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INTERACTION BETWEEN DOMESTIC AND FOREIGN RESOURCES IN ECONOMIC GROWTH: SOME EXPERIMENTS FOR INDIA

by

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I INTRODUCTION

The purpose of this paper is to present a multi-sectoral, single period, optimising programming model that explicitly incorporates two primary bottleneck constraints on economic growth, viz., domestic savings and foreign exchange.[1] The presently available multi-sectoral models[2] introduce only the trade constraint bringing out the import-financing role of foreign capital inflow. The justification for suggesting yet another model lies in introducing the savings constraint so as to focus also on the savings-supplementing role of foreign assistance in a multi-sectoral framework.[3] It is contended that this construction is better suited to highlight the interaction between domestic and foreign resources and its effects on economic growth.

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1. A pioneering study in this area was made by Chenery and Bruno [1962] who, in an aggregated one-sector framework, formulated a single period model for Israel which introduced both these bottleneck constraints simulataneously. Our model may be regarded as a multi-sectoral generalisation of theirs.

2. See e.g., Chenery and Kretschmer [1956] Chenery and Uzawa [1958] and Bruno [1966].

3. Bruno [1966] mentions the savings constraint in his algebraic formulation but does not include it explicitly in his solutions. However, he works out the implicit savings rates in the solutions with varying capital inflow. Eckaus and Parikh [1966] add the constraint in their Guidepath II version in an intertemporal framework. Both the Bruno and the Eckaus-Parikh formulations approach the savings constraint as a lower limit on incremental consumption whereas our model imposes savings as an upper limit on investment.

The problem posed by our model is comparative static in nature. It consists of making an optimal jump from the initial conditions in the base year to the target year of the planning horizon by maximising the criterion function subject to the constraints operating on the system in the terminal year. Although inter-temporal models are decidedly superior on theoretical grounds for analysing a dynamic process of economic development, the single period analysis has been adopted in this study by considering possible trade-offs (a) between inter-temporal and inter-sectoral disaggregation with reference to computational costs, (b) between methodological refinements and data requirements; and (c) between analytical complexity and easy comprehensibility.[4]

The central problem is to assess just how important the savings constraint is likely to be in practice in developing economies to which our model is claimed to be applicable. The current view appears to suggest that domestic savings are capable of being optimally adjusted to the investment requirements if the plan is "physically, technically and organisationally feasible and makes sense on the foreign exchange side."[5] In other words, domestic savings do not impose a binding constraint to economic growth. This approach is valid so long as no conflict appears

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4. This is set out in detail in Tendulkar [1968].

5. Lewis [1962], p. 35. This view is also implicit in the multi-sectoral models cited at the beginning of this paper.

between individual preferences and social judgments of the planning authority. However, possibilities of conflict arise from sociological behavioural and institutional considerations imposing a definite upper limit on the feasible rate of savings[6] in the underdeveloped countries. In these cirumstances, the planned quantum of investment is unlikely to be materialised because of infeasibilities involved in raising the domestic resources.[7] For successful planning, an attempt has to be made to ensure a mutual consistency between the investment plan and its sectoral allocation on the one hand, and its internal and external resource requirements on the other. The model suggested in this paper is well suited for this analysis. It incorporates both the balance of trade and the savings as primary constraints. For a given availability of foreign assistance and specified institutional limits on savings rates, the model permits an empirical determination of whether the savings constraint is binding or non-binding. Whenever the savings limit is not binding we get the usually available trade-limited multi-sectoral models as a special case.[8]

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6. See Sen [1961]. For empirical evidence, a convenient reference may be made to United Nations [1967], pp. 7-50.

7. It is assumed that foreign assistance is exogenously fixed and cannot be increased. As is well known, foreign aid can act as a substitute for domestic efforts in a limited range.

8. As an alternative possibility we may consider a purely savings-limited growth process which may apply to oil-rich foreign-exchange abundant economies.

Consequently, two variants of the basic model are developed and empirically investigated with reference to India. First, an open-loop variety is considered where the domestic financing of consumption and investment are regarded as exogenous to the system and the optimisation process is carried out unconstrained by the availability of domestic resources and subject to the only primary resource of foreign exchange.[9] This gives rise to the purely trade-limited (PTL for short) growth process. In terms of policy implications, this approach assumes that the government has sufficient fiscal and monetary control over the economy so that the mobilisation of domestic savings does not pose a binding constraint. When, however, the PTL process involves raising the domestic savings well beyond the institutional and behavioural limits, the implied investment strategy is unlikely to be successful. It is in such situations where the second variant, viz., a closed-loop variety is relevant. In this case, the problem of domestic financing is made endogenous to the system through an explicit feedback link that is provided from the process of production back to the generation of incomes and in turn back to the principal components of gross domestic expenditure. The feedback link is accomplished by the introduction of the domestic savings constraint through the

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9. An "optimal growth" theorist would immediately detect that this is a comparative static analogue of the optimal savings models of the Ramsey type. In our model, foreign exchange is the primary resource whereas in the Ramsey problem, labor is the autonomous factor limiting growth.

specification of the marginal savings propensities for wage and non-wage income earners. The criterion function is optimised subject to the two primary resources of foreign exchange and domestic savings.[10] Consequently, we get simulataneous trade-and-savings limited (TSL for short) growth process.

