by NESDB-IBRD.

A more disaggregated SAM was constructed for Thailand, within the confines of the totals given by the summary SAM in Table A.1. In the fully disaggregated SAM the following sub-accounts are distinguished:

(1) Activities

1.1) Agriculture

1.2) Consumer Goods

1.3) Capital Goods

1.4) Intermediate Goods

1.5) Public Infrastructure

1.6) Services

(2) Factors

2.1) Informal Rural Labor

2.2) Informal Urban Labor

2.3) Blue Collar Labor

2.4) White Collar Labor

2.5) Capital

2.6) Infrastructure

2.7) Land

(3) Households

3.1) Own Account Rural

3.2) Own Account Urban

3.3) Casual Rural

3.4) Casual Urban

3.5) Blue Collar

3.6) White Collar

(4) Consolidated Capital

4.1) Gross Fixed Investment

4.2) Investment in Infrastructure

4.3) Changes in Stocks

1. Activity Accounts

The activity accounts show the value added generated in 6 production sectors, listed in 1.1)-1.6) above. The correspondence of these sectors with the items listed in the Input-Output (I-O) Table of Thailand is presented in Appendix C. The value added generated by the model's 6 producing sectors is then to be distributed to the factors of production accounts. The basic factor disaggregation is listed in 2.1)-2.7) above.

Table A.2 shows the payments of the producing sectors to the primary factors (value added), to the government (indirect taxes), to domestic intermediates, and to the rest of the world (intermediate and final imports). First, the vector of value added was calculated, using the information in (SAMT) and (I-O), and then wages and salaries, obtained from (LFS) and (SAMT), were substracted, leaving the operating surplus of firms as a residual. Rents accruing to land and infrastructure were then extracted from the operating surplus.

The calculations to obtain the rent paid on the primary factor land were made using the criterion in (SAMT); where the total amount of land rent was calculated as the product of rent per unit area and the total agricultural land holding. Total figures for employment and wage data were obtained from (LFS). The employment and industry breakdown required for the level of disaggregation in the SAM were obtained from (SAMT) for 1975, and then adjusted proportionatelly to be consistent with the 1973 estimates.

Table A.2 shows the total payments of the producing sectors for the use of domestic and import intermediates. For example, agriculture pays a total of 18559.6 m. baht for the use of domestic intermediates, and 1253.2 m. baht for imported intermediates. These total were obtained by adding over the columns of the input-output domestic and import matrices shown in Tables A.3 and A.4 respectively. The 1975 (I-O) Table (at producer's prices) provided the raw data for these matrices, which were then RAS'ed to obtain the totals consisten with 1973 (NA) figures.

2. Household Income and Expenditure Accounts

The household current accounts in the SAM show the sources of income and expenditure of the 6 household types described in 3.1)-3.6) above. The number and type of household categories correspond more or less to the ones in (SAMT), except that we do not distinguish between crops and rubber own account households. The payments to households from different sources is shown in Table A.5. As we may observe, households derive income from labor, dividends, land rent (all accruing to own account rural households), and transfers from government and the rest of the world.

The households outlays are shown in Table A.6. On the expenditure side, each household distributes its income over consumption, taxes and savings. Total savings was calculated as the difference between total income and the expenditure on consumption and taxes. Total household consumption was divided into 6 commodities using the (I-O) structure, and then distributed proportionatelly amongst households using the structure in (SAMT). Saving rates for the different households were also obtained from (SAMT).

3. Consolidated Capital Accounts

Two types of investment activities are distinguished in the model: private investment, and public infrastructure investment. The latter represents government investment in areas such as transport and communications (eg. roads), electricity, public water works (eg. dams, irrigation projects), which are provided to the private sector at no cost.

The investment flow matrix in Table A.7 essentially shows the purchase of investment goods by the different producing sectors for the year 1973. Thus, for example, the agricultural sector in column 1 (sector of destination), paid 3351.5 m. baht to the capital goods sector in row 3 (sector of origin) for the purchase of investment goods.

There is no disaggregated investment data for Thailand, hence it was necessary to compute figures by using (I-O) structure, aggregate (NA) data, and available capital/ouput ratios from the industrial Census 1976. The original matrix was constructed for 1975 and then RAS'ed to adjust to (NA) data. Total gross fixed investment in 1973 amounted to 44,244 m. baht.

Appendix C

Sector No.	Sector	Correspondence with Codes in I-O Table of Thailand
1.	Agriculture	Paddy 001, Maize 002, Cassava 003, Beans and Nuts 004, Vegetable and Fruits 005, Sugar Cane 006, Rubber (Latex) 007, Other Saps C08, Livestock 009, Forestry 010, ishery 011
2.	Consumer Goods	Slaughtering 015, Processing and Preserving of Foods 016, Rice and Other Grain Milling 017, Sugar Refineries 018, Other Foods 019, Beverages 021, Tobacco Processing and Products 022, Textile Products 024, Leather Products 042, Other Manufacturing Products 044
3.	Capital Goods	Industrial Machinery 038, Electrical Machinery and Apparatus 039, Motor Vehicles and Repair 040, Other Transportation Equipment 041, Building Construction 047
4.	Intermediate Goods	Animal Feed 020, Spinning, Weaving and Bleaching 023, Paper and Paper Products 025, Printing and Publishing 026, Basic Chemical Products 027, Fertilizer, Pesticides 028, Other Chemical Products 029, Petroleum References 030, Rubber Products 031, Plastic Ware 032, Cement and Concrete Products 033, Other Non-Metallic Products 034, Iron and Steel 035, Non-Ferrous Metal 036, Fabricated Metal Products 037, Saw Mills and Wood Products 038, Unclassified 058
5.	Public Infrastructure	Electricity 045, Water Works and Supply 046, Public Works and Other Construction 048, Transportation 051, Communication 052
6.	Services	Trade 049, Restaurants and Hotels 050, Banking, Insurance 053, Real Estate 054, Business Services 055, Public Services 056 Other Services 057.

06/26/85

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Table A.1

MACROECONOMIC INDICATORS FOR THAILAND 1973-1982

Historical Data

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
I. GDP in Constant Prices 1/										
1. Total	1.000	1.054	1.129	1.228	1.316	1.449	1.537	1.625	1.749	1.821
2. Private Consumption	1.000	1.051	1.124	1.222	1.324	1.395	1.481	1.552	1.634	1.675
3. Government Consumption	1.000	1.005	1.102	1.269	1.386	1.614	1.873	1.898	2.051	2.102
4. Gross Fixed Investment	1.000	1.092	1.166	1.240	1.646	1.764	1.902	1.963	1.993	1.864
5. Change in Stocks	1.000	0.753	1.349	0.770	0.708	1.016	1.191	0.509	0.335	-0.105
6. Exports	1.000	0.984	0.998	1.193	1.400	1.630	1.780	1.915	2.262	2.328
7. Imports	1.000	0.882	0.882	0.940	1.180	1.276	1.525	1.516	1.547	1.271
II. GDP Deflators										
1. Overall	1.000	1.181	1.222	1.270	1.379	1.498	1.672	1.964	2.121	2.222
2. Private Consumption	1.000	1.223	1.280	1.334	1.425	1.560	1.727	2.045	2.272	2.363
3. Government Consumption	1.000	1.220	1.315	1.379	1.419	1.566	1.685	2.037	2.229	2.364
4. Gross Fixed Investment	1.000	1.201	1.282	1.337	1.354	1.496	1.717	2.040	2.145	2.167
5. Change in Stocks	1.000	1.214	0.955	0.879	0.682	1.346	1.772	2.405	2.154	2.653
6. Exports	1.000	1.301	1.382	1.297	1.342	1.403	1.742	2.061	2.090	1.777
7. Imports	1.000	1.641	1.740	1.832	1.971	2.128	2.461	3.055	3.335	3.696
III. GDP Shares										
1. Government Revenue	0.130	0.150	0.137	0.130	0.143	0.144	0.144	0.138	0.142	0.138
2. Government Expenditure	0.097	0.094	0.102	0.109	0.105	0.112	0.118	0.116	0.117	0.124
3. Exports	0.196	0.229	0.191	0.211	0.209	0.215	0.237	0.245	0.248	0.247
4. Imports	0.213	0.254	0.237	0.235	0.263	0.255	0.298	0.299	0.297	0.252
6. Government Savings	0.032	0.056	0.035	0.022	0.037	0.032	0.025	0.022	0.024	0.014
7. Total Savings	0.239	0.244	0.253	0.232	0.263	0.270	0.288	0.272	0.247	0.217
8. Current Account Deficit	0.003	-0.002	0.040	0.022	0.051	0.042	0.058	0.048	0.042	-0.001

1/ As ratios of 1973 data. Base year = 1973

Source: National Income of Thailand, years 1973 to 1982. Published by the NESDB

TABLE A.1

Aggregated SAM for Thailand: 1973
(Million Baht)

	Activities	Factors	Households	Firms	Government	Consolidated Capital	R.O.W.	Total
Activities			147,134		8,392	51,711	41,788	248,975
Factors	180,920				12,897			193,817
Households		174,711			280		2,399	177,390
Firms		19,106						19,106
Government	21,986		2,348	28,43			740	27,917
Consolidated Capital			27,908	16,263	6,967		573	51,711
R.O.W.	46,069				-569			45,500
TOTAL	248,975	193,817	177,390	19,106	27,917	51,711	48,500	

TABLE A.2

Activity Accounts
(Million Baht)

		Agriculture	Consumer Goods	Capital Goods	Intermediate Goods	Public Infrastructure	Service
Primary Factors	Informal Rural	50629.4					1113.5
	Informal Urban		3621.3	8529.0	2675.4	2939.2	5508.3
	Blue Collar		4462.4	9574.1	2396.9	3128.6	5261.9
	White Collar		109.0	251.6	1204.8	140.6	2888.2
	Capital	27278.9	2998.3	8800.7	5319.9	4305.9	8313.8
	Infrastructure	154.3	2493.9	991.9	4317.9	1837.6	4472.7
	Land	5200.0					
Taxes	Tariffs	309.3	737.4	1986.0	2248.8	495.3	314.2
	Excise Tax	6955.4	846.1	3217.1	1654.6	1513.8	1080.0
Intermediates	Domestic	18405.3	40565.0	22421.9	50553.2	11663.3	28705.3
	Imported	1253.3	2481.5	6073.3	14185.3	2590.9	1735.1
	Final Imports			10740.3			

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TABLE A.3

Domestic Input-Output Matrix
(million baht)

	Agriculture	Consumer Goods	Capital Goods	Intermediate Goods	Public Infrastructure	Service
Agriculture	6732.5	30347.8	289.4	9204.0	87.8	1646.7
Consumer Goods	2183.8	4343.8	194.3	3669.0	27.5	7379.1
Capital Goods	666.4	395.4	7216.3	1677.4	1485.4	3109.9
Intermediate Goods	7345.7	4699.6	13631.3	33205.2	9068.3	8556.6
Public Infrastructure	154.3	2439.9	991.9	4317.9	1837.8	4472.7
Service	1476.9	729.4	1090	2797.6	994.5	8013.0

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TABLE A.4

Import Input-Output Matrix
(million baht)

	Agriculture	Consumer Goods	Capital Goods	Intermediate Goods	Public Infrastructure	Service
Agriculture	15.7	159.1	3.0	1182.2	0.5	43.2
Consumer Goods	7.3	1294.2	20.0	95.6	0.9	329.9
Capital Goods	4.6	4.3	3521.4	14.4	339.3	105.5
Intermediate Goods	1224.7	1020.9	2512.13	12860.9	2250.2	1117.0
Public Infrastructure						
Service		3.0	16.8	32.2		139.5

TABLE A.5

Matrix for Household Income
(million baht)

Households	Wage of Informal Rural	Wage of Informal Urban	Wage of Blue Collar	Wage of White Collar	Dividends	Land Rent	Transfer from Government	Transfer from R.O.W
Own Account Rural	45810.4				26354.6	5.200	89.6	
Own Account Urban		20854.2			15506.2		59.3	
Casual Rural	5932.5				-		5.4	
Casual Urban		2419.0			2234.0		-	
Blue Collar			29289.2		4343.3		84.4	1919.3
White Collar				13025.9	3741.7		41.9	479.7

TABLE A.6

Matrix for Household Expenditures

(million baht)

	OAR	OAU	CAR	CAU	BC	WC
Agriculture	29474.3	9453.0	2701.7	1078.4	9810.1	3545.6
Consumer Goods	10357.0	5701.8	1074.8	429.0	5959.5	2509.6
Capital Goods	11575.4	5581.7	961.9	384.0	5023.4	3253.7
Intermediate Goods	1491.6	900.3	166.3	66.4	686.4	277.2
Public Infrastructure	2668.0	1890.6	219.7	87.7	1404.1	1065.1
Service	7457.9	6482.0	813.5	324.7	8518.1	3939.5
Income Tax	296.8	730.6		13.8	544.6	762.2
Saving	1433.0	5678.7		2269.0	3860.0	1936.3

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TABLE A.7

Investment Matrix

(million baht)

	Agriculture	Consumer Goods	Capital Goods	Intermediate Goods	Public Infrastructure	Service
Agriculture	8.2	18.0	13.7	19.7	32.4	17.6
Consumer Goods	22.8	50.1	37.1	53.9	90.1	52.5
Capital Goods	3351.5	1556.5	810.6	1773.4	5725.3	16144.4
Intermediate Goods	136.5	305.1	222.2	326.5	539.4	299.1
Public Infrastructure	652.7	1446.5	1064.8	1584.1	2575.8	1339.0
Service	292.1	647.8	479.5	694.4	1152.8	652.9

Fiscal Policy

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FISCAL POLICY, MONETARY TARGETS, AND THE PRICE LEVEL IN A CENTRALLY PLANNED ECONOMY; AN APPLICATION TO THE CASE OF CHINA

Andrew Feltenstein
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ABSTRACT

Fiscal Policy, Monetary Targets, and the Price Level in a Centrally Planned Economy; an Application to the Case of China
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This paper applies a monetary model of a planned economy to China. A supply equation derives the change in broad money corresponding to government transactions at official prices. There is an unobserved true price index that determines consumers' demands for money. Consumer demands for real cash balances, as well as the divergence between the official and true price indices are derived.

The model is estimated and it is found that changes in the money supply are explained by government transactions, while real money balances are explained by real income and the anticipated true rate of inflation. The true rate of inflation is 2.5 times the official rate.

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Fiscal Policy, Monetary Targets, and the Price Level in a Centrally Planned Economy; an Application to the Case of China

Andrew Feltenstein and Ziba Farhadian*

I. Introduction

In virtually all economies, whether centrally planned or market-oriented, a key task for government policymakers is to determine suitable targets for the macroeconomic variables under their control. In this paper we will demonstrate how, in the case of China, the use of official price indices, combined with certain standard estimation procedures, can cause these targets to be seriously misspecified. In developing a technique for correctly determining price level, money supply, and government budget deficit in a planned economy of this type, we shall also obtain an estimate of the degree to which repressed inflation has existed in China during the time period of our study, 1954-81.

Typical models of market economies may specify a government budget deficit that is exogenous, either in real or nominal terms. Other models may state that real government expenditures are exogenously determined, while the price level, the nominal value of taxes, and

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hence the nominal value of the government deficit, are endogenous. Aghevli and Khan (1978), Tanzi (1978), and Clements (1980) present models of the first type, while a model of the second type is constructed in Feltenstein (1984). Changes in the money supply are related to the size of the government budget defict but also depend upon the external economy. If the economy is completely open, then increases in the stock of money, beyond that which people are willing to hold, may leave the economy either through increases in imports or through capital outflows. If the economy is less than fully open, increases in the money supply may be translated into increases in prices, as well as losses in foreign reserves. Many empirical studies have been made of this approach, an example being The Monetary Approach to the Balance of Payments (1977).

In a market economy, the government will try to estimate the behavioral connections between the policy instruments under its control, such as the size of the budget deficit, and the endogenous variables that they affect, such as prices and the balance of payments. In a centrally planned economy, however, government controls can cause a number of distortions in behavior patterns. Many, if not all, prices are centrally determined and therefore do not, at least immediately, reflect the macroeconomic disturbances that would show up in market-determined prices. 1/ Because there are controls on both imports and the capital account, the external sector does not automatically act as a balancing agent, as it does in an open economy, although central planners do use foreign trade in a crude way to balance the plan at a macro level. Studies made of economies that are partially market-oriented and partially centrally planned tend to indicate that the impact of the government's actions on the market sector increases according to the degree of centralization of the economy, since the market sector must bear the full brunt of any adjustment made by the government. A general discussion of so called "repressed" economies is given in McKinnon (1973), while the specific example of Ethiopia has been studied in Feltenstein (1985). Another type of situation occurs in an economy with complete controls in which, for example, a rapid increase in the money supply leads to parallel markets whose prices reflect the consumer's increased nominal buying power.

The question then arises of whether government policies that cause changes in the money supply can matter in an economy where controls are strictly enforced. Suppose, for example, that in an economy with rigid price and capital controls, a large government deficit leads to a correspondingly large increase in the money supply. At the same time, however, suppose that there is no increase in real output. The study of resulting outlet for such excess monetary creation has been the subject of a body of literature on disequilibrium models for centrally planned economies (see, for example, Clower (1965), Barro and Grossman (1971, 1974), Howard (1976), and Charemza and Gronicki (1984 a).