In the standard dual gap analysis terminology[11], the PTL variant implies that the trade-gap is dominant at a given foreign aid availability so that the savings constraint becomes non-binding in character. The TSL variant, on the other hand, may be taken to represent a situation where foreign aid is insufficient to bridge even the smaller of the two gaps. This case may be quite realistic for a country like India with a large-sized population whose foreign assistance requirements may be too great to fit into the foreign aid budgets of the advanced countries. In both the variants, our model addresses itself to the problem of optimally adjusting to a given level of foreign aid. Instead of finding the foreign assistance requirements of attaining a pre-specified growth rate with a fixed output-mix on the lines of the standard two-gap analysis,[12] we allow both the output-mix and the growth rate to vary and the latter to be optimised in a multi-sectoral framework

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10. For a dynamic analogue of this variant in the optimal growth theory, see Phelps and Pollak [1968].

11. See as a basic reference, Chenery and Strout [1965, 1966].

12. i.e., "Model 1" or "Disequilibrium Model" in the Chenery - Strout paper.

so that in the optimal adjustment[13], both the constraints (viz., domestic savings and foreign exchange) may remain binding.

The next section presents the formulation of the model itself. In the discussion of the empircal results that follows, section III takes up the detailed comparison of the open and the closed-loop variants in the fifteen-year horizon, emphasizing their differential features with their implications for investment allocation. Section IV then explores the effects of varying foreign capital inflow on the two variants. The analysis concentrates on the features of domestic production and trade-structure, dynamic comparative advantage, and import-substitution, as also on the effectiveness of foreign assistance under the alternative systems. The last section attempts a brief summary of the results and makes some suggestions for improvement.

II FORMULATION OF THE MODEL AND ITS VARIANTS

We start by algebraically specifying the constraint sets appearing in the model. (The Notation is presented in the Table on page 8). Detailed comments are made on those relations which constitute a point of departure as compared to the already formulated multi-sectoral models. Other constraints are described only briefly. It may be observed at this point that all the constraints involve the flows of the endogenous and exogenous variables (denoted without and with bars) either in the final year or base year (distinguished

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13. The problem of optimal adjustment has been studied in a two-sector, inter-temporal framework by Chenery and MacEwan [1966]. See also Chenery and Strout [1965,1966], Chenery and Eckstein [1967], Cohen [1966] and McKinnon [1966], Vanek [1967] for possible adjustments in an inter-temporal consistency model at the aggregate level.

by an absence or presence of a superscript "o") of a given planning horizon. No time-subscript appears because of the single period nature of this study.

(A) $$X_i + M_i \geqq C_i + \sum_j (a_{ij}+\eta_i)X_j + \bar{G}_i + I_i + E_i \qquad i = 1,2....32$$

(B) $$C_i = \alpha_i C \text{ where } \sum_i \alpha_i = 1 \text{ and } \sum_i C_i = C$$

(C) $$I_i - \theta \sum_j k_{ij}X_j \geqq \bar{I}_i^{exo} - \theta \sum_j k_{ij}\bar{X}_j^{o} \qquad i = 1,2....5 \quad (\text{Also, } \sum_i I_i = I)$$

(D) $$\mu_i X_i - (1-\mu_i)M_i \geqq 0 \qquad i \in \text{subset of importable sectors.}$$

(E.a) $$E_i \geqq \underline{E}_i$$

(E.b) $$E_i \leqq \bar{E}_i \qquad i \in \text{Exportable sectors.}$$

(F) $$\sum_i f_i X_i + \sum_i d_i^M M_i - \sum_i d_i^E E_i \leqq \bar{F}$$

(G.a) $$\sum_j \nu_{1j}X_j - W_1 = 0$$

$$\sum_j \nu_{2j}X_j - W_2 = 0$$

(H) $$(I-\bar{I}^o) \leqq s_1(W_1-\bar{W}_1^{\,o}) + s_2(W_2-\bar{W}_2^{\,o}) + (\bar{S}_g-\bar{S}_g^{\,o}) + (\bar{S}_c-\bar{S}_c^{\,o}) + (\bar{D}-\bar{D}^o) + \gamma\,(\bar{F}-\bar{F}^o)$$

(I) $$C + I - W_1 - W_2 \leqq \bar{S}_g + \bar{S}_c + \gamma\,\bar{F} + \bar{D}$$

TABLE 1 : NOTATION

(a) Endogenous variables:

C_i	Private consumption expenditure on commodities in the ith sector.
C	Total private consumption expenditure.
X_i	Gross output level in the ith sector.
I_i	Gross fixed investment originating in the ith fixed capital producing sector.
I	Total fixed investment.
M_i	Level of competitive imports in the ith sector.
E_i	Level of exports from the ith sector.
W_1 & W_2	Levels of wage and non-wage incomes respectively generated from domestic production.

(b) Exogenous variables:

$\bar{G}_i$	Public current consumption demand on the ith sector.
$\bar{I}_i^{exo}$	Exogenous investment requirements in the ith fixed capital producing sector.
$\underline{E}_i$ & $\bar{E}_i$	Floor and ceiling requirements on exports in the ith sector.
$\bar{M}_i$	Import ceiling level in the ith sector.

TABLE 1 (continued)

Exogenous variables (continued)

$\bar{S}_g$ & $\bar{S}_g^o$	Public savings in the target and base years respectively.
$\bar{S}_c$ & $\bar{S}_c^o$	Corporate savings in the target and base years respectively.
$\bar{F}$ & $\bar{F}^o$	Maximum permissible import surpluses in the target and base years respectively.
$\bar{D}$ & $\bar{D}^o$	Depreciation provisions in the target and base years respectively.
$\bar{G}$ & $\bar{G}^o$	Total current government expenditure in the target and base years respectively.
$\bar{W}_1^o$ & $\bar{W}_2^o$	Base year levels of corresponding variables in (a).

(c) Parameters:

a_{ij}	Current input requirement from the ith sector per unit of output in the jth sector.
η_j	Inventory investment per unit of output in the jth sector.
k_{ij}	Marginal fixed capital requirement of the ith type per unit of output in the jth sector.
θ	Stock-flow conversion factor.
f_i	Non-competitive imports per unit of output in the ith sector.
d_i^M	Foreign exchange outlay per unit of imports from the ith sector.
μ_i	Proportion of imports in the ith sector in relation to total supplies in that sector.

Parameters (continued)

d_i^E	Foreign exchange earning per unit of exports from the ith sector
v_{1j} & v_{2j}	Wage and non-wage income respectively generated per unit of gross output in the jth sector.
S_1 & S_2	Marginal propensities to save out of wage and non-wage incomes respectively.
γ	Nominal rate of exchange (Rupees per dollar)

The first set of inequalities (A) describes the familiar sectoral supply-demand relationship stating that the supplies from domestic production and imports in each sector be at least as great as the aggregate demand arising from current private, public and intermediate consumption, fixed and inventory investment and export.

The relations (B) specify the composition of the private consumption basket.

The third set of relations (C) indicates that the output of the ith investment producing sector allocated for gross investment purposes be as great as that required to meet the needs of exogenous investment (for education, health etc) and of capacity creation for the production of commodities in excess of the base year level. The parameter θ describes the stock-flow conversion coefficient[14] which is a device to transform the additions to capital stock over a given horizon into the investment flow of the target year of the plan. It provides a built-in rationale for investment activity in the final year of the finite planning horizon.

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14. This has been derived under the following assumptions:
    a) The length of the planning horizon is 15 years;
    b) The average gestation lag between investment and output is two years;
    c) The gross investment grows at an exponential rate of 8.7 per cent throughout the planning horizon.

    Assumptions (b) and (c) are numerically the same as those of Manne and Rudra [1965]. For further details, see Manne [1963, 1966] and Tendulkar [1968].

The fourth set (D) incorporates the import-substitution target by stipulating that the competitive imports in a given sector be less than or equal to a pre-specified proportion (μ_i) of supplies in that sector. μ_i is regarded as a policy parameter. It may be noted that if the economy has a comparative advantage in the domestic production of the ith sector, this constraint would not be binding. If the constraint operates with a strict equality, a forced import-substitution policy would be indicated and the corresponding shadow price would provide the evidence of the cost involved in terms of the criterion function.

The constraint set (E) makes a crude attempt to introduce the rigidities and non-linearities in the export sector by imposing upper and lower bounds on the export-earnings in individual sectors. The lower limits are meant to eliminate a sharp and unrealistic drop in the export-earnings resulting from the specialisation implicit in linear models[15] whereas the upper limits are expected to reflect certain exogenous factors such as non-expanding, inelastic demand conditions, as well as quota and tariff restrictions on imports in the industrialised countries.

The next constraint (F) describes the balance of trade or the familiar "trade-gap". It states that the demand for foreign exchange from non-competitive (first term on the left) and competitive imports must not exceed the supplies from exports and the net private and public inflow of capital. This constraint is formulated in terms of foreign currency (dollars). The shadow price would give the marginal productivity of foreign aid within a given optimal structure. Alternatively, it also reflects the extent of under (over) valuation of the national currency in terms of the criterion function.

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15. See e.g. Bruno [1966].

The definitional income-generating equations are given in (G). The total net value added (after deductions are made for depreciation, undistributed profits and direct taxes) per unit of gross output in each sector is decomposed into two components: (a) wage-income plus income from self-employment in agriculture and (b) non-wage income. These sectoral incomes are aggregated to derive total wage (W_1) and non-wage (W_2) income which is connected in the next two relations to appropriate constraints.