The aim of this paper is to construct a very simple model representing such a situation. The model is applied to China where, over the past several years, the money supply has grown considerably more quickly than real income. The increase in money has, however, largely been reflected in increased savings and time deposits, thereby relieving the pressure on prices. 2/ Because it is unlikely that this rapid increase in savings can continue indefinitely, it is important for the government to be able to measure accurately the impact of its own actions on the money supply, so that it is not continuously required to use savings deposits as a balancing tool.

In the situation just described, savings have increased because of shortages in available consumer goods. Because the official price index is rising less rapidly than the money supply, however, real cash balances held by the public (measured by household money holdings and valued at the official price index) are also rising. The question then arises as to what rate of inflation would induce people to hold the increased nominal money stock, if there were no price controls and the availability of consumer goods remained limited, as discussed in Portes (1977), and Portes and Winter (1980). 3/

Applying a neoclassical description of consumers' attitudes toward money in the Chinese economy could be somewhat controversial. A lengthy justification for using such methodology in this context is given in Peebles (1983), which also presents a useful description of the Chinese monetary system. The possibility of excessive monetary expansion influencing prices is also recognized by Chinese sources:

> If social purchasing power much exceeds commodity supplies, then part of the purchasing power will not be realized and will become excess currency circulation on the market which will influence the stability of the market and currency. Of course, if it is the purchasing power of the urban and rural population that is not realized then currency will accumulate in their hands, or in the form of savings deposits. 4/

We do not claim that the Chinese monetary system operates in a neoclassical manner, but rather that the empirical techniques described in the next section can help identify and estimate certain underlying pressures associated with governmental fiscal policies.

The next section contains a simple model designed to estimate certain behavioral characteristics of the Chinese monetary system, and, in particular, to simulate the impact on money and prices of various government fiscal instruments. The model, particularly on the side of the money supply equation, contains certain features which apply particularly to China. The third section will present the results of estimations using Chinese data, while the fourth section will present a simple simulation example. The final section will be a summary and conclusion.

II. The Model

The model consists of two basic equations: the first describes changes in the money supply; the second is a behavioral equation describing consumer demand for real cash balances. The money supply equation is straightforward and shows that changes in the nominal quantity of broad money are explained by four variables.

$$\Delta M_2 = a_0 + a_1 (D-F-AWB) + a_2\ CA + a_3\ F + a_4\ AWB \qquad (1)$$

where: M_2 = the stock of broad money;

D = the budget deficit of the central government, minus foreign borrowing and domestic bond sales; 5/

CA = the current account expressed in domestic currency;

AWB = the total wage bill of the government and state enterprises;

F = procurement payments made by the government to the rural sector for agricultural purchases;

Δ = change in a variable expressed as a first difference.

Equation (1) is partly an accounting identity and partly a behavioral equation that is specific to China. The equation postulates that increases in the money supply pay for, at least partially, increases in the total wage bill of the public sector (AWB) as well as in the level of procurement payments to the rural sector (F). 6/ These terms are subtracted from the money-financed portion of the government deficit in order to avoid double counting. Ideally, changes in foreign reserves should have been used as the final explanatory variable in equation (1). Data on the overall balance of payments are, however, not available for the period over which these estimates are made. Instead, the domestic currency value of the current account has been used. According to Peebles (1983, p. 87), "The main item of currency issue is wages, bonuses, and other labor remuneration . . . . The second element is for the purchase of agricultural and subsidiary products, and the third is credit extended to the rural population . . . . The fourth channel is for the sundry expenses of enterprises and units."

We should make certain qualifications concerning the reasoning underlying equation (1). The Chinese series for broad money reflects money held by households, and does not, for example, contain money held by state enterprises. One would expect that procurement payments to farmers and wage payments to public sector workers would have a direct impact on household money balances. The impact of other items of government spending on household money balances is less clear. The significance of the coefficient of these terms in the estimated version of equation (1) perhaps reflects the possibility that, over the extended time period of our study, household money balances have moved broadly in line with overall cash balances. It should also be noted that the Chinese definition of broad money is in terms of the net amount that remains after retail sales have caused money to be withdrawn from the gross amount injected by wage payments, agricultural procurement payments, and other credit items. 7/

Variables AWB and F, entering equation (1) as independent variables, reflect the behavioral nature of the equation and explain the formation of the money supply. In effect, the equation suggests that the government sets the targets for these two variables, and corresponding increases in the money supply are made, independent of their connection with the overall government budget deficit. Thus, the government could realize a budgetary surplus yet still carry out an expansionary monetary policy. One would, of course, expect that the estimated coefficients in equation (1) have positive signs.

The representation of consumer demand for real cash balances is somewhat more complex. Possibly the most important problem in estimating the demand for real money balances in a planned economy comes from the fact that official prices do not necessarily reflect the implicit prices that consumers actually face. Such prices, while not necessarily observable, may, for example, reflect the presence of scarcities or black markets. There is an extensive literature on black markets, or underground economies. See Tanzi (1982) for a number of articles on the subject. The problems of estimating corresponding excess demands are discussed in Portes and Winter (1977, 1980). Charemza and Gronicki (1984 b) arrive at quite different conclusions, however, in a model of Poland that is based upon slightly different assumptions about excess demand formation. 8/ A study of an earlier period in Chinese history is given in Jao (1967-68). Although there are no observable black markets in China, there is, however, evidence of shortages in certain consumer goods markets. 9/ It is assumed that there is some rate of inflation which would cause consumers, in the absence of commodity shortages, to hold the same quantity of money as they are observed to hold at the existing official prices and existing shortages. Consumers are assumed to behave "as if" there were some rate of inflation different from the official rate. If this observation can be proven, it would allow macroeconomic forecasts to be made even without the knowledge of individual market shortages, assuming that some stable relationship exists between this implied inflation rate and the official rate.

The representation of the demand for money function that is developed is based on the Cagan (1956) specification, while the form we use is described in Khan (1980). 10/ The demand for real cash balances, m^d, is assumed to be given by

$$m^d = a_0 + a_1 \log y + a_2 \pi_T^E \quad (2)$$

Here, $m^d = (M_2/P_T)^d$, where M_2 is the nominal supply of broad money and P_T is the true price index, which is unobservable, though effectively perceived by the consumer in terms of his consumption behavior. In addition, y denotes the real income of the economy, and π_T^E the expected rate of inflation in the true price index. Also, π_T, the unobserved true rate of inflation, is given by

$$\pi_T = \log P_T - \log P_{T-1} \tag{3}$$

Since the level of real income in China is measured directly, rather than by using price deflators, real income has not been modified by the true price level, P_T.

It is assumed that there is a connection between the true and official price indices given by

$$\log P_T = \alpha \log P, \tag{4}$$

where P is the official price index as reported by the government and $\alpha > 0$. There is no way to know a priori whether this is a reasonable specification. The estimation results reported in Section III suggest, however, that it is indeed reasonable and that the coefficient α may be treated as a constant. 11/ It will also be assumed that π_T^E, the expected rate of inflation in the implicit price index, is given by an adaptive expectations scheme depending, in turn, upon the historical series of true rates of inflation. Thus

$$\pi_T^E - \pi_{T(-1)}^E = \beta(\pi_T - \pi_{T(-1)}^E), \; 0 < \beta < 1 \tag{5}$$

where the subscript (-1) denotes the lagged value of the corresponding variables. Thus, the anticipated true rate of inflation adjusts proportionally to the error made in predicting the previous rate of inflation.

In addition, it is assumed that the real stock of money, valued at the true price index, adjusts proportionally to the difference between the demand for real money in the current period and the actual stock in the previous period. Hence

$$\Delta \log m = \lambda(\log m^d - \log m_{-1}),\ 0 < \lambda < 1 \tag{6}$$

and where $m = M_2/P_T$

This is not to say that the Chinese monetary authorities actually follow such a rule in adjusting the stock of money, rather that changes in the money supply have tended to behave in such a way. Combining equations (2)-(6) and setting $M \equiv M_2$ for simplicity of notation, 12/

$$\begin{aligned} &\log M - \alpha \log P - (1-\beta) \log M_{-1} + (1-\beta)\, \alpha \log P_{-1} \\ &= \lambda a_0 + a_1\, \lambda(\log y - (1-\beta) \log y_{-1}) + \lambda a_2\, \beta\alpha\pi \\ &+ (1-\lambda)(\log M_{-1} - \alpha \log P_{-1} - (1-\beta)\log M_{-2} + (1-\beta)\, \alpha \log P_{-2}) \end{aligned} \tag{7}$$

The interested reader may see Khan (1980) for an example of how this type of derivation is carried out. The above expression may be then simplified by redefining variables in the following way:

$$\tilde{m} = b_0 + b_1\tilde{y} + b_2\tilde{\pi} + b_3\tilde{m}_{-1} \tag{8}$$

where: $\tilde{m} \equiv \log M - \alpha \log P - (1-\beta) \log M_{-1} + (1-\beta)\, \alpha \log P_{-1}$

$\tilde{y} \equiv \log y - (1-\beta) \log y_{-1}$

$\tilde{\pi} \equiv \beta\alpha\pi$

An expression has thus been derived representing the original money demand equation, but in which all unobserved variables, namely those represented by the true price index, have been replaced by observed variables, viz., the official price indices. The equation is underidentified in this form, however. As a result, a priori values, arising out of a constrained search procedure, based on a log-likelihood function, will have to be given to α and β to identify the equation.

III. Equation Estimates

In this section, parameter estimates of equations (1) and (2) using Chinese data are presented. The sources for data used in these estimates are Chinese Statistical Yearbook (1983); International Financial Statistics, various issues; and Byrd (1983).

Equation (1) was estimated using annual data over the period 1954-81. Ordinary least squares were used with the following results:

$$\Delta M_2 = \underset{(-3.62)}{-3.90} + \underset{(4.10)}{0.427}\,(D\text{-}F\text{-}AWB) + \underset{(0.01)}{0.005}\,CA + \underset{(4.64)}{0.672}\,F + \underset{(2.33)}{0.323}\,AWB$$

$$R^2 = 0.83 \qquad D.W. = 2.00 \qquad (9)$$

The numbers in parenthesis denote t-statistics. Changes in broad money are thus reasonably well explained, and the coefficients of the explanatory variables are, with the exception of the current account, all significant at the 5 percent level. The obvious reason for the lack of explanatory power of the current account variable in equation (9) is that the overall balance of payments (the change in foreign reserves) would have been a more appropriate variable. As mentioned earlier, the necessary data are, however, not available. The difference between the estimated coefficients reflects the behavioral characteristic of the money supply equation. Thus, for example, a higher proportion of payments for farm procurements appear to be monetized than are public sector wage payments. Finally, all coefficients have the correct sign and have plausible magnitudes. 13/

One may now turn to the estimation of equation (2). As mentioned at the end of Section II, it is necessary to carry out a simultaneous search over values of the parameter α connecting the official to the true rate of inflation, and the parameter β, representing the speed of adjustment of inflationary expectations. By doing so, one can identify individual parameters in an equation which is nonlinear in its parameters. Dhrymes (1971) contains a description of search methods for under-identified equations. 14/ The criterion for choosing a value for α and β is the log-likelihood function, since for each value of β and α, the equation can be estimated by ordinary least squares. Bounds can be placed on the values of these parameters, however, as we would expect that

$$0 < \beta < 1,$$

and $\alpha > 0$.

The parameter β is allowed to vary with increments of 0.05 over the range 0-1, and for each value of β, we changed α between 0-4 (also with increments of 0.05). The values of α and β that maximized the log-likelihood function of the estimated parameters of equation (8) were $\alpha = 2.5$ and $\beta = 0.45$, with the following results:

$$\tilde{m} = -0.408 + 0.350\ \tilde{y} - 1.026\ \tilde{\pi} + 0.745\ \tilde{m}_{-1}$$
$$(-2.15)\quad (2.35)\quad (-1.78)\quad (5.19)$$
$$R^2 = 0.91 \qquad D.W. = 1.87 \tag{10}$$

All coefficients in equation (10) have the correct sign and, with the exception of the expected inflation variable, $\tilde{\pi}$, are significant at the 5 percent level. 15/ The goodness-of-fit and Durbin-Watson statistic are also satisfactory.

The value for α indicates, by equation (4), that the true rate of inflation is 2.5 times higher than the official rate, i.e.,

$$\pi_T = 2.5\ \pi \tag{11}$$

The parameter $\beta = 0.45$ indicates that the rate of adjustment of inflationary expectations to changes in the historical series of inflation is relatively slow, as might be expected in a country with fairly stable price indices. The original parameters from equations (2) and (6) may now be identified and are:

$$\alpha_0 = -1.60,\ \alpha_1 = 1.373,\ \alpha_2 = -4.023,\ \lambda = 0.255 \tag{12}$$

Thus, the income elasticity of real money balances is 1.373.

It is interesting to compare this result with that generated in other studies of the demand for money in economies with price controls. In Feltenstein (1985), for example, where a similar equation was estimated for the Ethiopian economy, the corresponding income elasticity was found to be 5.7. Similar results (i.e., income elasticities higher than 2.5) have been found in other planned economies with price controls. The key difference between these estimates and those in the model comes from the use of the parameter α, connecting official and true rates of inflation. This parameter indicates that inflation, as perceived by the public in its attitude toward holding money, should actually have a greater weight in explaining demand for money than would be the case if the official price index were used. Accordingly, studies that use the official price index tend to place too much weight on the real income variable. The usual explanation for these high coefficients is the increasing monetization of the economy. It seems, however, quite unlikely that such rapidly increasing monetization could continue for the length of the sample's time period. It is also interesting that the estimate of the income elasticity of real cash balances is broadly in line with estimates for economies without price controls.

A problem with our equation estimates could arise if it were determined that the parameters were not stable over the time period in question. Such a situation might occur because of the many policy changes that have taken place inChina over the past 30 years. Accordingly, we have carried out the test of stability described in Brown, Durbin, and Evans (1975), which has been applied in Heller and Khan (1979). We have implemented the cusum test, as described in Brown, et al. If the value of the cusums is greater than the critical value at a particular significance level, then the null hypothesis that the parameters of the model are constant is rejected at that significance level (see Heller and Khan (1979) for a more detailed explanation). Using forward recursive regressions for both money demand and supply equations, equation (8), money demand, has a cusum value of 0.55, while equation (1), money supply, has a cusum of 0.74. The critical value at the 10 percent level is 0.85. We may thus assume that both equations are stable over the time period.

It may be useful to report the results of a similar regression where, instead of using the methodology described above, official data combined with a partial adjustment, adaptive expectations pattern is used. The following estimation results emerge:

$$\underset{}{\tilde{m}} = \underset{(-2.82)}{-0.639} + \underset{(2.89)}{0.465}\,\tilde{y} + \underset{(0.83)}{0.955}\,\tilde{\pi} + \underset{(4.28)}{0.645}\,\tilde{m}_{-1}$$

$$\beta = 0.6 \quad R^2 = 0.95 \quad D.W. = 1.67 \qquad (13)$$

Here the variables are defined by:

$$\tilde{m} = \log M/P - (1-\beta)\log (M/P)_{-1}$$

$$\tilde{y} = \log y - (1-\beta)\log y_{-1}$$

$$\tilde{\pi} = \beta\pi$$

Thus, equation (13) represents the estimates resulting from the standard methodology for estimating a demand for money function using adaptive expectations. When the underlying parameters from equations (2), (5), and (6) are identified--equations (3) and (4) are not used here--the following coefficient estimates result:

$$\alpha_0 = -1.80, \ \alpha_1 = 1.31, \ \alpha_2 = 2.69, \ \lambda = 0.355 \qquad (14)$$

It is immediately clear that the apparently good fit of equation (13) is a spurious correlation. The coefficient of expected inflation α_2 is positive so that a 1.0 percent increase in anticipated inflation would lead to the public's increasing its holding of real cash balances by 2.69 percent. 16/ Clearly this result is unacceptable, since it requires the public to increase the real value of its money holdings simultaneous with the decline of that money's purchasing power. In particular, if equation (13) were used to estimate the impact of changes in government-controlled price and monetary variables on public attitudes toward holding money, it would lead to predictions in exactly the wrong direction. Thus, the method used in this paper for deriving a true rate of inflation leads to a significant qualitative improvement in estimating the demand for money function.

IV. A Simulation Example

Let us suppose that the government wishes to estimate the monetary effect of changes in the parameters under its control. Let us suppose also that the government, in setting its monetary targets by using equation (9), wishes to do so in such a way as to confirm the public's predicted demands for real money balances in the forthcoming year. In order to give our data the proper order of magnitude, we will suppose that information for 1980 is known, and that it is desired to set targets for 1981. Let us take the target for inflation to be the actual rate of growth in the consumer price index for 1981, i.e., Π = 2.6 percent. Let us also suppose that the target rate of real growth is 6.0 percent. Based on the past series of historical data, we may then solve equation (10) to obtain:

$$M_2 = 152.9 \text{ billion yuan}, \quad \Delta M_2 = 8.9 \text{ billion yuan} \tag{15}$$

Thus, the planners would have a targeted expansion for 1981 of 8.9 billion yuan, or 6.2 percent of the 1980 supply of broad money (144.0 billion yuan) if they wished to conform to the public's historical behavior toward money holdings, corresponding to the inflation and real output targets they have set.

Suppose, again as a purely hypothetical example, that the planners set a target of 2.5 billion yuan for the government deficit, D, and a target of equilibrium in the current account, i.e., CA = 0. Incorporating these numbers, as well as the results of equation (15), in equation (9), we obtain:

$$52.24 + 0.42\ AWB = F \tag{16}$$

Thus, for example, if it were desired to set AWB = 30.0 billion yuan, then a target of F = 64.84 billion yuan should be set for procurement payments to farmers in order to remain consistent with the monetary expansion target, as well as the historical behavior of the money supply equation.

It is, of course, perfectly possible for government planners to use equation (9) to set monetary targets that do not conform to the public's anticipated demands, given the rate of inflation set for the official price index. The result of such a policy would be that the public would increase its real cash holdings. Such a phenomenon has actually occurred in China since 1978, and is reflected in the rapid growth of savings deposits. Indeed, prior to 1979, an accommodating credit policy interacted with the system of central planning, as practiced at the time, to generate excess liquidity. This excess was checked through rationing and administrative controls. Since 1978, however, new macroeconomic policies have been developed that rely less on direct controls. In particular, enterprise managers have increased autonomy in setting their own levels of investment. The rapid, and unexpected, increase in savings, due to monetary targets not in line with the public's demands, has led to the easy availability of funds for investment. Accordingly, there has been an increase in the rate of capital formation far beyond the levels envisaged in the annual plans, while there have simultaneously been shortfalls in the outputs of consumer goods.

V. Conclusion

This paper constructs a monetary model of a centrally planned economy with price controls. The first part of the model, a money supply equation, derives the change in the money supply corresponding to exogenous fiscal and trade parameters for which the planners set targets. Since the government carries out its transactions at official prices, this monetary target reflects the target rate of inflation. In the second part of the model, the assumption is that there is an implicit, or true, price level, reflecting shortages and certain other factors, that determines consumer demand for money. An equation is derived that simultaneously estimates consumer demand for cash balances, as well as the divergence between the official and true price indices.

For China, the money supply and real balance demand equations were estimated using historical data. Changes in the money supply were found to be explained by the government deficit, the wage bill of the government and state enterprises, and procurement payments to farmers. Real money balances were found to be explained by real income and the anticipated true rate of inflation, and the true rate of inflation was determined to be approximately 2.5 times the official rate. A simulation was carried out to indicate the way in which the estimated model could be used to either determine market clearing prices, or to approximate the level of monetary disequilibrium that would be caused by a particular target for official prices.

Footnotes

1/ There are, however, other indicators of these disturbances, such as savings accumulation, inventory changes, black market, or second economy price levels.

2/ This increase in savings that occurred is as most of the models mentioned in the previous paragraph would predict.

3/ The official price index in China is a consumer price index that comprises a retail price index for state-owned enterprises, with a weight of 90 percent, and a service sector price index, with a weight of 10 percent. The estimation results of Section III will indicate that it is incorrect to use the official price index as a deflator, since it tends to understate the underlying rate of inflation.

4/ Liu (1980), p. 169, quoted in Peebles (1983), p. 86.

5/ Thus, D reflects that portion of the government deficit to be financed by monetary expansion.

6/ The government acts as a purchasing agent by buying goods from farmers and selling them in urban centers.

7/ In most centrally planned economies there is a distinction made between enterprise deposits and household cash, with enterprise deposits not being readily convertible in cash and vice versa. Presumably, monetary and fiscal policy would affect the enterprise sector first and then spread gradually to the market for household cash as, for example, household wages were bid up. Thus, it would have been incorrect to estimate a money demand equation when the money supply series contained both enterprise deposits as well as household cash holdings. Fortunately, the Chinese money supply series contains only household deposits, so we are able to avoid this problem.

8/ Unlike the models developed in these papers, the authors do not assume that trading actually takes place at black market prices.

9/ There is much impressionistic discussion of this problem (as an illustration see Delfs (1982)).

10/ The reader interested in the use of this type of specification to a much earlier period in Chinese history, the Southern Sung dynasty (1127-1298 A.D.), may wish to see Liu (1983).

11/ It might be claimed that equation (4) should contain a constant term, i.e., $\log P_T = b_0 + b_1 \log P$. As will become clear, this would lead to an underidentification problem in the estimated form of the equation.

12/ Recall that, as in equation (2), y—real income—is not deflated by P_T, since the original estimates for Chinese national income are price independent.

13/ Although it is possible that there may be multicollinearity between the estimated coefficients in equation (9), this would not be relevant for the purpose of this study, since the interest is in the power of the entire equation in explaining changes in household money, rather than in the impact of any one of the exogenous parameters.

14/ The values of α and β that maximize the log-likelihood function have asymptotic maximum-likelihood properties.

15/ The coefficient of expected inflation falls just short of being statistically significant, although its sign is correct and its order of magnitude is plausible. It is interesting to note that the coefficient of the real income variable is significant, although in many such short-run money demand equation estimates for other developing countries, the corresponding coefficient fails to be significant. We should note that the use of national income as an explanatory variable is not strictly correct. Ideally we should use household consumption; such figures are not, however, available.

16/ The coefficient of inflation is not significant, but the goodness-of-fit of equation (13) would cause its point estimate to nonetheless be used as an explanatory parameter, thus reflecting its positive sign.

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INFLOW OF FOREIGN PRIVATE CAPITAL AND NATIONAL WELFARE OF DEVELOPING COUNTRIES: A GENERAL EQUILIBRIUM ANALYSIS

An Abstract

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INFLOW OF FOREIGN PRIVATE CAPITAL AND NATIONAL WELFARE OF DEVELOPING COUNTRIES: A GENERAL EQUILIBRIUM ANALYSIS

An Abstract

1. The Problem Addressed

The rate of return to capital in a typical developing economy is significantly higher than that in a developed counterpart.[1] In response to the net=of=risk differential[2] in rates of return, private capital is expected to flow from developed to developing economies provided the latter do not restrict these flows through multifarious regulations.[3]

The purpose of this paper is to determine the extent of the expected inflow and to evaluate both static and dynamic welfare implications of such foreign investment for a developing economy. The welfare analysis is carried out, first, analytically in terms of a two-sector growth model where the saving is generated by intertemporal utility maximization; two sector model is then extended to a computable general equilibrium model which is applied to India for a quantitative evaluation of welfare.

2. Methodology: A Two-Sector Growth Model.

In order to derive analytical results, a two sector growth model similar to Imam (1984b) is developed. Two factors of production, labour (L) and capital (K), are employed to produce two commodites, consumption good (C) and investment good (I). Other than the inflow of foreign capital, if any, and the consequent repatriation of profit, the economy is assumed to be closed.

The Consumption: The consumer's preference is described by an intertemporal utility function defined over current consumption (C_o) and stream of future

consumptions $(C_1,C_2,\ldots,C_t)$. The intertemporal utility maximization by a typical consumer subject to his income determines the demands for current and future consumptions. The demand for future consumption, in turn, determines the amount of saving that should be made out of his current income. This saving, is then used for acquiring investment goods, the return of which enhances his future consumption stream. In this framework, therefore, saving is endogenously determined, the exact amount of which depends on the elasticity of substitution between current and future consumption.[4]

The Production: Availability of labor at any period is determined by the labour available in the previous period, and its exogeneously determined growth rate. Similarly, the stock of capital is determined by its stock in the previous period, investment (saving) made in that period, and the inflow of foreign capital, if any, in the period under consideration. For simplicity, we assume, no inflow of foreign capital before the liberalization policy. The technology of production in each of the sectors is described by a constant return to scale production function. Supply of output in each of the sectors is determined by the cost minimization subject to the production function and relative factor prices. Factor prices themselves are endogenously determined by demand condition in the commodity markets of the Host country.

3. Analytical Results: Before the inflow of foreign capital, the economy is assumed to be on a steady state equilibrium growth path implying that the exogeneously determined growth rate of labour is equal to the endogeneously determined growth rate of capital. With the inflow of foreign capital this balance is lost due to an increase in per capita availability of capital in the economy. The production possibilities boundary will shift outward with a bias towards capital intensive commodity due to an absolute as well as relative

increase in capital. However, consumption possibilities of the host economy will be less than its production possibilities as it must repatriate the return to foreign capital. Despite this repatriation, consumption possibilities will be still greater than that of the initial situation due to the MacDougall effect.[5] Therefore, the host country will experience an improvement in welfare immediately following the inflow of foreign capital. This result of static welfare is generally known in the literature. Besides the static welfare gain, inflow of foreign capital may have intertemporal welfare consequences.

With the inflow of foreign capital, the rate of return to all available capital in the host economy will decline due to a per capita increase in capital stock. Since the cost of future consumption is inversely related to the rate of return to capital,[6] the inflow of foreign capital may potentially discourage future consumption and thus saving, depending on the elasticity of substitution between current and future consumption (σ_c). For example if $\sigma_c > 1$, (i.e. interest elasticity of savings (η_s) is greater than zero; see footnote 4), domestic capital formation will be adversely affected and vice versa. If $\eta_s > 0$, share of capital owned by the host economy will decline overtime. This, in turn, will require the host country to repatriate an increasing share of its income for servicing foreign capital. Therefore, it is not clear whether an unrestricted inflow of foreign capital improves the intertemporal welfare of the host country or not.

Given our framework, it poses a basic theoretical question whether the host economy would reach a new steady state equilibrium at all once the initial equilibrium is disturbed by the inflow of foreign capital. We attempt to answer this question first before the intertemporal welfare analysis is attempted.

The static welfare is evaluated by using Hicksian compensating variation and equivalent variation. For intertemporal welfare evaluation, I use dynamic analogs of compensating variation (DACV) and equivalent variation (DAEV) developed by Fullerton-Shoven-Whally (1978, 1983).

4. A Numerical Exercise:

In order to evaluate the national welfare of the host country numerically, we transform our two-sector model into a computable general equilibrium model, with n consumer groups and m commodities. Of these commodities, one investment good and the remaining m-1 are consumer goods which can not be stocked for consumption in the future periods.

The Consumption: The intertemporal preference of each of the consumer groups is described by a C.E.S. utility function while the contemporaneous preference is described by a Cobb-Douglas type function which the consumer maximizes sequentially. In the first stage, the consumer j maximizes his intertemporal utility function, described over current (C_o) and future consumptions ($C_1, C_2, \ldots C_t$), to determine current and future consumption expenditure. The demand for future consumption stream determines his saving (S^j) which in turn determines his demand for investment good (I^j). The demand for investment good in the economy is derived by aggregating individual investment. In the second stage, the consumer maximizes a contemporaneous utility function, defined over X_{it}, where X_{it} is the i th good in t th period, subject to his current consumption expenditure determined in the first stage. The demand for a particular consumer good, X_i, in any given period, t, is derived by the utility maximization at the second stage.

The Production: The technology of production in each of the sectors is described by the C.E.S. production function defined over primary inputs, labor (L) and capital (K). Besides primary inputs, intermediate inputs are also used, the requirements of which are described by a fixed coefficient input-output matrix. The supply of output in each of the sectors is once again determined by cost minimization subject to the production technology and endogenously determined input prices.

The Static Equilibrium: Given market demand and supply functions for each of the commodities at a particular period of time, one can determine the competitive equilibrium of the economy for that instant. In our numerical exercise, vectors of equilibrium prices and quantities at a given period of time are determined by a fixed point algorithm[7]. The welfare is assessed numerically by evaluating the indirect utility function underlying the direct utility functions indicated above. tem

The Interperal Analysis: As indicated above, investment (I) at a particular period of time is generated from two potential sources: the internal saving resulting from intertemporal utility maximization by consumers and, if allowed, inflow of foreign capital. Assuming the investment of period t_0 to enhance stock of capital in period t_1 and so forth and that labor grows at an exogeneously determined rate, one can determine a new production possibilities set for every period time. In order to capture dynamic consequences numerically, I adopt Hicks-Lindahl's "temporary equilibria" approach which computes a new equilibrium for every period of time.

According to "temporary equilibria" approach, trades take place at each date and sequentially over time. Unlike Arrow-Debreu's perfect foresight type model, the future is unknown at a particular period of time. In order to make a decision, each economic agents must forecast the future states of the economy.

However, forecasts made today may not be necessarily realized when the actual time period occurs.

Using a "temporary equilibria" approach, a sequence of competitive equilibria is computed over time which mimics an equilibrium growth path. For example, at a given period of time, t_0, stocks of capital and labor, consumers' preferences and production technologies generate a competitive equilibrium through the profit maximization by firms and utility maximization by consumers. In such an equilibrium, quantity of investment good (I) is determined along with all other quantities and prices. Investment good purchased in the current period is assumed to increment capital stock in the next period (t_1). The new stocks of labor and capital along with given preferences and technologies of that period, similarly, generate an equilibrium quantity of investment good which increments capital of the following period (t_2) and so forth. A sequence of equilibria so generated over time, yields a growth path.

Welfare is evaluated by comparing two sequences of equilibria, one with the unflow of foreign capital and the other without it. A numerical exercise is carried out for Indian economy with five production sectors and four consumer groups.

3. <u>The Contributions</u>

As indicated earlier, economic consequences of the inflow of foreign capital have been extensively analysed in the literature . However, these studies have not attempted to analyse the dynamic consequences of the inflow of foreign capital. Moreover, the host country has been assumed to be a small open economy[8], implying that relative prices are determined elsewhere in the world. The last but not the least, the literature does not provide any quantitative evaluation of economic consequences, neither in partial nor in general equilibrium framework.

In this paper it is attempted to bridge some of the gaps in the existing literature. The specific contributions of this paper are highlighted below:

i) Reformulation of the static analysis where prices in the host economy are determined endogenously. Therefore, other than the inflow of capital and repatriation of its profit, the economy is taken to be closed where the domestic demand and supply conditions determine equilibrium vectors of prices and quantities.

ii) Development of an analytical framework suitable for capturing dynamic consequences of the inflow of foreign capital. In this framework, saving is endogenously determined by consumers maximizing intertemporal utility functions.

iii) Quantitative assessment of static and dynamic effects of the inflow of foreign capital on national welfare. In order to achieve this, we develop a computable general equilibrium model. We carry out the numerical exercise for Indian economy.

FOOTNOTES

1. Several authors with diverse methodologies have estimated the real rate of return to capital in developing countries. These estimates vary from 12% to 27% while the corresponding estimates for developed countries are in the range of 3 to 4%. For more details, see Imam (1984a).

2. The investment in a developing country is typically more risky than that in a developed counterpart due to the differences in socio-political environments. As indicated by Meier (1984a), investment in a thirld world country must earn a risk premium of 3 to 4% over and above the normal rate of return to capital in developed economies. Even after allowing for risk premium, the capital can therefore earn 8 to 24% net-of-risk rate of return/or capital in a typical developing economy.

3. These regulations may restrict the ownership and management by foreign investors, in general, prohibit foreign investments in high-yielding sectors, restrict the repatriation of profit and impose prohibitive taxes on the return to foreign investments and so forth. For more details see Meier (1984a).

4. The responsiveness of saving to interest rate is measured by the interest elasticity of saving (η_s) which, in turn, depends on the elasticity of substitutions (σ_c) between current and future consumption, the exact relationship being $\eta_s = \sigma_c - 1$. For more details, see Feldstein (1978a, 1978b).

5. For an excellent discussion, see Meier (1984b).

6. See, for example, Liviatan (1966) and Feldstein (1978b).

7. See Imam and Whalley (1982, 1984).

8. See, for example, Bhagwati and Brecher (1980) Brecher and Bhagwati (1981).

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INFLOW OF FOREIGN PRIVATE CAPITAL AND NATIONAL WELFARE OF A DEVELOPING COUNTRY: A GENERAL EQUILIBRIUM ANALYSIS.

The Model

For the qualitative analysis, I take a two-sector model. However, for quantitative evaluation ~~__~~ I adopt a multisectoral computable general equilibrium model.

The Two-Sector Analysis:

Two Commodities:

C : Consumption good
I : Investment good.

Two factors of production.

L : labor
K : Capital.

The economy is assumed to be CLOSED, with the exception of the inflow of foreign capital, if any, and the consequent repatriation of the return to foreign capital.

Other than the restriction on the inflow of foreign capital, the economy is assumed to be functioning smoothly.

Resource Constraints

(1) $$L_t = L_0 e^{nt}$$

(2) $$K_t = K_t^d + K_t^f$$

(3) $$K_t^d = K_{t-1}^d + I_t^d$$

(4) $$K_t^f = K_{t-1}^f + I_t^f$$

Where

n = growth rate of labor (exogenous)

L_t = Labor supply in the tth period

K_t = Total capital stock in the tth period

K_t^d = Capital owned by the host country

K_t^f = Capital owned by the foreign country

I_t^d = domestic investment in the begining of tth period
= domestic saving of $t-1$ period
= S_{t-1}

I_t^f = Investment made by the foreigners at the ~~pe~~ begining of ~~e~~ period t.