The domestic savings constraint is described in (H). It uses the well known national accounting relationship that aggregate net investment equal domestic savings plus net foreign capital inflow. Total domestic savings are divided into three components of personal, corporate and public savings. The public and corporate parts are treated exogenously whereas personal savings are related to the wage and non-wage income. The constraint (H) is formulated as an upper limit on aggregate investment and in marginal terms with reference to the base year initial conditions. It directly gives us the familiar "savings-gap". Several advantages of this specification may be noted. In the first place, it explicitly takes into account the role of foreign aid as a supplement to domestic savings[16] in addition to its

16. The alternative formulation (see Bruno [1966], p. 331 constraints (b.4) and (h.1)) of savings constraint as an upper limit on incremental consumption does this only implicitly through the gross national product. Moreover, it has two other drawbacks. First, it does not highlight the domestic savings as a primary resource and its connection to the income generated from production. Second, the shadow price of the equation determining GNP (his equation (h.1)) creates difficulties of interpretation. Our formulation appears to be better on all the three counts.

import-financing aspect incorporated already in the trade-gap (F). Secondly, it helps reveal the interaction between the autonomous resource of foreign aid and the endogenous resource of domestic savings in bringing about the optimal solution and their oft-repeated complementary relationship. Thirdly, with its origins in the income-generation equations (G), it discloses the interdependent links between the output-mix, income creation, feasible ranges of savings and investment (consistent with the foreign aid availability) and the resulting components of gross domestic expenditure. Fourthly, by incorporating savings propensities by income-type, the income-distribution and the significance of its components in generating domestic savings have been brought into the picture. The empirical analysis also comes closer to the theoretical growth models where different savings propensities for wage and non-wage income-earners have been recognized and their effects on growth investigated. This constraint turns out to be an important point of departure in comparison with the already formulated multi-sectoral models cited in the beginning of the present paper. It may be taken to reflect the institutional, behavioral, and policy limitations on financing the additional capital formation, and its shadow price would indicate the extent of scarcity of this domestic resource.

The final constraint (I) is required to ensure consistency between income-generation and its uses. We have closed the model from the savings side in the relation (H). We have to close it also from the consumption side by establishing a definitional equality between the aggregate disposable income and consumption plus savings. Some computational difficulties, however, arise in this connection. Note that the exogenously specified $\bar{D}$, $\bar{S}_g$ and $\bar{S}_c$ (on the right-hand side of (I)) in the target year have to be fixed independently of

the related prior adjustments necessary in the sectoral gross values added per unit of output for depreciation, direct taxes, and undistributed corporate profits while deriving the disposable income components W_1 and W_2 on the left-hand side of (I). Mutual consistency between these related quantities cannot be guaranteed in advance because W_1 and W_2 are endogenously determined from the solution of the model, whereas $\bar{D}$, $\bar{S}_g$, and $\bar{S}_c$ are determined outside the system. Consequently, we have to be content with a less elegant alternative of the inequality constraint stating that private consumption plus savings be less than or equal to the aggregate disposable income generated. Whenever private consumption plus savings tend to exceed disposable income, the model adjusts the output-mix through the constraint (I) by satisfying it with a strict equality and no conceptual problem arises. When, however, it is satisfied with a strict inequality, we have to assume transfer payments (such as taxes) from within the system to the exogenous sectors. Theoretically it is uncomfortable indeed. In actual solutions, however, its nature turns out to be quantitatively unimportant in most of the cases.

This completes the description of the various components of the model. Except for the last three constraints (G), (H), and (I), the other elements of the model are on the same lines as those followed in the formulations cited at the beginning of this paper.

THE SOLUTION & TWO VARIANTS OF THE MODEL

The solution of the model consists of finding the maximum value of the aggregate private consumption, C, in the target year of the planning horizon, subject to the constraints listed above.

The open-loop or purely-trade-limited (PTL) variant concentrates only on the foreign exchange bottleneck to economic growth

and assumes that the savings constraint is made non-binding a priori by hypothesizing that the mobilization of domestic savings may be taken care of exogenously. This implies that the constraint (H) is satisfied either with a strict inequality or drops off altogether. Consequently the related constraints (G) and (I) also become redundant. In other words, the open-loop system contains the constraint sets (A) to (F) only.

The closed-loop or simultaneous savings-and-trade-limited (TSL) variant, on the other hand, explicitly introduces the feedback link between gross output and its uses through the income-generation equations (G) and the savings and closing constraints (H) and (I). As a result, the optimization problem incorporates all the constraint sets (A) to (I).

III COMPARISON OF CLOSED & OPEN-LOOP VERSIONS ON THE FIFTEEN YEAR HORIZON

The two variants of the model discussed in the last section are empirically investigated in a 32-sectoral breakdown for the Indian economy with a fifteen year planning horizon starting from the base year 1960-61 and ending with 1975-76. This section seeks to bring out the structural differences between the open-loop and the closed-loop versions and their policy implications.