In the absence of the inflow of foreign capital,

$$K^f_t = 0 = I^f_t \qquad \text{for all } t.$$

Therefore resource constraints 1 and 2 can be written as:

$$(1') \qquad L_t = L_0 e^{nt}.$$

$$(2') \qquad K_t = K^d_t.$$

Production:

$$(5) \qquad C = F(L_C, K_C)$$

$$(6) \qquad I = G(L_I, K_I) \qquad \text{for all } t.$$

No technological change is assumed for the sake of simplicity.

These production functions are continuous, twice differentiable and satisfy constant return to scale requirements.

The supply of each of the products is determined by cost minimization; zero profit condition is met. Thus,

(7) $P_I = b_I(w,r)\,w + a_I(w,r)\,r$

(8) $P_c = b(w,r)\,w + a(w,r)\cdot r$.

Where

P_I = Price of investment good

P_c = " Consumption good

w = wage rate

r = rental price of capital

b_I = labor requirement for a unit of investment good

a_I = capital requirement for one unit of investment good.

b = Labor requirement for one unit of consumption good

a = Capital requirement for one unit of consumption good.

The right hand side of (7) and (8) is the unit cost of production. For positive quantities to be supplied prices must be equal to the unit costs.

Definitions:

(9) $$\delta = \frac{\lambda \cdot r}{P_I}$$

δ = rate of return to capital
r = rental price for capital
λ = units of capital services for each unit of physical capital
P_I = Price of a unit of Investment good.

NO distortion between the rates ~~rate~~ of return to saving and investment.

(10) P_f = "Price" (opportunity cost) of a unit of future consumption.

$$= \frac{1}{\delta} = \frac{P_I}{\lambda r}.$$

Consumption

The consumption preference of the ith consumer is described as follows: (for the sake of notational simplicity ~~we~~ I avoid using subscript i):

(11) $$U = U(C_0, C_1, \ldots C_t) \qquad t = 0, 1 \ldots N.$$

Where C_0 = current consumption
C_t = future consumption, (of tth period)

The utility function (11) assumed to be separable between C_0 and H, where H is a linear homogenous function of all C_t, $t \geq 1$.

The Consumer maximizes the above utility subject to (i) life-time income and (ii) the total current consumption in the economy can not exceed the total production

Life-time income

$$(12) \qquad Y_t = \sum_{t=0}^{N'} W_t L_t e^{-\delta t} + \sum_{t=0}^{N} r_t k_t e^{-\delta t}$$

N' = Number of working periods.
N = Life expectancy of the Consumer. (group)

The Consumer does not have any choice between labor and leisure.

Formation of Expectation.

The Consumers and producers are assumed to be myopic in their expectation about the future states of the economy. Thus

$$(13) \qquad E_t = E_0 \quad \text{for all } t$$

Where the elements of vector E include such variables as commodity ~~prices~~, and factor prices, rate of return to capital, state of the government regulation and so forth. The relation (13), therefore, implies:

$$W_t = W_0$$

$$r_t = r_0$$

$$L_t = L_0 \qquad \text{for all } t.$$

Given the static expectation function, the consumer would expect a constant rate of return to capital throughout the life of his capital. That is,

(14) $\qquad \delta_t = \delta_0 \qquad$ for all t

Therefore, the "price" of future consumption is constant for all the future periods.

The separability of utility function (11) and constant price for the future consumption allow us to define a composite commodity (C_f) for all future consumptions which will have ~~price~~ P_f as the price.

Thus, (11) can be written as

(15) $V = V(C_0, C_f)$

The income constraint (12) can be written as:

(16) $$Y_t = PC_0 + P_f C_f = \sum_{t=0}^{N'} WLe^{-\delta t} + \sum_{t=0}^{N} rke^{-\delta t}$$

Maximizing (15) subject to (16), we can derive the demands for C_0 and C_f:

(17) $$C_0 = C_0(P, P_f, P_I, r)$$
$$= C(P, P_I, r)$$ as P_f can be defined in terms of the other vari

Similarly

(18) $$C_f = C_f(P, P_I, r)$$

We can define the saving function as:

(19) $$S = P_f C_f - \left(\sum_{t=1}^{N'} WLe^{-\delta t} + \sum_{t=1}^{N} rke^{-\delta t} \right)$$

where S is the "financial" saving in terms of the numeraire commodity.

For any individual consumer, $S \gtrless 0$. But the aggregate savings of the nation can not be negative.

Demand for investment good is given by.

$$I = \frac{S}{P_I}$$

(20) $$= I(P, P_I, r)$$

General Equilibrium and Static Welfare

We assume labor to be the numeraire commodity. Therefore $W = 1$.

Given the resource constraints, (1) and (2); demand functions, (17) and (20) and the supply conditions, (7) and (8), we can determine a competitive equilibrium in the economy. Given the convexity restrictions of the preference and production functions are satisfied, we can easily prove the existence of a competitive equilibrium.

Let the vectors of equilibrium prices and quantities are (P^*, P_I^*, r^*) and (C^*, I^*) respectively. The equilibrium quantity of future consumption implied by I^* is given by C_f^*.

Therefore, we can determine the level of welfare by deriving an expenditure function as follows:

(21) $V^* = V^*(C^*, C_f^*)$ Direct utility function.

(22) $M^* = M^*(V^*, \Pi^*)$ Expenditure function

Where M^* is the minimum expenditure required to achieve V^* at price vector $\Pi^* = (P^*, P_I^*, r^*)$.

Inflow of Foreign Capital

The host country is assumed to be a small ~~op~~ economy, implying that it faces an infinitely elastic supply curve of the foreign capital at the world rate of return to capital, δ^w. However, the demand condition in the economy may not justify enough inflow of foreign capital to reduce the K/L to the level where $\delta = \delta^w$

Once allowed, the foreign capital will enter the host country if $\delta \geq \delta^w$; where δ is the equilibrium rate of return / r capital in the host country. The change in demand for capital by the ith sector is given by

$$(23) \qquad dk_i = \sigma_i \frac{k_i}{r}(r - r^w) + \eta_i \, \Phi_i \left(\frac{r - r^w}{r}\right) \qquad i = 1, 2.$$

Where σ_i = elasticity of substitution between L & K in the ith sector

η_i = Price elasticity of demand for ith commodity

Φ_i = share capital in the unit cost of the ith commodity.

Aggregating the changes in capital demand ~~from~~ over all the sectors, we have

$$dk = \sum_{i=1}^{2} dk_i$$

$$(24.) \quad \therefore dK = L \cdot dk = k_0^f$$

as all new capital comes from abroad.

Substituting 24 in 2 we can determine the new stock of capital in the economy. Relations 1 and 2 ~~wa~~ and the production technologies given by 5 and 6 will determine a new production set.

However, the consumption set is less than the production set as the return to foreign capital must be repatriated. Let T^w is the income of foreign capital which is assumed to be repatriated in terms of consumption good. Therefore,

$$T^w = r.k^f$$
$$= P.C^T.$$

(25) or, $C^T = \dfrac{r.k^f}{P}$, where C^T = amount of current consumption good that will be repatriated ~~to service the~~ for the service of foreign capital.

The consumption possibilities (Walras law) is therefore given by:

(26) $$Y^d = (C - C^T)P + P_I I$$

Given the demand conditions described by 17 and 20, supply conditions, 7 and 8 ~~and~~ and

Consumption possibilites (26) we can determine a competitive equilibrium in the presence of foreign capital. Let C^{**} and I^{**} are the equilibrium quantities and $(p^{**}, p_I^{**}, r^{**})$ are equilibrium prices.

Change in Welfare:

The I^{**} will imply a future consumption C_f^{**}. Given C^{**} and C_f^{**} we can derive an expenditure function (following eqns. 21 and 22)

Let $M^{**} = M^*(V^{**}, \Pi^*)$ is the new expenditure function.

$\therefore$ Welfare change $= (M^{**} - M^*)$..

Dynamic Consequences:

The economy is assumed to be in the steady state equilibrium growth path before the foreign capital is allowed to enter. Thus.

27 $\quad \dot{k}_t = n \qquad$ for all t.

where $\dot{k}_t = \dfrac{I_t}{k_t} = \dfrac{\bar{I}_t^d}{\bar{k}_t^d}$ as $k_t^f = 0 = I_t^f$, $\forall t$

Where $\bar{I}^d_t$ = domestic investment in the steady state
$\bar{k}^d_t$ = domestic stock of capital in the steady state

Relation (27) implies a constant capital-labor ratio $(\bar{k})$ for all the period.

Defining δ as a function of capital-labor ratio, we have

(28) $\delta_t = \psi\left(\frac{k_t}{L_t}\right)$; $\psi' < 0$, $\psi'' > 0$

Therefore, the steady state equilibrium growth path can also be characterized as follows:

(29) $\delta_t = \psi(\bar{k}) = \bar{\delta}_0$ for all t.

Once the inflow of foreign capital is allowed, we have,

$K^f_0 = I^f_0 > 0$

as given by (24). The subscript 0 implies the period of the change in policy.

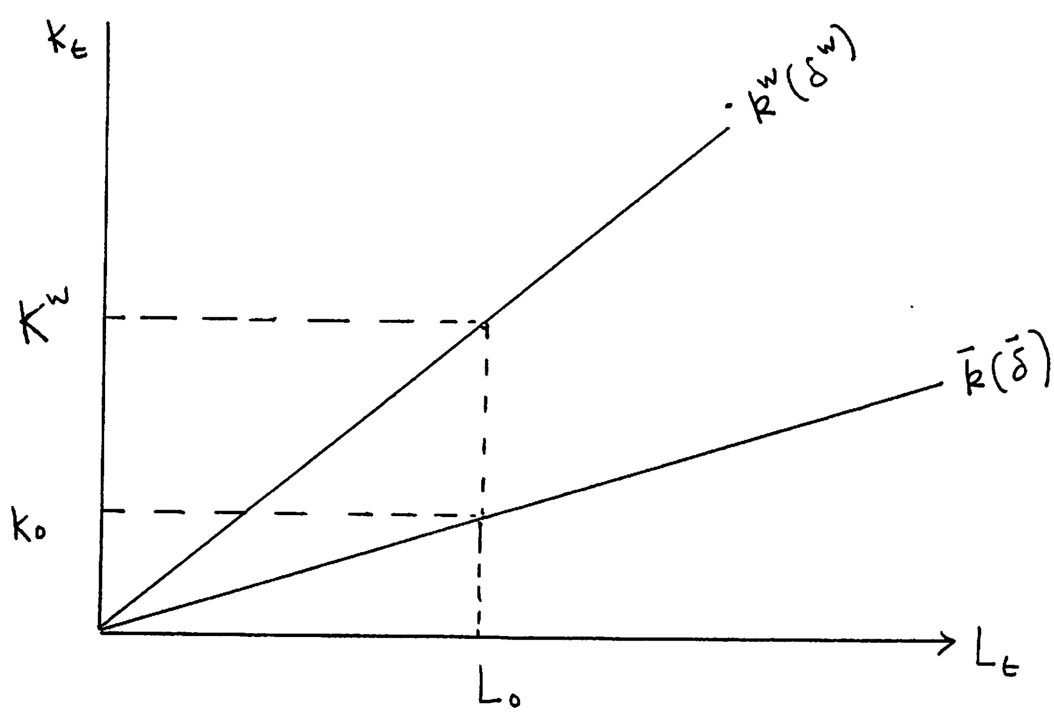
Since $$\frac{\bar{K}^d + K_0^f}{L_0} = \frac{K_0}{L_0} = k_0 > \bar{k}$$

$$\delta_0 = \psi(k_0) < \bar{\delta}_0 \tag{30}$$

Whether δ_0 ~~will~~ will be equal to δ^w or not depends on the demand conditions of the host country. If k^w is the capital-labor ratio that will ~~separate~~ ~~the~~ give $\delta_0 = \delta^w$, we have

$$k^w \geq k_0 > \bar{k} \tag{31}$$

The loci of k^w and $\bar{k}$ are drawn in the ~~Heart~~ diagram below



After the inflow of foreign capital, the Total capital stock is jointly owned by the domestic residents and the foreigners.

$$K_t = K_t^d + K_t^f \tag{32}$$

The income from capital earned by the foreigner is directly proportional to K_t^f.

The investment in the economy is given by

$$I_t = I_t^d + I_t^f \qquad \text{for } t \geq 1 \tag{33}$$

where $I_t^f \geq 0$, depending on the domestic demand condition, including the demand for investment good (I_t^d).

Given that the interest elasticity of saving (η_s) is greater than zero (i.e, $\sigma_c > 1$, where σ_c is the elasticity of substitution between current and future consumption) the relation (30) implies that the domestic saving will be adversely affected by the inflow of foreign capital due to the substitution effect. However, the foreign capital will enhance the consumption possibilities which in turn will potentially increase the saving. The final outcome will depend on the relative strength of these opposite forces. Thus

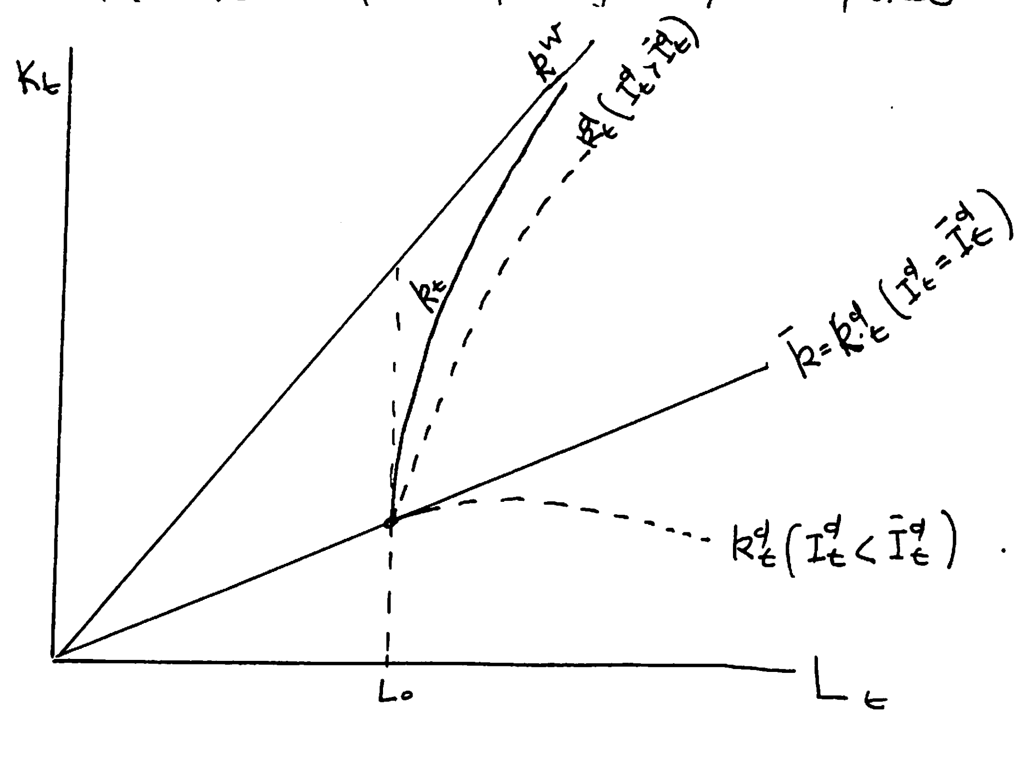
(34) $I^d_t \gtrless \bar{I}^d_t$

I^d_t = domestic investment after the inflow of foreign capital.
$\bar{I}^d_t$ = domestic investment before the inflow of foreign capital.

Expressing (32) as per capita basis, we have,

(35) $k_t = k^d_t + k^f_t$

Given that the new steady state equilibrium growth path exist, k_t will converse to k^w ~~locus~~ over time. However k^d_t will coincide with $\bar{k}$ if and only if $I^d_t = \bar{I}^d_t$. If $I^d_t < \bar{I}^d_t$, k^d_t will decline over time. On the other hand, ~~if~~ k^d_t will approach k^w_t if $I^d_t > \bar{I}^d_t$ and may even choke off the inflow of foreign capital.



Welfare Implication:

If $I_t^d \geq \bar{I}_t^d$, the host country will enjoy an improvement in its intertemporal welfare. If $I_t^d < \bar{I}_t^d$, the home country may not necessarily be worse off during the disequilibrium periods of time; but it will be ~~worse~~ necessarily worse off in the new steady state.

A SHORT-RUN GENERAL EQUILIBRIUM MODEL FOR A SMALL, OPEN ECONOMY

Revised Version

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ABSTRACT

This paper introduces some features observed in developing countries into a CGE model. In particular, quantitative restrictions on exports and imports are incorporated and quota-derived rents are included as a source of income. The economy is assumed to be small only on the import side, such that export prices are endogenous. A distinction between traded and tradeable goods is introduced, together with the possibility of 'water in the tariff.' Thus, the law of one price need not hold.

Another key feature is the modelling of supply with unutilized capacity. Thus, excess demands clear by price changes, output adjustments, or imports, depending on the degree of capacity utilization, the tradeability of the good, and the trade regime. An empirical application of the model shows that in a GE context, import quotas can worsen the trade balance while lowering real income and the real wage rate.

A Short-Run General Equilibrium Model for a Small, Open Economy

I. Introduction*

Computable General Equilibrium (CGE) models are tools that can numerically simulate the effects of alternative policies in a framework where prices and quantities simultaneously adjust to a policy change. It is clear, however, that to properly evaluate the response of the economy to an exogenous change, the institutional features of the economy under study must be incorporated into the model such that the numerical results in fact reflect the adjustment mechanism of different markets.

In this paper, an attempt is made to model some of the institutional arrangements that characterize many LDCs which have not been fully analyzed in the literature. In particular, and in contrast to Dervis, et.al. (1983) and Black and Taylor (1974), attention is paid to the possibility that trade flows be affected by quantitative restrictions (QRs) aside from the usual export and import taxes. It will be shown that QRs have a significant impact on the pattern of sourcing, the distribution of income, as well as the level of output and employment consistent with balanced trade.

With respect to the labor market, most CGE models either assume flexible wage rates such that full employment of labor occurs (Serra-Puche (1981)) or, alternatively, fix the real wage at some exogenously given level (Dervis, et.al. (1983)). More recently, Bourguignon, et.al. (1983) have linked nominal wages to

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the rates of unemployment introducing a short-run Phillips curve into a CGE framework. For some countries, however, it seems more appropriate to take the nominal wage rate as exogenous, as in these countries this parameter is set by the government based on political or other considerations without following any rigidly prescribed indexation rule or related mechanism. A similar argument applies to the exchange rate, where it is not unusual to find situations where this parameter is fixed regardless of the values taken by other variables in the economy. In the context of a CGE model this implies, of course, that the equilibrium solution will not necessarily be associated with balanced trade. Or, alternatively, that if balanced trade is required it is achieved through means other than movements of the exchange rate, like variations in the level of aggregate demand.

The model constructed in the paper is meant to serve for short-run analysis. This derives from the fact that the capital stock installed in each sector is taken as given, such that output levels are constrained by exogenously determined upper bounds. Our framework, however, allows for the possibility of unutilized capacity, a feature which seems to be characteristic of many LDCs but that has not been consistently incorporated into CGE models.[1]

The model focuses its attention on the foreign sector of the economy and, in particular, on the determination of exports and competitive imports under alternative trade regimes. While the structure of the model is flexible enough to analyze changes in tax, trade, and other policies, the empirical application will be centered around the use of QRs, particularly on the import side, as

1. A notable exception is Bourguignon, et.al. (1983). Schydlowsky (1979) presents documentation of unutilized capacity in many Latin American economies.

tools to improve the balance of trade.

The paper is organized as follows. Section II states the basic assumptions and develops the formal structure of the model. Section III describes the data set and the properties of the 'benchmark equilibrium.' Some simulations capturing the effects of QRs are presented in section IV. Finally, section V contains some concluding comments.

II. The Model

II.1 Consumers

Private consumers are of two types: workers and capitalists. Both groups are assumed to maximize a Stone-Geary utility function leading to a LES, such that:

(1) $c_w = \underline{c}_w + \{(1-t_w)\, Y_w - p\, \underline{c}_w\}\, \hat{p}^{-1} \eta_w$

(2) $c_\pi = \underline{c}_\pi + \ (1-t_\pi)\, Y_\pi - p\, \underline{c}_\pi\}\, \hat{p}^{-1} \eta_\pi$ where:[1]

$\underline{c}_w$, $\underline{c}_\pi$ (n,1) = vector of minimum consumption level for each group

Y_w, Y_π (1,1) = income level for each group

t_w, t_π (1,1) = tax rate on income for each group

η_w, η_π (n,1) = vector of marginal expenditure shares ($\sum_{i=1}^{n} \eta_i = 1$)

p(1,n) = vector of prices

^ = an operator to turn a vector into a diagonal matrix.

While tax rates and expenditure shares can be taken as exogenous, the same is not true of income levels. For workers, income is equal to the wage bill,

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1. The dimensions of each variable are given in the parentheses immediately after it.

while capitalists' income is made up of profits on current production -- via a mark-up over wage and intermediate costs -- together with rents from the QRs on exports and imports. We thus write:

$$(3) \quad Y_w = w \{\ell q^{SD} + g_\ell\}$$

$$(4) \quad Y_\pi = \{(w\ell + pA + ep^{nc}V)\hat{\gamma}\} \; q^{SD} + R \qquad \text{where:}$$

$w(1,1)$ = nominal wage rate

$\ell(1,n)$ = vector of labor/output coefficients

$q^{SD}(n,1)$ = vector of domestic supply

$g_\ell(1,1)$ = workers directly hired by the government

$A(n,n)$ = matrix of technical input/output coefficients

$e(1,1)$ = nominal exchange rate (domestic/foreign currency)

$p^{nc}(1,s)$ = vector of world prices for non-competitive imports expressed in foreign currency

$V(s,n)$ = matrix of non-competitive intermediate import coefficients

$\gamma(1,n)$ = vector of profit mark-up rates

$R(1,1)$ = value of total rents on exports and imports

II.2 Exports

Traditionally, the notion of a small economy has implied demand curves for exports and supply curves for imports that are infinitely elastic at the given world price. More recently, however, this interpretation of the "small economy" has been questioned, with one of the main criticisms being centered on the implied behavior of exports (Dervis, et.al. (1983)).

This paper assumes there exists an important asymmetry in the behavior of trade flows such that the economy can buy any amount of imports at fixed world prices, but can only increase its exports by reducing their foreign currency price. More concretely, we assume that the rest of the world will only purchase domestic goods if their foreign currency price does not exceed the world price for the same good. Thus, world prices represent, on the one hand, the prices at which imports can be obtained but, on the other hand, a cut-off or reference price above which no exports will occur.

At the same time, exports might be limited by QRs, which can either reflect the imposition of an import quota by the rest of the world, an international agreement, or a limit on exports imposed by the government of the domestic country. This, in turn, can reflect the desire to limit exports, if the country faces an inelastic demand curve, or a decision to reduce exports of a particular good so as to lower its price in the domestic market (see below).

If we let τ_i be the export subsidy ($\tau_i < 0$) or tax ($\tau_i > 0$) rate, then the foreign currency price of goods produced by the country will be $\tilde{p}_i = p_i(1+\tau_i)/e$. Then, if $\bar{d}_i$ denotes the export quota, we can write sectoral exports as:

$$(5)\quad d_i = \begin{bmatrix} \min\{\rho_i(p_i^c/\tilde{p}_i)^{\beta_i},\ \bar{d}_i\} \\ \\ 0 \end{bmatrix} \quad \text{as } \tilde{p}_i \begin{bmatrix} \leq \\ \\ > \end{bmatrix} p_i^c$$

where p_i^c is the world price of good i (in foreign currency), ρ_i is some positive constant, and $\beta_i \in [0, \infty)$, the exogenously given price elasticity of export demand.

As we take government expenditures -- given by vector g -- as exogenous, we can write total demand as:

(6) $q^D(p) = Aq^{SD}(p) + c_w(p) + c_\pi(p) + d(p) + g.$

II.3 Producers

Given the short-run nature of the model, it seems reasonable to ignore problems of choice of technique. The view taken here is that at a given point in time there is a vector of non-shiftable capital goods installed in each sector. Thus, the short-run response to exogenous changes is mainly through variations in the rates of capacity utilization. As output and capacity utilization levels can expand pari passu, however, there is no presumption that the marginal product of labor is decreasing. Once the assumption of full capacity is dropped, it appears more reasonable to take the labor/output ratios as constant. This, in turn, implies that domestic production will occur at constant costs, such that the short-run domestic supply functions are horizontal up to the point of full capacity output.

Domestic producers are assumed to maximize profits, which are given by a mark-up over wage and intermediate costs. While mark-up rates are endogenous, they are assumed to have a lower bound below which production in the respective sector would not occur. When domestic production in a particular sector is positive but less than full capacity, the equilibrium mark-up rate, γ_i, will -- by existence of competition -- be equal to the exogenously given minimum mark-up rate, $\underline{\gamma}_i$. This, together with the level of output, will determine producer profits. Of course, when imports are forthcoming or production is at full capacity, the equilibrium mark-up rate will differ from $\underline{\gamma}_i$, leading to different behavior of producers' profits.

The procedure outlined above, while not fully satisfactory, is introduced to solve a difficulty associated with excess capacity. In models where full capacity utilization is assumed, diminishing returns to labor generate positively-sloped supply functions. Prices then result from the interaction of supply and demand and payments to capital (or quasi-rents) are a residual obtained from subtracting wages and intermediate costs from product price (cf. Dervis, et.al. (1983)). With excess capacity and constant costs, payments to capital cannot be so obtained, as in these conditions demand will determine quantities produced with supply giving the equilibrium price. This price, however, should include some minimum payment to capital and the lower bounds on mark-up rates introduced above are just a convenient way of doing this.

The behavior of producers can be formalized with the introduction of a "shut-down" price, $\underline{p}_i$, below which no production would occur. This price is given by:

(7) $\underline{p}_i = (\underline{p}_i a_{ii} + p\underline{A}_i + ep^{nc}V_i + w\ell_i)\ (1 + \underline{\gamma}_i)$

where $\underline{A}_i(V_i)$ denotes the i^{th} column of matrix $\underline{A},(V)$ and the bar below matrix A indicates that its main diagonal has been deleted.

Domestic producers, however, must compete with imports which enter the economy at the price $p_i^m = ep_i^c\ (1+t_i)$, where t_i is the import tariff rate. Clearly, min $(\underline{p}_i,\ p_i^m)$ is the floor price below which no supplies will be forthcoming, neither from domestic producers nor foreign suppliers.

When min $\{\underline{p}_i,\ p_i^m\} = \underline{p}_i$, domestic producers will be able to undercut foreign suppliers and will thus be the first source of supply. As long as the ruling price, p_i equals $\underline{p}_i$, any level of production is profitable and the actual quantity produced will be determined by demand conditions subject, however, to the maximum output that can be produced given the capital stock installed in that sector. For $p_i \in (\underline{p}_i, p_i^m)$, profits for domestic producers are above the minimum bound so that producers will be induced to produce at full capacity output. If the ruling price is equal to p_i^m, on the other hand, foreign supplies will be forthcoming. Since at that price domestic producers are already at full capacity, the actual quantity imported will equal the excess demand over domestic output subject, however, to any QR that applies to imports in the relevant sector. Of course, for any price that exceeds p_i^m, both domestic producers and importers will be willing to supply as much as their respective bounds allow them. If we denote by $\bar{q}_i^{SD}$ the maximum output producible at full capacity and by $\bar{q}_i^{SF}$ the maximum imports allowed given the import quota, we can summarize the behavior of supplies for the case when $\min(\underline{p}_i, p_i^m) = \underline{p}_i$:

$$
\text{(8)}\quad \text{If } p_i \begin{cases}
< \underline{p}_i & \rightarrow q_i^{SD} = 0 \quad ; \quad q_i^{SF} = 0 \\
= \underline{p}_i & \rightarrow q_i^{SD} = \min(q_i^D, \bar{q}_i^{SD}) \quad ; \quad q_i^{SF} = 0 \\
\in (\underline{p}_i, p_i^m) & \rightarrow q_i^{SD} = \bar{q}_i^{SD} \quad ; \quad q_i^{SF} = 0 \\
= p_i^m & \rightarrow q_i^{SD} = \bar{q}_i^{SD}; \quad q_i^{SF} = \min(\max((q_i^D - \bar{q}_i^{SD}), 0), \bar{q}_i^{SF}) \\
> p_i^m & \rightarrow q_i^{SD} = \bar{q}_i^{SD} \quad ; \quad q_i^{SF} = \bar{q}_i^{SF}
\end{cases}
$$

This behavior can be depicted in graph 1, where the supply curve is the step-shaped curve $\underline{p}$ ABCD. When demand is at q_o^D, equilibrium is at point E with the ruling price equal to $\underline{p}$ -- the shutdown price -- and unused capacity equal to the distance EA. When demand equals q_1^D, output is at full capacity and price settles at $p^1 \in (\underline{p}, p^m)$. Clearly at p^1 the relevant mark-up rate in the sector has increased beyond $\underline{\gamma}$ producing, in fact, the price increase from $\underline{p}$ to p^1. For larger values of demand, however, price cannot increase further, as now imports are forthcoming. Thus, when $q^D = q_2{}^D$, competitive imports equal to $q_2 - \bar{q}^{SD}$ appear with the ruling price being p^m. At this point mark-up rates are determined as a residual and, in particular, will be equal to:

(9) $\bar{\gamma}_i = (p_i{}^m /(p_i{}^m a_{ii} + p\underline{A}_i + ep^{nc}V_i + w\ell_i)) - 1$

As long as the QR on imports is not binding, $\bar{\gamma}_i$ is an upper bound on the mark-up rate in the given sector. For greater values of demand, however, the import quota will be binding and it will be possible for mark-up rates to increase beyond $\bar{\gamma}_i$. Thus, when $q^D = q_3{}^D$ price settles at $p^3 > p^m$ the price at which total quantity demanded is equal to total supply $\bar{q}^{SD} + \bar{q}^{SF}$.

A second possibility arises, of course, when min $(\underline{p}_i, p_i{}^m) = p_i{}^m$.[1] In this case, foreign suppliers will undercut domestic producers and will be the first source of supply. As long as $q_i{}^D < \bar{q}_i{}^{SF}$, the ruling price will be $p_i{}^m$ and no domestic production will occur. If, however, the quantity demanded exceeds the QR on imports, price will increase to clear the market and when $p_i = \underline{p}_i$, domestic production will be profitable and forthcoming. As long as domestic producers operate below full capacity, competition will insure that $\underline{p}_i$ is the ruling price and $\underline{\gamma}_i$ the mark-up rate. If, of course, demand exceeds $\bar{q}_i{}^{SF} + \bar{q}_i{}^{SD}$, the price and mark-up rate will have to increase beyond $\underline{p}_i$, $\underline{\gamma}_i$, respectively, until the quantity demanded is brought into equality with the total quantity supplied. Thus, we can summarize the behavior of supply when

1. Obviously, when $\underline{p}_i = p_i{}^m$, the solution is indeterminate. In this case, however, we will arbitrarily assume that domestic suppliers will come first and treat this possibility under (8).

$\min(\underline{p}_i, p_i^m) = p_i^m$ by:

$$
(10)\ \text{if } p_i \begin{cases} < p_i^m & \rightarrow q_i^{SF} = 0 \ ; \ q_i^{SD} = 0 \\ = p_i^m & \rightarrow q_i^{SF} = \min(q_i^D, \bar{q}_i^{SF}) \ ; \ q_i^{SD} = 0 \\ \varepsilon\ (p_i^m, \underline{p}_i) & \rightarrow q_i^{SF} = \bar{q}_i^{SF} \ ; \ q_i^{SD} = 0 \\ = \underline{p}_i & \rightarrow q_i^{SF} = \bar{q}_i^{SF} \ ; \ q_i^{SD} = \min(\max((q_i^D - \bar{q}_i^{SF}), 0), \bar{q}_i^{SD}) \\ > \underline{p}_i & \rightarrow q_i^{SF} = \bar{q}_i^{SF} \ ; \ q_i^{SD} = \bar{q}_i^{SD} \end{cases}
$$

Once again, (10) will generate a supply curve similar to the one depicted in graph 1 except, of course, that now p_i^m will be the lower bound on price and competitive imports will be the first segment of the step-shaped function.

It is important to note that the ruling price will equal p_i^m only when $q_i^{SF}\ \varepsilon\ (0, \bar{q}_i^{SF})$, that is to say, when imports are forthcoming but are not subject to a binding import quota. When, however, sourcing is first from domestic producers -- eq.(8) -- the ruling price can be below p_i^m generating the so-called case of 'water in the tariff.' Conversely, the ruling price will exceed p_i^m only when the QR on imports has become binding. It thus follows that, in general, $p_i \gtreqless p_i^m$ such that the 'law of one price' ($p_i = p_i^m$) is only one out of many possible outcomes. Furthermore, note that whenever $q_i^{SF} > 0 \rightarrow p_i \geq p_i^m$. This behavior of price will then have important implications for the determination of exports. In particular, equation (5) shows that when $q_i^{SF} > 0 \rightarrow d_i = 0$ such that exportables and importables will form two mutually exclusive sets.[1]

From the preceding analysis we can note that as long as tariffs protect domestic producers (i.e., $p_i^m > \underline{p}_i$) supplies are determined by (8) such that

---

1. Unless, of course, $\tau_i > t_i/(1+t_i)$. In what follows, however, we will rule out this situation.

competitive imports are excess demands over domestic capacity output (as in Schydlowsky (1978) or Bourguignon, et.al. (1983)). On the other hand, if tariffs fail to protect domestic producers and no quotas are in place ($\bar{q}_i^{SF} = \infty$, see below), then competitive imports will be the sole source of supply and domestic production will shut down. When, however, tariffs do not protect but the import quota is binding ($q_i^D > \bar{q}_i^{SF}$), domestic production will occur as now the quota allows a domestic price equal or greater than the shut-down price, $\underline{p}_i$. In this case one will be able to observe competitive imports at the same time that the sector operates below full capacity output.[1] Thus, the proposition that competitive imports are excess demands over capacity output will only hold in models where no QRs on imports exist. But even in these cases, one must insure that $\underline{p}_i$ is indeed below (or equal to) p_i^m. This, nevertheless, cannot be guaranteed a priori as the shut-down price is not exogenously given but depends, as (7) indicates, on the vector of prices ruling in the economy as a whole. Put differently, even in models with constant costs, one cannot predict the behavior of competitive imports independent of the structure of relative prices.