The reference point of net foreign aid has been fixed at $0.50 billion in the target year 1975-76 for both the versions. It conforms closely to that projected by the Perspective Planning Division [1966]. This was done in order to keep some contact with the official thinking and explore its implications. With the same purpose, projections of government and corporate savings were taken from the Perspective Planning Division [1964].[17] (See Appendix, Table I). Coming to the component of personal savings two parameters require specification viz. the marginal savings propensity for (i) wage-income plus income from self-employment in agriculture, and (ii) residual non-wage income. (These two

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17. The outbreak of war with Pakistan in late 1965, the two successive droughts of 1965-66 and 1966-67, the subsequent recession and the postponement of the starting date of the fourth Five Year Plan from April 1966 to April 1969 have made these projections obsolete and also make impossible the comparison of our results with the official targets. For these reasons and others connected with weaknesses in data, the present calculations are regarded as experimental in character. They do, however, serve to highlight the differential policy implications of the two variants of the basic model suggested in this paper.

propensities are denoted respectively by s_1 and s_2). Following Houthakker [1965] we adopted $s_1 = 0.05$ and $s_2 = 0.45$. With these particulars, the two Reference Solutions we investigate in detail in this section may be conveniently summarised with reference to primary resources as follows:

	FIFTEEN YEAR HORIZON
OPEN-LOOP OR PTL VARIANT	F = \$0.50 billion No Savings limitation
CLOSED-LOOP OR TSL VARIANT	F = \$0.50 billion $s_1 = 0.05$, $s_2 = 0.45$

The discussion of the Reference Solutions starts with the salient features of the macroeconomic results followed by the detailed analysis of primary resource productivities, the trade-structure, the structure of the domestic output-mix and the allocation of investment.

A. Macroeconomic Results:

The optimal level of aggregate private consumption of Rs. 32,485 crores (See Appendix B, Table II which summarises the relevant macroeconomic results), in the open-loop Reference Solution turns out to be 7 per cent higher than the corresponding projected value for 1975-76 worked out by Srinivasan, Saluja and Sabherwal [1965] in collaboration with the Perspective Planning Division.

When the savings constraint is introduced in a closed-loop framework (for the same level of foreign assistance as in the open-loop solution), the immediate impact is reflected in a decline in the average rate of growth of private consumption from 6.5% to 4.5% per annum and that of gross national product from 8.2% to 6.2% per annum in comparison with the open-loop solution.

This sharp reduction is brought about by a limited availability of domestic savings curtailing the gross capital formation over the 15 year planning horizon[18] from 109 thousand crores in the open-loop version to 71 thousand crores, or by about 35 per cent. Not only is there a severe cutback in the gross capital formation, but the importance of new capacity creation in the aggregate investment is also reduced. This is indicated by a fall in the ratio of induced fixed investment to aggregate gross investment[19] in the target year from 67% in the PTL version to 57% in the TSL system.

The sectoral output-mix is adjusted in such a way as to produce a somewhat higher aggregate gross incremental capital-output ratio[20] (ICOR for short) at 3.4 in a closed-loop system as against 3.0 in the open-loop solution. On the other hand, the ratio of aggregate gross investment to gross national product in the target year is lower at 25.6% in the closed-loop model in relation to 28.3% in the open-loop variant. It thus transpires through the Harrod-Domar mechanism that the lower growth rate in

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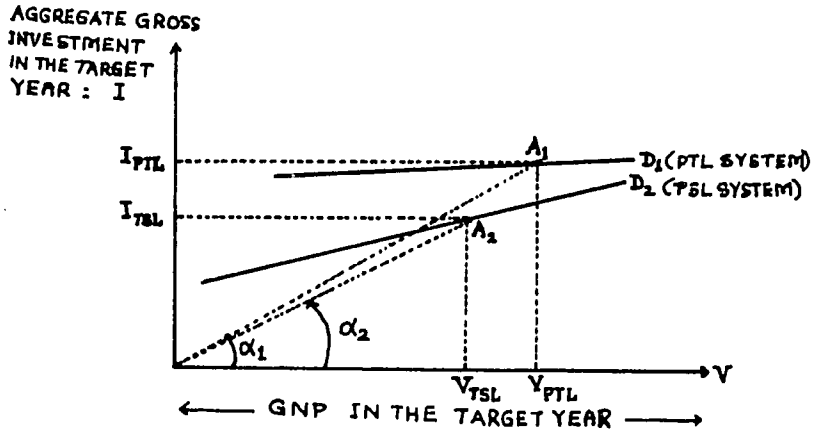
18. The gross capital formation over a given planning horizon is obtained by dividing the target year levels of gross induced fixed investment (with a gestation lag of 2 years) and inventory plus exogenous investment (with no lags) by appropriate stock-flow conversion factors and adding them together.

19. The difference between the quantities in the denominator and numerator of this ratio is accounted by inventory plus exogenous investment components.

20. This is given by a ratio of gross capital formation over a planning horizon (see footnote 16) to the incremental gross national product in the target year.

the closed-loop system has resulted from both the reduction in the proportion of gross national product diverted to gross investment and the rise in the aggregate ICOR. This, in turn, can be shown to be a consequence of a shift in the underlying curves relating investment and GNP. The shift factor, in its turn, can be traced to the non-binding or binding nature of the institutional savings constraint in passing from one version to another. The intuitive explanation may be facilitated by the accompanying diagram



It describes the relationship between aggregate gross investment (I) and GNP (V) in the target year of the planning horizon under the two systems for varying levels of the autonomous resource of foreign assistance. The linear form is postulated for convenience D_1 represents the relationship under the PTL system with the assumption of non-scarcity of domestic resources, the only limit to growth being varying availabilities of foreign assistance. When, however, there are institutional and behavioural limits on raising the domestic resources, this constraint puts an upper bound on feasible levels of gross investment by introducing a

downward shift in the curve to D_2 appropriate to the closed-loop system.[21] Consequently, the optimal equilibrium shifts from A_1 to A_2 in I-V plane in going from the PTL to the TSL system. Notice that in the absence of the shift factor in the form of endogenous personal savings limit, the target year ratio of gross investment to GNP would increase at a lower level of GNP in the savings constrained solution.

Let us now turn to the investigation of domestic resources. Only the personal savings component is endogenous to the model. Other sources of savings have been treated as exogenous. In the closed-loop solution, we directly get the aggregate personal savings consistent with the trade and the savings constraints.

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21. The construction of the curves implies that the same level of GNP can be produced by a lower level of gross investment in the TSL system than in the PTL system. Strange though this result may appear prima facie, it can be explained in the following manner. Whenever the savings constraint is binding, the same level of GNP as in the open-loop system is possible only through higher availabilities of foreign aid which also contributes towards lowering the aggregate gross ICOR by enabling higher imports of formerly domestically produced capital-intensive commodities. These two factors together enable the closed-loop system to reach the same level of GNP which the open-loop system produces with higher gross-investment but lower supplies of foreign assistance. Two more brief observations may be made about the nature of these curves. First, the flatter shape of D_1 relative to D_2 is warranted by the investment being at the domestic resource-saturation level in the open-loop system. Additional foreign assistance may not be expected to add as much to gross investment as to consumption. Second, since foreign exchange is the primary limit to growth and the only one operating in the PTL system, D_1 would always lie above or at the same level as D_2 where savings are an additional limiting factor to growth. These hypotheses will be verified in the next section where we trace the shape of these curves empirically by varying foreign capital inflow.

In the open-loop solution we can compute the comparable implied personal savings (S_i) by the following formula in the notation of Section II:

$$S_i = I - \bar{S}_g - \bar{S}_c - \gamma\bar{F} - \bar{D}$$

as a difference between gross investment and exogenous components of savings plus replacement requirements. It is assumed that the investment program is carried out by sacrificing consumption. It is instructive to compare the relevant savings ratios in the alternative systems. This is presented in the following table.

PERSONAL SAVINGS-RATIOS & THEIR CONTRIBUTION TO GROSS INVESTMENT : REFERENCE SOLUTIONS

	Open-Loop System	Closed-Loop System
1) Target year personal savings-Ratio (S/W)	23.09	15.28
2) Marginal Personal Savings-Ratio ($\Delta S/\Delta W$)	31.33	20.73
3) Ratio of Personal Savings to Gross Investment (S/I)	62.27	44.25

The comparison between the ratios in the alternative systems at once indicates the nature of the conflict between the social judgment of the planning authority (given by the open-loop solution) and the private preferences of the population consistent with the savings propensities and shown in the closed-loop solution. It is also interesting to note that personal savings are expected to contribute as high as 62% of the aggregate gross investment in the target year in the open-loop system whereas they do so only up to 44% in a closed-loop solution optimal with respect to both foreign assistance and domestic savings.

B. Productivity of Foreign Assistance and Domestic Savings:

Having examined the quantity solutions in the form of macro-economic results, it is appropriate to turn to the price-solutions and the important question of assessing the relative effectiveness of the primary resources under the two systems we have been considering.

Taking up the balance of trade constraint[22] first, its shadow price indicates the marginal addition to the criterion function resulting from an additional unit of foreign exchange. Notice that there are two ways of earning a unit of foreign exchange, viz., (a) through foreign assistance and (b) through an expansion of exports. In the present context, the essential difference between them is that the former acts as a supplement as much to the domestic savings (constraint (H) in Section II) as to the availability of foreign exchange, whereas the latter adds only to the supply of foreign exchange. Both are equivalent in the open-loop system since the savings-constraint remains non-binding. In the closed-loop system, however, the shadow price of the balance of trade constraint (P_f) being derived on the assumption of holding all other constraints unchanged, would indicate the productivity of foreign exchange through an expansion of exports. The marginal productivity of foreign assistance (P_F) under the closed-loop conditions is given by a sum of the shadow prices of savings (P_S) and balance of trade (P_f) constraints.