Lastly, it is useful to write, for future reference, the vector or total supply as:

(11) $q^S(p) = q^{SD}(p) + q^{SF}(p)$.

II.4. Traded and Non-Traded Goods

The endogenization of exports and competitive imports developed above

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1. Therefore, although the QR "protects" by allowing a domestic price higher than the world price just as the tariff does, its effects on output and employment are quite different.

presents some difficulties if certain goods cannot be either exported or imported due to their physical characteristics. Fortunately, our approach can easily handle these situations through the appropriate manipulation of the vectors of quantitative restrictions. We will now adopt the convention that for any good j that cannot be traded $\bar{q}_j^{SF} = \bar{d}_j = 0$. Conversely, any good i that can be traded without any quantity restrictions will be one for which $\bar{q}_i^{SF} = \bar{d}_i = \infty$. The case of import and export quotas will be those for which $\bar{q}_i^{SF}, \bar{d}_i \in (0,\infty)$.

Thus, the set of all goods, N, is partitioned into two mutually exclusive and exhaustive subsets: Set I of tradeable goods ($\bar{q}_i^{SF}, \bar{d}_i > 0$) and set J of non-tradeable goods ($\bar{q}_j^{SF} = \bar{d}_j = 0$). Clearly, these two sets are exogenously specified. In fact, however, out of all goods in set I only a subset -- depending on prices and demand conditions -- will actually be traded (either q_i^{SF} or $d_i > 0$). Let us define, therefore, set R as the set of endogenously determined traded goods. Clearly $R \subseteq I$. As N is the set of all goods, $H = N \setminus R$ will be the set of endogenously determined non-traded goods.

The imposition of trading restrictions, particularly on the import side, along with the existence of non-tradeable goods will have important implications for the mechanism by which excess demands are eliminated. Quite clearly, for non-tradeables excess demands must be eliminated by increases in mark-up rates that will, in turn, increase price and decrease quantity demanded. For tradeable goods that have no import quotas, excess demands are cleared through the trade balance. Thus, the relative profitability of tradeable vs. non-tradeable production will change when there are exogenous changes in demand. As the stock of capital is fixed in each sector, however, this seems an admissible and even likely short-run event.

Import and export quotas, however, can alter these results. Thus, consider q_3^D in graph 1. In the absence of the import quota price would have settled at p^m with a larger volume of imports ($= q^3 - \bar{q}^{SD} > \bar{q}^{SF}$). With the QR, however, price settles at p^3 generating a higher mark-up rate in the relevant sector. In consequence, a binding import quota will imply that the sector behaves like a non-tradeable, with excess demands being cleared through price adjustments. The case of an export quota can be analyzed by means of graph 2, where it has been assumed that min $(\underline{p}, p^m) = \underline{p}$. A downward sloping demand curve for exports has been drawn beginning at ep^c (for simplicity, the export tax or subsidy has been set equal to zero). In the absence of the export quota, total demand is given by q_2^D and price settles at p^2. With an export quota set at $\bar{d}$, however, the demand curve has a kink at point I and is now equal to q_1^D, with price settling at $\underline{p}$. Thus export quotas, as opposed to import quotas, generate a lower price and mark-up rate whenever they are binding.

One further effect of export and import quotas must be noted. It concerns the fact that when quotas are binding income not associated with production will flow to quota holders. In particular, these flows of income -- which are properly called rents -- will accrue to capitalists in the respective sectors, assumed here to be the sole holders of the quotas. It follows that import quotas, when binding, affect income distribution not only by raising the relevant mark-up rates and thus profits on current production but, additionally, by the rents derived from the ability to sell some imports at a price that exceeds the world price. These rents will simply be equal to the difference between the equilibrium price, p_i, and the domestic currency price of imports,

p_i^m, times the volume of imports. Since we have just seen that $p_i > p_i^m$ only when $q_i^{SF} = \bar{q}_i^{SF}$, it will then hold that rents from import quotas will be positive only when the quota is indeed binding.

Export quotas will also affect income distribution first by lowering price and thus mark-up rates on current production and, second, by the ability to sell a restricted quantity in the world market at a price that exceeds the domestic price. In the case of exports, however, it is necessary to find the domestic currency price at which exports occur (denoted by $\bar{p}_i$) given that the economy faces a negatively-sloped world demand curve for its products. This can be done by inverting the demand curve implicit in (5) and solving for price as follows:[1]

$$(12)\quad \bar{p}_i = \begin{cases} \min\{ep_i^c / (1+\tau_i),\ (ep_i^c / (1+\tau_i))(d_i/\rho_i)^{-1/\beta_i}\} \\ \\ 0 \end{cases} \text{as } d_i \begin{Bmatrix} > \\ \\ = \end{Bmatrix} 0$$

Given rents from the export and import quotas, we can calculate total income from rents as:

$$(13)\quad R = (p - p^m)\, q^{SF} + (\bar{p} - p)\, d$$

where the first term on the R.H.S. of (13) is equal to the area BCFG in graph 1 while the second term is area $\bar{p}AB\underline{p}$ in graph 2. The value of R can

---

1. Note that when $d_i = \rho_i(p_i^c/\bar{p}_i)^{\beta_i}$ -- such that exports are positive but less than the export quota -- then $\bar{p}_i = p_i$. This follows from substituting the value for d_i in the R.H.S. of (12) and noting that if $d_i > 0$, then $p_i \leq ep_i^c/(1+\tau_i)$ by (5). Thus, with a non-binding export quota, the domestic currency price received for export sales will be the same as that received for domestic sales, with no quota rents on exports.

then be substituted in (4) to give total income accruing to capitalists.

II.5 Feasibility

So far, very few restrictions have been placed on the parameters of the model. Nevertheless, the existence of non-tradeable goods and import quotas together with the fixed capital stock in each sector do impose certain limitations on output levels. In particular, even if there was no consumption of non-tradeables or goods subject to import quotas, it is still necessary to satisfy the demand for these products derived from the exogenous component of final demand, i.e., the vector of government expenditures. Let us, therefore, explicitly write total demand as function of vector g, $q^D(g)$. Clearly, there exists a vector $\bar{g}$ such that $q_n^D(\bar{g}) = \bar{q}_n^{SD} + \bar{q}_n^{SF}$ for at least one $n \in N$. It follows that there exists no price adjustment in the economy that could satisfy a vector of government expenditures that is greater than $\bar{g}$. We must therefore define the set:

$$(14) \qquad G = \{g \mid 0 \leq g < \bar{g}\}$$

which is the set of vectors of government expenditures that will allow feasible solutions for this economy. In what follows it will be assumed that any vector g exogenously chosen belongs to set G.[1]

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1. Other CGE models that include government spending treat it analogous to consumer demand and therefore make vector g sensitive to relative prices (Dervis, et.al. (1983)). While this avoids a requirement like (14) it is not, in our opinion, a very realistic formulation. This is particularly important in LDCs, where government expenditures are a large component of final demand. Treating the government as any other consumer will overestimate the response of final demand to expenditure-switching policies and will thus underestimate the changes in relative prices required to change the structure of final demand (say from tradeable to non-tradeable goods).

II.6 Equilibrium

An equilibrium for this economy will obtain when at the price vector p^* it holds that:[1]

(15) $$q^D(p^*) - q^S(p^*) = 0$$

Inspection of the equations presented above shows that no analytical solutions can be obtained as only positive values are allowed for some vectors and certain minimum conditions must be satisfied. Furthermore, some of the functions involved are not single-valued and everywhere differentiable such that standard methods for the solution of systems of non-linear equations could not be used. Therefore, a solution algorithm was designed to solve the model.[2]

Condition (15) describes a short-run equilibrium in the goods markets. It is possible to have at these values unequal profit rates, unutilized capacity in some sectors, a trade deficit, and labor unemployment. These last two features are, obviously enough, the result of taking w and e as exogenous. Thus, it can be argued that a full-employment equilibrium with balanced trade has been eliminated by construction. While this is indeed the case, it is still true that some LDCs operate with these type of "institutional rigidities," such that the equilibrium defined in (15) is of some interest.

III. Data and Benchmark Equilibrium

The model developed in section II was applied to an economy producing 10 goods: 2 primary, 6 manufactured, and 2 non-tradeables. The source of most of

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1. An asterisk is used for equilibrium values.
2. Available from the author upon request.

the data was the Mexican System of National Accounts for 1975 (SPP, 1978). However, the parameters describing the trade regime (vectors β, τ, $\bar{d}$, t, $\bar{q}^{SF}$) were arbitrarily chosen with the purpose of reflecting the mix of trade policies commonly found in LDCs. Thus, no attempt was made to reproduce the Mexican economy in 1975 and no claim is made that the comparative static results that follow reflect the reaction of the Mexican economy to exogenous shocks.[1]

Rather, we decided to create a "stylized" economy that shared some of the features of Mexico and other semi-industrialized LDCs and use it to illustrate some numerical results that can be obtained with the model.[2]

Table 1 lists the sectors included in the model, as well as the values of the main parameters. The following observations are in order.

(i) Expenditure shares for workers and capitalists are assumed to be the same -- column (1).

(ii) The export regime grants subsidies only to manufactured goods

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1. Of course, we could have manipulated the data such that the benchmark equilibrium exactly reproduced the Mexican economy in 1975. The point, nevertheless, is that the behavioral equations underlying the model miss some critical features of this economy -- particularly the existence of price controls -- which are vital to the mechanism of relative price determination. As a result the responses to exogenous shocks that will be simulated in section IV will not be an accurate description of the way in which markets in Mexico adjust. (See Levy (1984) for an elaboration of the role of price controls in the Mexican economy).

2. To give more plausibility to the underlying numbers the model was extended to include a value added tax (with different tax rates, α_i, for each sector) and purchases of non-competitive imports by the government (denoted by the vector $g_V(s,1)$) which can be thought of as imported capital goods associated with public investment. Thus, the revenue side of the government budget consists of value added tax plus indirect taxes on trade (tariffs and subsidies) as well as direct taxes on wages, profits, and rents. The expenditure side, on the other hand, consists of purchases of goods, hiring of labor and purchases of non-competitive imports.

(considered to be "non-traditional exports")with non-uniform subsidy rates -- column (4). Export price elasticities are higher than unity in all sectors except mining and oil extraction, a primary sector where we assume the country faces an inelastic demand curve -- column (3). At the same time, we assume there exists an export quota for this sector, together with an export prohibition on food and beverages -- column (5).

(iii) With regards to imports, tariffs escalate a little. The average tariff rate on manufactures (28%) exceeds that on primary goods (21.5%) -- column (6). At the same time we also assume that non-competitive imports pay a tariff rate of 13%. On the other hand we assume imports of textiles are prohibited and that an import quota is imposed on Other Manufactured Goods. Remaining sectors are assumed to be affected only by tariffs -- column(7).

(iv) Value added tax rates vary across sectors, with the highest rate applying on Chemicals and Oil Refining -- column (9).

(v) The vectors of world prices -- column (10) -- and capacity output -- column (12) -- were manipulated such that at the benchmark equilibrium the economy operated with excess capacity in manufacturing and services and had exports of a primary good and some manufactured products.

(vi) Finally, the vectors of government expenditures (g, g_{ℓ}, g_v) were set at the levels found in the National Accounts. At the same time, the nominal wage and exchange rates were taken to be unity.

The benchmark equilibrium is described by tables 2,3, and 4. From table 2 we see that Income and Expenditure differ by .0003%, indicating that the solution algorithm is very precise. This small discrepancy is, of course, also found between the trade and fiscal deficit. With the nominal exchange rate equal to unity and no private savings or investment, these two values must be the same.

Table 3 describes the structure of the economy on the basis of some aggregate ratios, which resembles one at an advanced stage of import substitution industrialization. Tradeable output represents 55% of total output, with the manufacturing sector accounting for 40% of this figure. Shares of profits and wages in GNP are similar to those observed in Mexico in 1975. The same is true of the share of exports and imports in GNP. Non-competitive imports account for 66% of total imports, while traditional exports (mining and oil) account for 76% of total exports. Thus, this economy mostly requires imported goods for intermediate use and pays for them with an export of a primary good. Government expenditures account for 31% of GNP. With tax collections being only 25% of total income, the original equilibrium is characterized by a budget (= trade) deficit of 6% of GNP.

The equilibrium values of prices and quantities for each sector are found in table 4. In sectors 2 and 5 the equilibrium price is given by the world price (plus tariff) with imports positive but less than the QR. In sector 8, on the other hand, min $(p^m, \underline{p}) = p^m$ but since the QR is binding the equilibrium price is higher than the world price generating positive rents for importers of about 0.4% of GNP (see table 3). In the remaining tradeable sectors the equilibrium price is below the world price (plus tariff) indicating the existence of 'water in the tariff.'

Excess capacity is found in six sectors of the economy -- column (11) -- where the equilibrium price is equal to the shut-down price and hence equilibrium mark-up rates coincide with the exogenously given minimum mark-up rates. The remaining four sectors are at full capacity, with $p_i > \underline{p}_i$ and hence $\gamma_i > \underline{\gamma}_i$.

Only two sectors show positive exports in the initial equilibrium -- column (10) --. Export levels, however, are below the QRs and hence the domestic currency price received by exporters (column (4)) equals the equilibrium price (column (1)), with no rents from the export quotas. Note that with a 20% export subsidy on textiles the foreign currency price of exports (column (5)) is below the domestic price.

To sum up: the benchmark equilibrium depicts a semi-industrialized LDC with excess capacity in manufacturing and services and full capacity in the primary sectors and a key non-tradeable (electricity and transport). Manufacturing production takes place behind high tariff rates that generate water in the tariff. Exports consist mostly of primary products and imports of non-competitive goods used as intermediates and/or for investment. Given the size of government expenditures and the nominal wage and exchange rate, the economy is running a trade deficit equal to 6% of GNP.

IV. Import Quotas and the Balance of Trade

In this section we simulate the effects of QRs on competitive imports on the behavior of the balance of trade. Let E and M denote the foreign currency value of exports and imports, respectively, such that $B = M - E$ is the trade deficit $(B>0)$ or surplus $(B<0)$, and let the superscript o(1) denote the initial (new) equilibrium value of a variable. As discussed in section III, $B^o > 0$.

Assume that for some unspecified reason the trade deficit must be reduced, with QRs on imports being the tool used for this purpose. At the initial equilibrium competitive imports are given by q^{SF^o}. The effects of changing QRs on these imports can be modelled by writing the vector of import quotas as $\bar{q}^{SF} = \phi q^{SF^o}$, where $\phi \in [0,1]$ measures the proportion by which competitive imports are reduced from the original equilibrium.[1] Clearly, for any sector where $\bar{q}_i^{SF^o} > 0$ a binding import quota will be introduced (if $\phi < 1$). For given values of government expenditures, nominal wage and exchange rate we are now interested in the behavior of $B(\phi) = M(\phi) - E(\phi)$ where, by construction, $B(\phi=1) = B^o$.

Graph 3 considers the impact of this policy on various markets. In panel (a) a market for an importable with an initial equilibrium satisfying $\min(\underline{p}_i^o, p_i^m) = \underline{p}_i^o$ is depicted, with the supply curve being given by $\underline{p}^o$BCF. If the initial demand curve, q^D, was such that the equilibrium was found at E the ruling price would be p_i^m with competitive imports equal to q^{SF^o}. With an import quota equal to ϕq^{SF^o} the effective supply becomes $\underline{p}^o$BCDH, with equilibrium at G and domestic price at $p_i^1 > p_i^m$. Thus, the import reduction has a direct counterpart in a price increase. This price increase, in turn, will have immediate repercussions on costs of production in other sectors of the economy.

Of course, if the initial equilibrium had been at point A (with excess capacity AB) there would have been no direct effect either on imports or prices. Thus, it would appear that the foreign exchange savings from QRs on competitive imports are negatively correlated to the degree of excess capacity existing in the initial equilibrium.