On <u>a priori</u> grounds, the marginal productivity of foreign exchange through export expansion may be expected to be higher in the open-loop system where it is the only primary bottleneck to growth than in the case of a closed-loop solution where a limited availability of domestic savings, by restricting the feasible level of gross investment and hence the rate of growth of economic

22. i.e., constraint (H) in Section II

activity introduces a downward shift in the demand for and consequently in the marginal productivity of foreign exchange earning through export expansion.[23] This can be verified from our Refere Solutions (see Appendix B, Table II) by observing that the shadow price of the balance of trade constraint (P_f) turns out to be very high at Rs. 23.64 per dollar in the open-loop system and declines by about 58% to Rs. 10.00 per dollar in the closed-loop framework. Thus, the capacity to earn foreign exchange through export expansi is adversely affected whenever a domestic resource bottleneck is experienced.

Coming next to the domestic savings constraint[24], its shadow price (P_S) reveals how scarce the domestic resources are - both endogenously generated personal savings and exogenous components of government and corporate savings. The marginal productivity of domestic savings is zero under the assumptions of the open-loop system. For the closed-loop system, Table II (Appendix B) shows that a Rupee worth of domestic savings adds 3.6 times its value to the criterion function.

Since the marginal productivity of foreign assistance (P_F) is given by

$$P_F = P_f + P_S$$

we can now get the idea of its relative magnitudes in the two systems. Converting P_f at the nominal rate of exchange, we find that a Rupee worth of foreign aid makes a marginal contribution of Rs. 3.14 in the open-loop system and of Rs. 4.93 in the closed-loop framework. The dual role of an additional unit of foreign capital inflow in the TSL version may thus be seen to make larger absolute additions to the criterion function than in

23. This follows from Le Chetalier principle. See Samuelson [1947], pp. 36-39.

24. i.e., Constraint (H) in Section II.

the case of the PTL variant when the level of foreign assistance remains the same under both the systems.

C. Trade Structure, Comparative Advantage, and Import Substitution:

We have studied in the last two sub-sections the basic features of the open-loop and the closed-loop Reference Solutions connected with macroeconomic aggregates and resource productivities It is relevant now to carry the analysis to the disaggregated sectoral level. Since foreign exchange, being the primary bottleneck to growth, governs the composition of the domestic output-mix through the trade-structure, it is necessary to investigate the pattern of the trade-structure and how it is affected by the saving limitation in the closed-loop in comparison with the open-loop system. This would naturally pave the way to the examination, in the next sub-section, of how the optimal adjustment in the domestic output-mix and investment allocation work out at a disaggregated level.

The trade-structure in the optimal models is determined by the principle of comparative costs. A tradeable sector is importable if the unit domestic cost at the margin exceeds c.i.f. foreign exchange outlay on imports and exportable if the unit domestic cost at the margin is less than f.o.b. export price in the international market.

The basic cost elements in the trade-constrained open-loop system consist of direct and indirect current outlays on fixed capital requirements and direct and indirect foreign exchange costs necessitated by imported inputs. Since the system is domestic resource-saturated, the cost of investment turns out to be equal to that of sectoral domestic production.

The joint scarcity of foreign exchange and domestic savings is the major determinant of the comparative cost-structure in a closed-loop system. The non-zero scarcity price of domestic savings has two-fold consequences. First, the system now differentiates between a unit of output going into investment and non-investment uses. The former use has a higher cost associated with it because investment involves raising the scarce domestic resources. Second, current primary factor payments enter the system as ligitimate cost elements and are determined by the capacity of various sectors to contribute to the endogenous resource of personal savings.[25]

The criteria outlined above for both the systems are subject to modifications introduced by import-restrictions and export-ceiling constraints.

Having presented the general principles determining the trade-structure, we may examine how they operate empirically by starting with the import-structure in the two systems. It is summarized in the table on the following page. Since sectoral direct and indirect fixed capital requirements form a major cost element in both the systems, they are presented in the table along with the ranking of sectors resulting from them.

It may be noted that the aggregate import outlays did not change significantly in the two versions. With net foreign capital inflow remaining fixed, it immediately implies virtual invariance of the export-structure to the savings limitation to which we turn shortly.

An obvious inference from the open-loop import-structure is that it is not entirely governed by the domestic fixed capital costs.

25. An interested reader may easily confirm these statements by analyzing the dual to the two systems presented in Section II.

IMPORT-STRUCTURE IN THE REFERENCE SOLUTIONS
[Rupees Crores Unless Otherwise Indicated]

Competitive Imports Sector:	Unit Fixed Capital Costs (Direct & Ind.)	Rank	Open-Loop System Imports	Open-Loop System % Distb'n	Closed-Loop System Imports	Closed-Loop System % Distb'n
4	2.23	8	409	25.00	---	---
6	4.86	3	---	-----	339	33.25
9	6.90	2	332	35.98	488	26.99
15	2.06	9	---	-----	242	15.44
19	4.01	4	---	-----	85	19.51
23	2.35	6	190	17.48	---	-----
24	7.57	1	240	6.27	179	1.55
25	2.27	7	19	13.21	---	-----
26	3.31	5	40	1.70	23	3.26
TOTAL			1,230	100.00	1,762	100.00
NON-COMPETITIVE IMPORTS			536	-----	426	-----
TOTAL IMPORT OUTLAY			1,766	-----	1,762	-----

The other cost-element of non-competitive import outlays and import-restrictions play a predominant role. This is not surprising in view of a very high accounting price of foreign exchange in the open-loop system. This phenomenon explains why Transport Equipment (4), Petroleum Products (23), and Rubber Products (25) with relatively low domestic fixed capital-costs but higher foreign exchange input costs are imported, whereas the high capital-cost outputs like Iron and Steel (6) and Chemical Fertilizers (19) are domestically produced.