A second possibility in markets for importables arises if $\min(\underline{p}_i^o, p^m) =$

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1. Of course we can write $\bar{q}_i^{SF} = \phi_i \cdot q_i^{SF^o}$ with $\phi_i \neq \phi_j$, i.e., a situation where selective QRs on imports are introduced. To simplify matters in the text we discuss the case where $\phi_j = \phi \; \forall_j$, although in the numerical simulations selective QRs will be considered.

p^m. In this case, depicted in panel (b), the initial supply curve is given by p^mABCD with equilibrium at E, domestic price at $\underline{p}^o$, and domestic output equal to the distance BE. Considering the quota reduction together with price changes in other sectors (such as panel (a)) that will have increased costs of production, the new supply curve is given by p^mGHIJ with equilibrium at F and price at $\underline{p}^1 > \underline{p}^o$. Interestingly, in this case the quota reduction is accompanied by an increase in domestic output (from BE to HF) and we obtain the result of an import cut together with an increase in the sector's output, price and employment.[1]

Since import quotas increase prices in some sectors there will be a spill-over effect into the market for exportables. This is shown in panel (c) with the equilibrium shifting from A to B and exports falling to d_i^1 as a result of cost increases which shift the sector's shut-down price from $\underline{p}_i^o$ to $\underline{p}_i^1$. Whether this reduces total export revenues in foreign currency will depend on the values of β_i, the price elasticities of demand for exports. For any sectors where $\beta_i > 1$, however, export quantities and export revenues will move in the same direction and will thus fall. The magnitude of the endogenously induced fall in export revenues associated with the import quotas will clearly depend on the input structure of exports. If exports are (directly or indirectly) intensive in importables subject to progressively smaller import quotas (as $\Phi \rightarrow 0$) the net effect could be a worsening of the balance of trade.

1. Note, however, that as output expands non-competitive intermediate imports required for the sector's production will also increase thus reducing the net savings of foreign exchange. Moreover, if this sector had negative value added at world prices there could be a net loss of foreign exchange as the QR is reduced!

Put differently, in a general equilibrium context one cannot establish that B will be a monotonically increasing function of Φ. Graph 4 depicts the function $B(\Phi)$ once the feedback effect of import quotas on exports is considered. As import quotas are reduced ($\Phi \to 0$) the balance of trade improves from its original position at B^o. However, for import quotas smaller than $\Phi^* \geq 0$ the loss of export revenues associated with the price increases dominates the savings from the import cut, with a worsening balance of trade. The important result that follows is that even if our only aim is to improve the trade balance the optimal import quota -- that which minimizes the value of B -- need not be zero.

Real incomes will also change as a result of the import restrictions affecting in turn consumption demand and changing the location of the demand curves in graph 3 (not shown). The direction of change in real income, however, is difficult to determine. Employment stays constant in market (a), increases in (b), and falls in (c). While the real wage rate drops, the change in total labor income will be affected also by the changes in employment and thus will depend on whether sectors that are activated by the import restrictions (panel (b)) dominate those that suffer a drop in output (panel (c)).[1]

Capitalists' income will also be affected. Note in panel (a) the creation of quota rents associated with the import restrictions (equal to area CDGJ). In panel (b), on the other hand, quota rents change from $p^m AB\underline{p}^o$ to $p^m GH\underline{p}^1$. At the same time, profits on current production increase pari passu

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1. The real wage rate is defined as w/P where P is the price level obtained from the inner product P=pf, where f is a (column) vector of weights. In the simulations this vector was made equal to η, the vector of expenditure shares (see column (1) of table 1).

with the output increase (from BE to HF). Of course, the opposite holds in the markets for exportables.

Without knowledge of the relevant parameters it appears that the only results that can be established are that QRs on competitive imports will have a positive effect on the level of prices with an ambiguous effect on the balance of trade.

Table 5 presents the results obtained from imposing QRs on competitive imports under two alternatives. In the first one (case A) import quotas are assumed to apply to all sectors while in the second one (case B) we exempt imports of sector 5, Chemicals and Oils, from any QRs. This second alternative was considered given that Chemicals and Oils -- being a key intermediate input -- turned out to play a central role in the analysis.

Consider first case A. As import quotas are reduced (with Φ going from 1 to 0) the same happens to effective supply. With aggregate demand still at its original level (given that government expenditures are constant) the result is a sharp increase in the level of prices, along with a reduction of the real wage rate. Rents on imports also increase quite substantially up to the point where $\Phi = 0$ when, of course, they are completely eliminated. Note, at the same time, a slight increase in employment. This is associated with an expansion of output in sector 8 where, as mentioned in section III, supra, $\min(p^m, \underline{p}) = p^m$ was satisfied in the original equilibrium, with imports preceding domestic supply (see table 4 and panel (b) of graph 3). As import quotas are reduced domestic output substitutes for competitive imports with a concomitant increase in employment.

The most striking result, nevertheless, is the behavior of the balance of trade. As Φ drops from 1.0 to 0.2, there is a steady improvement in the balance of trade resulting mostly from a reduction of imports. Note that exports also fall, however, given that with a constant nominal exchange rate and a higher price level the competitiveness of the economy diminishes. When Φ drops from 0.2 to 0.1, on the other hand, the balance of trade worsens. This, quite clearly, is associated with the fact that exports are reduced to zero as the price level increases substantially to accomodate the lower effective supply. Interestingly enough the trade deficit at $\Phi = 0.1$ is higher than in the original equilibrium ($\Phi=1.0$). This shows quite conclusively that import quotas can actually worsen the trade deficit.

Note, furthermore, that as QR's on imports are reduced further (with Φ going from 0.1 to 0.0) the balance of trade improves once again. This results from the fact that at $\Phi = 0.1$ exports have been already shut-out such that the only further effect is a reduction of imports. From this we can conclude that the function $B = B(\Phi)$ is not only not monotonically decreasing in Φ but might actually have more than one turning point (see graph 4).[1]

At the same time note that as $\Phi \to 0$ there is an increase in the price level with an associated decline of the real wage. The fall in the real wage, moreover, is larger than the employment increase such that real total labor income contracts. This, in turn, generates a substantial drop in real GNP (which moves in a direction opposite of total employment).

When Chemicals and Oils are excluded from the QRs the situation is quite different, however (case B). In this scenario there is a slight increase

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1. The results just obtained can, of course, be interpreted in the opposite direction. Thus, if one takes $\Phi = 0.1$ to be the benchmark equilibrium, then it follows that larger import quotas will lead to a reduction of the trade deficit.

in the price level with a concomitant decrease in the real wage. Exports, however are almost constant. Thus, the role played by sector 5 as a supplier of a key intermediate input is highlighted and points out that a policy of differentiated import quotas can be superior to that of proportional reduction in all imports. Moreover, with selective import quotas the function $B(\Phi)$ is modified, turning out to be in this case strictly decreasing in Φ. At the same time the increase in the price level (and thus fall in the real wage) is substantially mitigated, as is the fall in real GNP.

It is important to emphasize, however, that the numerical results just obtained depend critically on the characteristics of the benchmark equilibrium. Thus, for instance, if no sector satisfied $\min(\underline{p}, p^m) = p^m$ in the benchmark equilibrium, there would have been no increase in employment as $\Phi \to 0$. Or, alternatively, if the initial structure of competitive imports had been different -- say, with no imports of a key intermediate like Chemicals and Oil -- then the price increases associated with the import quotas would be smaller, reducing in run the negative feedback on exports. Thus, the behavior of $B(\Phi)$ as $\Phi \to 0$ depends critically on the structure of relative prices holding in the initial equilibrium as well as on the initial pattern of excess capacity.

It thus becomes essential for policy purposes to carefully characterize the initial equilibrium before concluding on the effects of import quotas (either selective or across the board) on the trade balance and other variables. Once QRs are modelled in a GE framework there are indeed a large number of possible outcomes and, at the present state of knowledge, there seems to be no alternative to numerically calculating their effects in the particular case for which they are being considered.

V. Summary and Conclusions

The objective of this paper was to incorporate some of the institutional rigidities observed in LDCs into a CGE model. In particular, QRs on exports and imports, the modelling of supply under excess capacity together with a fixed nominal wage and exchange rate have been the main features of the model. Furthermore, the economy has been assumed small only on the import side, such that export prices are endogenous. A distinction between traded and tradeable goods, the possibility of water in the tariff (or domestic prices higher than world prices) has been allowed for. Thus, the 'law of one price' is not imposed. Moreover, the effects of quota-derived rents on income distribution have been included.

The model was calibrated for a ten sector economy trying to reproduce a "stylized" semi-industrialized LDC. The benchmark equilibrium depicted an economy operating with full capacity in the primary sectors and a key non-tradeable (Electricity and Transport), but with excess capacity in services and manufacturing production, which takes place behind protective tariffs. At this equilibrium the economy was running a trade deficit of around 6% of GNP.

The numerical simulations were centered on the effects of changing QRs on imports. It was found that QRs on competitive imports can increase the trade deficit while lowering real GNP and the real wage rate. It was also found, however, that the results depended on whether QRs were applied on a selective or across the board basis and that with selective QRs the trade deficit could be reduced (although with a lower real wage). At the same time, it was shown that the impact of QRs was critically dependent on the characteristics of the original equilibrium (i.e., the pattern of relative prices and excess capacity ruling before QRs are changed).

The model developed here, of course, lends itself to other type of applications and has been used to analyze issues of foreign exchange rationing, export promotion as well as traditional policies like devaluations and changes in government expenditures. Moreover, the possibility of real wage rigidity has also been considered.[1]

While we hope to have made a contribution to the GE literature, more work remains to be done. In particular, in this model all commodity prices are flexible and thus the resulting solutions are always price-induced equilibriums. "Price controls", which are common in LDCs, would modify the model as prices in some sectors could not adjust to clear markets. Furthermore, price controls could introduce the need for quantity rationings as supplies are bounded from above in non-tradeable sectors (or tradeable sectors subject to import quotas). Moreover, -- and perhaps more important from an empirical point of view -- price controls would alter the government's budget constraint if, as is generally the case, it is publicly produced goods that are subject to price controls. Further research should concentrate on incorporating this important phenomenon into CGE models such that alternative scenarios can be simulated under the realistic conditions prevailing in some LDCs.

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1. The modelling of these extensions, along with numerical results, can be found in Levy (1985).

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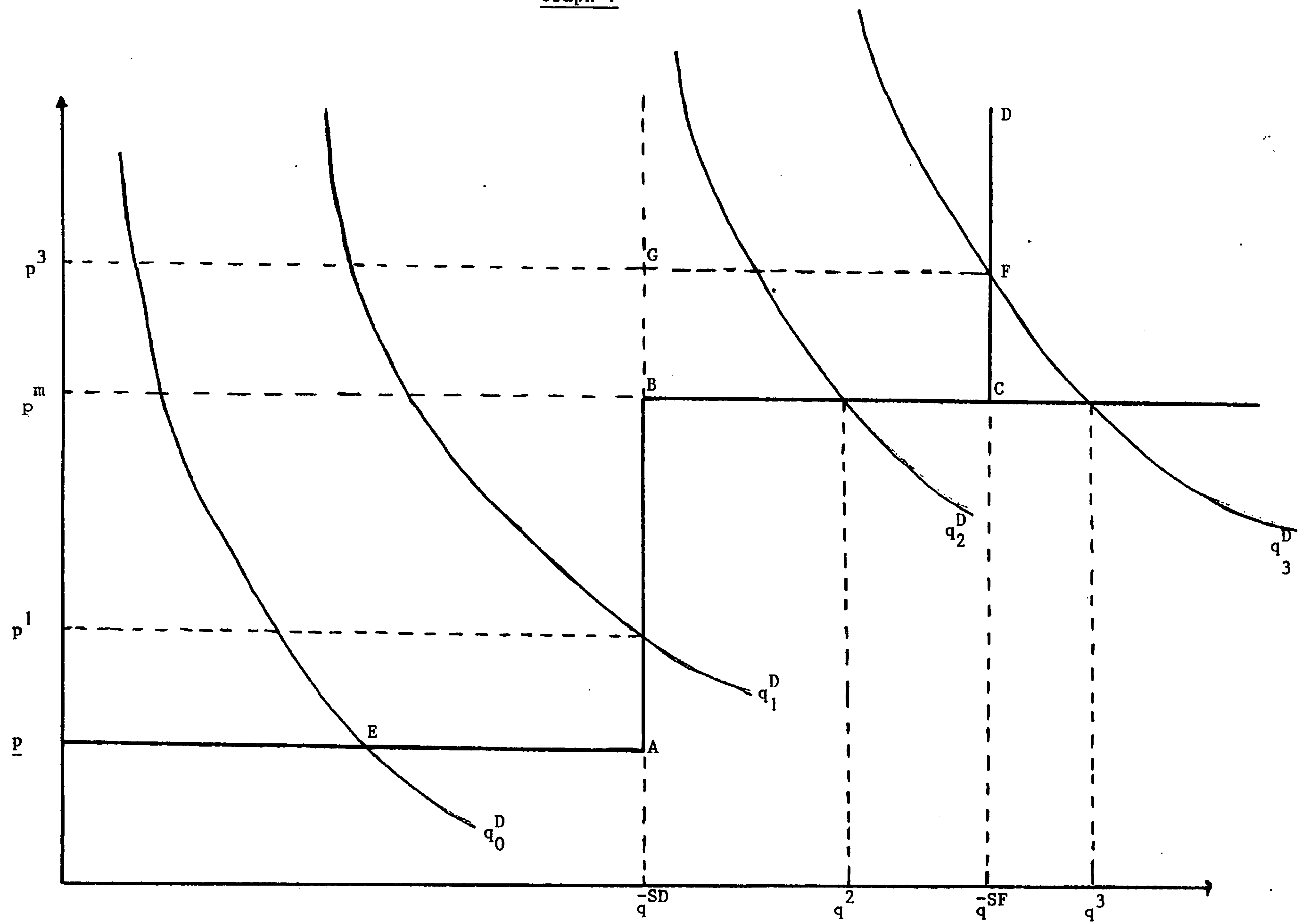
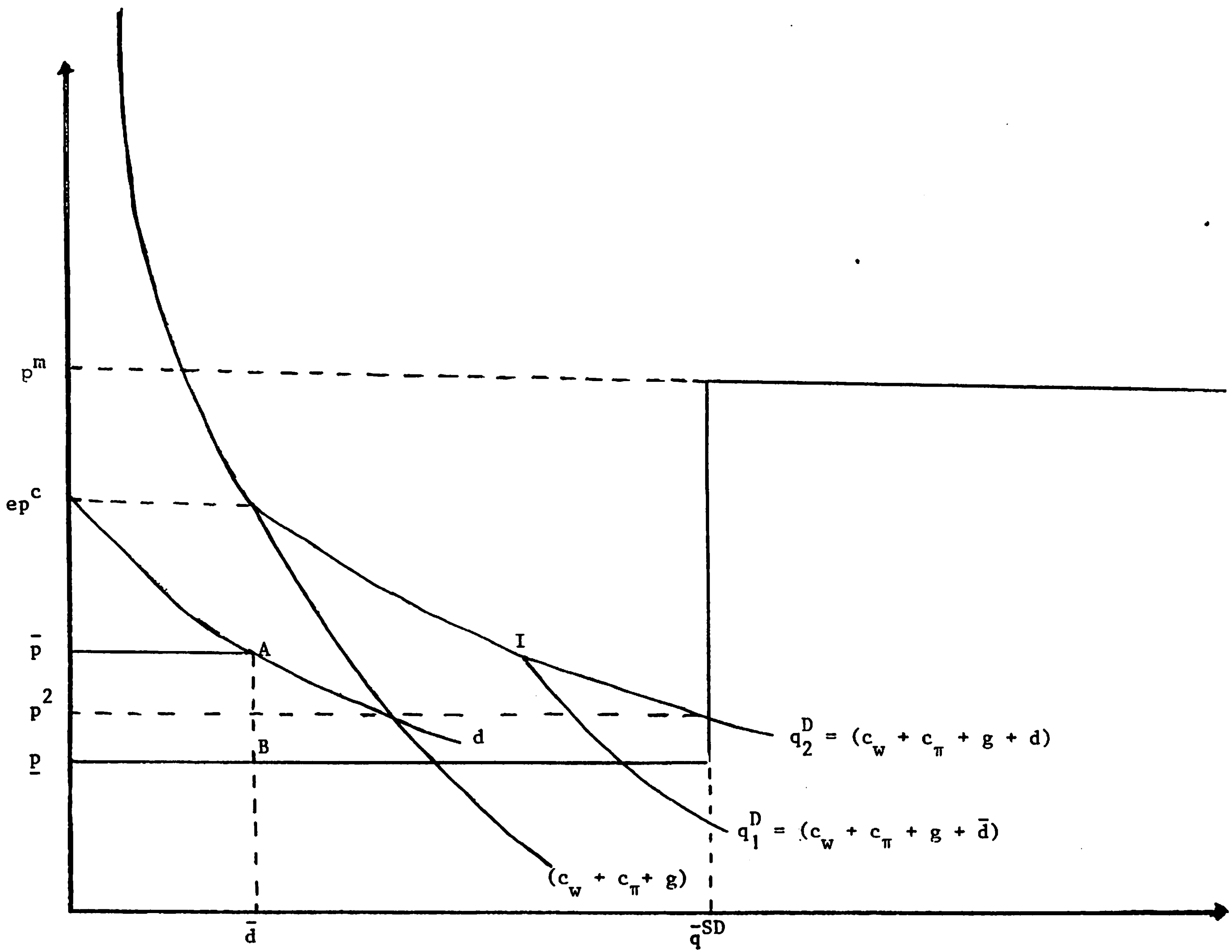
Graph 1


p^3
p^m
p^1
$\underline{p}$
G
F
D
B
C
E
A
q_0^D
q_1^D
q_2^D
q_3^D
$\bar{q}^{SD}$
q^2
$\bar{q}^{SF}$
q^3

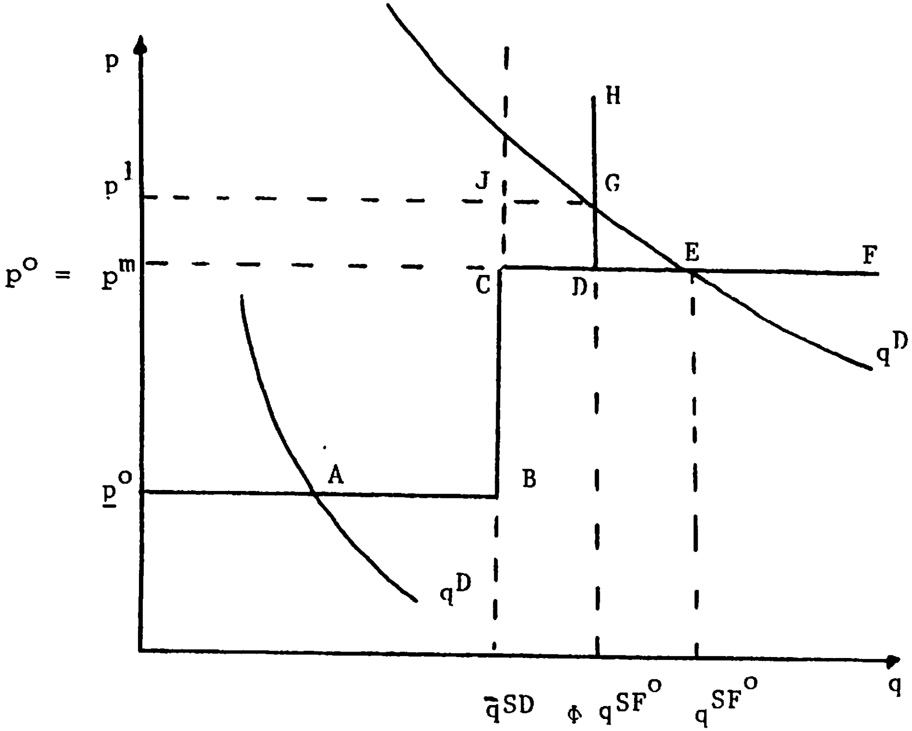
Graph 2



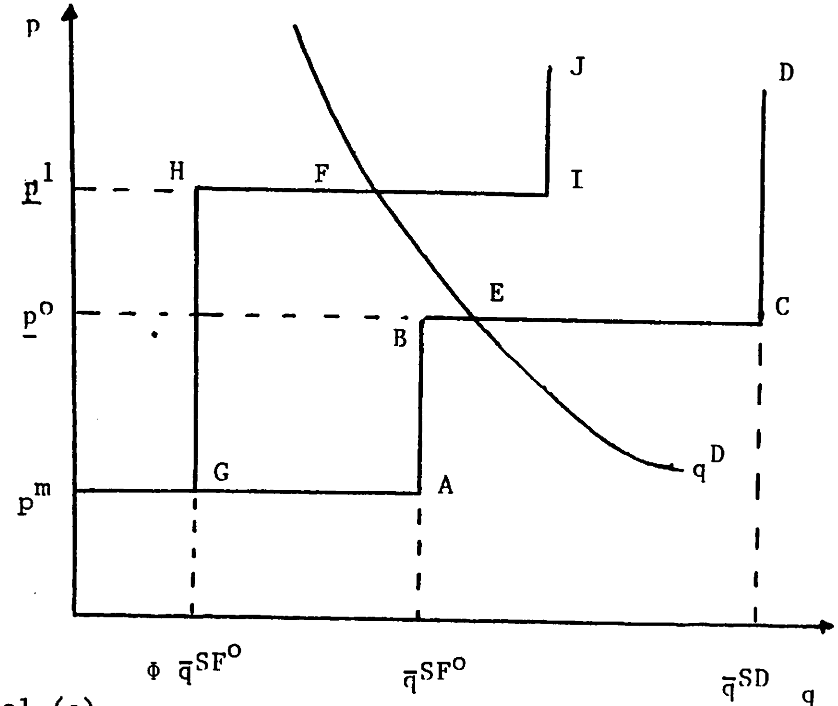
p^m
ep^c
$\bar{p}$
p^2
$\underline{p}$
A
B
I
d
$q_2^D = (c_w + c_\pi + g + d)$
$q_1^D = (c_w + c_\pi + g + \bar{d})$
$(c_w + c_\pi + g)$
$\bar{d}$
$\bar{q}^{SD}$

Graph 3

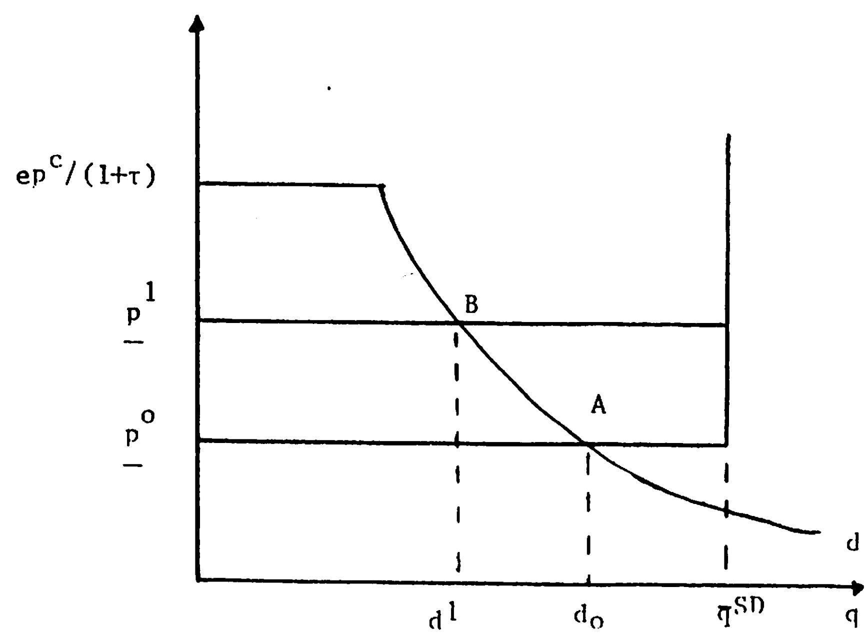
Panel (a)



Panel (b)



Panel (c)



Graph 4

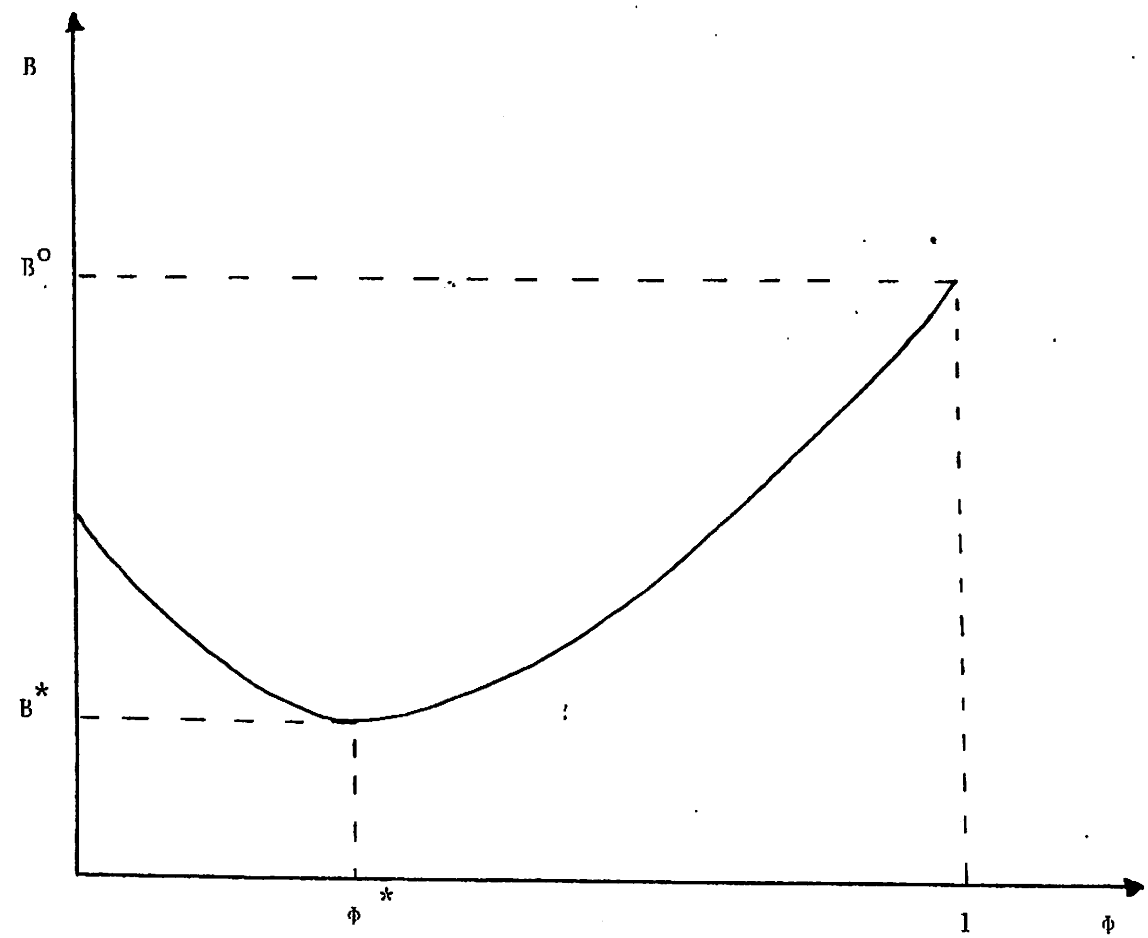


Table 1

Parameter Values for General Equilibrium Model

SECTOR / PARAMETER	(1) η	(2) ρ	(3) β	(4) τ	(5) $\bar{d}$	(6) t	(7) $\bar{q}^{SF}$	(8) $\underline{\gamma}$	(9) α	(10) p^c	(11) g	(12) $\bar{q}^{SD}$
1. Agriculture	.0780	3.2	1.5	0	*	.25	*	1.146	.055	1.0	11.2	151.3
2. Mining & Oil Extraction	.0002	17.9	0.9	0	35	.18	*	.517	.171	2.5	0.76	56.7
3. Food & Beverage	.2222	7.4	1.5	-.10	0	.25	*	.257	.154	1.0	3.00	286.6
4. Textiles	.0637	4.0	2.5	-.20	*	.25	0	.225	.107	1.45	1.99	134.9
5. Chemicals & Oil Refining	.0373	2.6	2.5	0	*	.33	*	.235	.201	1.3	15.25	91.9
6 Glass & Cement	.0041	.67	2.5	0	*	.35	*	.281	.100	.85	0.85	36.5
7. Metals & Machinery	.0362	4.05	2.5	-.10	*	.35	*	.183	.100	.85	45.4	196.0
8. Other Manufactures	.0219	1.25	2.0	-.10	*	.15	10	.239	.106	.5	3.64	72.6
9. Electricity & Transport	.0738	-	-	-	0	-	0	.325	.104	-	7.17	106.4
10. Services	.4626	-	-	-	0	-	0	.417	.135	-	226.2	1250.7

* Unbounded from above

Other parameter values: $p^{nc} = 1.1$; $g_{\ell} = 40.1$; $g_v = 27.8$; $(t_\pi \; t_w) = (.20 \; .12)$

$t_{nc} = 0.13$

Table 2

Macroeconomic Aggregates

Income Accounts

Total Wage Bill	$463.54
Total Profits	562.70
Rents on Exports	0.00
Rents on Imports	4.27
Value Added Tax	124.41
Tariffs on Competitive Imports	12.35
Tariffs on Non-Competitive Imports	6.93
(GNP) = TOTAL INCOME	$1,174.20

Expenditure Accounts

Worker's Consumption	$426.46
Capitalist's Consumption	453.58
Government Expenditures	360.55
Export Subsidies	3.32
Exports	56.55
(-) Competitive Imports	42.29
(-) Non-Competitive Imports	83.93
TOTAL EXPENDITURE	$1,174.24

Government Accounts

Government Purchases of Goods	$289.87
Government Wage Bill	40.10
Government Imports	30.58
Export Subsidies	3.32
(-) Direct Taxes	150.47
(-) Indirect Taxes	143.69
FISCAL DEFICIT	$69.71

Trade Accounts

Traditional Exports	$43.25
Non-Traditional Exports	13.30
(-) Competitive Imports	42.29
(-) Non-Competitive Imports	83.93
TRADE DEFICIT	$69.67

Table 3

Macroeconomic Ratios

1. Income Distribution

   Wages / GNP = .395
   Rents / GNP = .004
   Profits / GNP = .479
   Indirect Taxes / GNP = .122

2. Trade Accounts

   Exports / GNP = .051
   Traditional Exports / Exports = .760
   Non-Traditional Exports / Exports = .240
   Imports / GNP = .107
   Non-Competitive Imports / Imports = .660
   Competitive Imports / Imports = .340

3. Fiscal Accounts

   Government Spending / GNP = .307
   Budget Deficit / GNP = .059
   Indirect Taxes / GNP = .122
   Total Taxes / GNP = .251
   Subsidies / GNP = .003
   Direct Taxes / GNP = .128

4. Structure of Output

   Tradeable Output / Total Output = .552
   Manufacturing Output / Total Output = .402
   Primary Output / Total Output = .150
   Non-Tradeable Output / Total Output = .448

5. Structure of Employment

   Primary Employment / Total Employment = .087
   Manufacturing Employment / Total Employment = .209
   Non-Tradeable Employment / Total Employment = .618
   Government Employment / Total Employment = .086

Table 4

Sectoral Equilibrium Values

VARIABLE / SECTOR	PRICES						QUANTITIES				
	(1) p	(2) $\underline{p}$	(3) p^m	(4) $\bar{p}$	(5) $\tilde{p}$	(6) γ	(7) q^{SD}	(8) q^{SF}	(9) q^D	(10) d	(11) $\dot{q}_i^{SD}/\bar{q}_i^{SD}$
1. Agriculture	1.25	1.17	1.25	--	1.25	1.269	151.3	8.8	160.1	0	1.0
2. Mining & Oil Extraction	1.78	0.87	2.95	1.78	1.78	1.559	56.7	0	56.7	24.3	1.0
3. Food & Beverage	1.15	1.15	1.25	--	1.04	0.257	217.6	0	217.6	0	0.76
4. Textiles	1.04	1.04	1.81	1.04	0.83	0.225	106.6	0	106.6	15.9	0.79
5. Chemicals & Oil Refining	1.73	1.21	1.73	--	1.73	0.561	91.9	21.9	113.8	0	1.0
6. Glass & Cement	1.05	1.05	1.15	--	1.05	0.282	29.6	0	29.6	0	0.81
7. Metals & Machinery	1.07	1.07	1.15	--	0.96	0.183	161.2	0	161.2	0	0.82
8. Other Manufactures	1.00	1.00	0.58	--	0.90	0.239	60.5	10	70.5	0	0.69
9. Electricity & Transport	1.18	0.96	--	--	--	0.599	106.4	0	106.4	0	1.0
10. Services	0.80	0.80	--	--	--	0.417	922.8	0	922.8	0	0.74

Table 5

Impact of Import Quotas on Some Macroeconomic Aggregates

Φ	TRADE DEFICIT *		EXPORTS *		IMPORTS *		EMPLOYMENT **		REAL WAGE **		REAL GNP **		RENTS ON IMPORTS **		PRICE LEVEL **	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1.0	69.7	69.7	56.5	56.5	126.2	126.2	-	-	-	-	-	-	-	-	-	-
0.80	63.4	67.9	55.0	56.4	118.4	124.4	0.8	0.4	-6.3	-1.1	-0.3	0.0	67.4	-13.0	6.6	1.0
0.40	58.4	64.3	43.3	56.3	101.8	120.5	2.3	1.3	-39.6	-3.3	-7.3	-0.1	605.7	-48.8	65.5	3.3
0.20	48.7	62.4	44.0	56.1	92.7	118.5	2.7	1.8	-68.8	-4.5	-16.3	-0.3	483.8	-72.5	219.9	4.7
0.10	87.0	61.5	0	56.1	87.0	117.6	2.2	2.0	-91.9	-5.1	-23.7	-0.3	279.5	-85.8	1143.0	5.2
0.00	82.1	60.5	0	56.0	82.1	116.6	0.7	2.3	-95.0	-5.6	-26.4	-0.4	-100	-100	1908.9	5.8

* In foreign currency
** % Deviation from Benchmark Equilibrium (Φ = 1.0)
A = Quotas on all sectors
B = Excludes Quotas on Chemicals & Oil (Sector 5)

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