In contrast to the open-loop system, the additional domestic resource-costs involved in the closed-loop system combined with a lower accounting price of foreign exchange (resulting from a downward shift in its demand curve because of the savings limitation) restore the ranking of comparative advantage consistent with the domestic (direct and indirect) unit fixed capital costs. It is interesting to note that in this case, competitive imports take place in industries with the six largest fixed capital cost elements. The import activity in Foodgrains (15) with the lowest domestic capital requirements enters the structure because it is intensive in Chemical Fertilizers (19), whose cost is high due to import-restrictions. We come to the nature and importance of these restrictions shortly.

In order to reflect the import-substitution drive, we constrained the competitive imports in Iron and Steel (6) as well as in Chemical Fertilizers (19) to be less than or equal to 15% of the total supplies in each sector. It is instructive to observe that these import-restrictions are not binding in the open-loop system, whereas they do so in the closed-loop variant. This means that the average annual growth rates of domestic output of 18% and 27%, respectively, for Iron and Steel and Chemical Fertilizers (see Table IV, Appendix B) in the open-loop variant reflect the efficient working of comparative advantage, whereas the growth rates of 14% and 22% for the same two sectors in the closed-loop system highlight the effects of the forced import-substitution strategy. In order to assess the cost of import-substitution, the closed-loop Reference Solution was re-computed after removing import-restrictions in Sectors 6 and 19. The new solution indicated the optimal level of consumption in the target year to be Rs. 24,547 crores or a little over one per cent higher than the level reached in the Reference Solution. The

relative magnitude of the cost does not appear to be quantitatively significant.[26]

The final feature of the trade-structure relates to exports. As we have observed in Section II, we have imposed upper limits on export-expansion to take into account exogenous limitations on demand. In certain traditional exporting sectors like Iron Ore (7), Plantations (11), Cotton and Other Textiles (16), and Jute Textiles (17), we also added lower limits to avoid an unrealistically sharp drop in export-earnings possible in linear models. Since foreign exchange is a primary bottleneck to growth under both the systems, export-expansion, in general, would always remain profitable. However, in view of a downward shift in the demand for foreign exchange in the closed-loop variant as compared to the open-loop system, we may expect some reshuffling in the composition of exports at a disaggregated level. From Table III in Appendix B, we observe that in passing from the open-loop to the closed-loop version, the exports of Iron Ore (7) have been reduced to the lower limit, those in Cement (8) and Coal (30) disappear, whereas Transport Equipment (4) emerges from being an importable sector to an exportable one. The quantitative significance of these shifts is quite small. The upper limits on exports are binding in all the other exporting sectors--traditional as well as non-traditional, and in both the versions. The importance of the limitations on export-expansion highlights a realistic though

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26. The new solution brings about an increase in consumption by lowering competitive imports of Iron and Steel (6) and expanding them in Chemical Fertilizers (19) whose domestic production turns out to be inefficient. This makes profitable the fertilizer intensive process of Foodgrains (15), thereby eliminating competitive imports in that sector altogether. This produces the import structure strictly according to the direct and indirect fixed capital requirements.

disturbing phenomenon faced by most of the underdeveloped countries.[27]

D. Sectoral Gross Outputs and Allocation of Resources:

The trade-structure, which was analyzed in the last subsection with reference to its composition and forces operating on it, in turn, determines the structure of the domestic output-mix to which we turn presently.

Table III in the Appendix B presents in detail, the sectoral gross output levels, the corresponding demands on the investment goods producing sectors for induced fixed investment along with the international trade-structure emerging from the Reference Solutions. From this, we have worked out the average annual compound rates of growth of sectoral gross outputs which are given in Table IV (Appendix B), whereas Chart I provides a visual description in the form of a scatter diagram.

The dotted line through origin indicates the effect of the savings constraint on the aggregate growth rate of GNP. For a given level of foreign capital-inflow, the PTL or the domestic-resource-saturated variant gives the upper limit to growth, consistent with the technology complex available to the economy. When this requires raising the domestic resources beyond feasible limits, the growth is constrained both by domestic and external resources. This results in a reduction in the over-all growth rate, thereby pushing the dotted line away to the left of the 45° line, the exact location being determined by the availability of exogenous and endogenous domestic savings. This ray of aggregate growth rate may be taken to serve as a standard of comparison in examining the disaggregated balanced adjustment of the output-mix to the twin primary resources of savings and

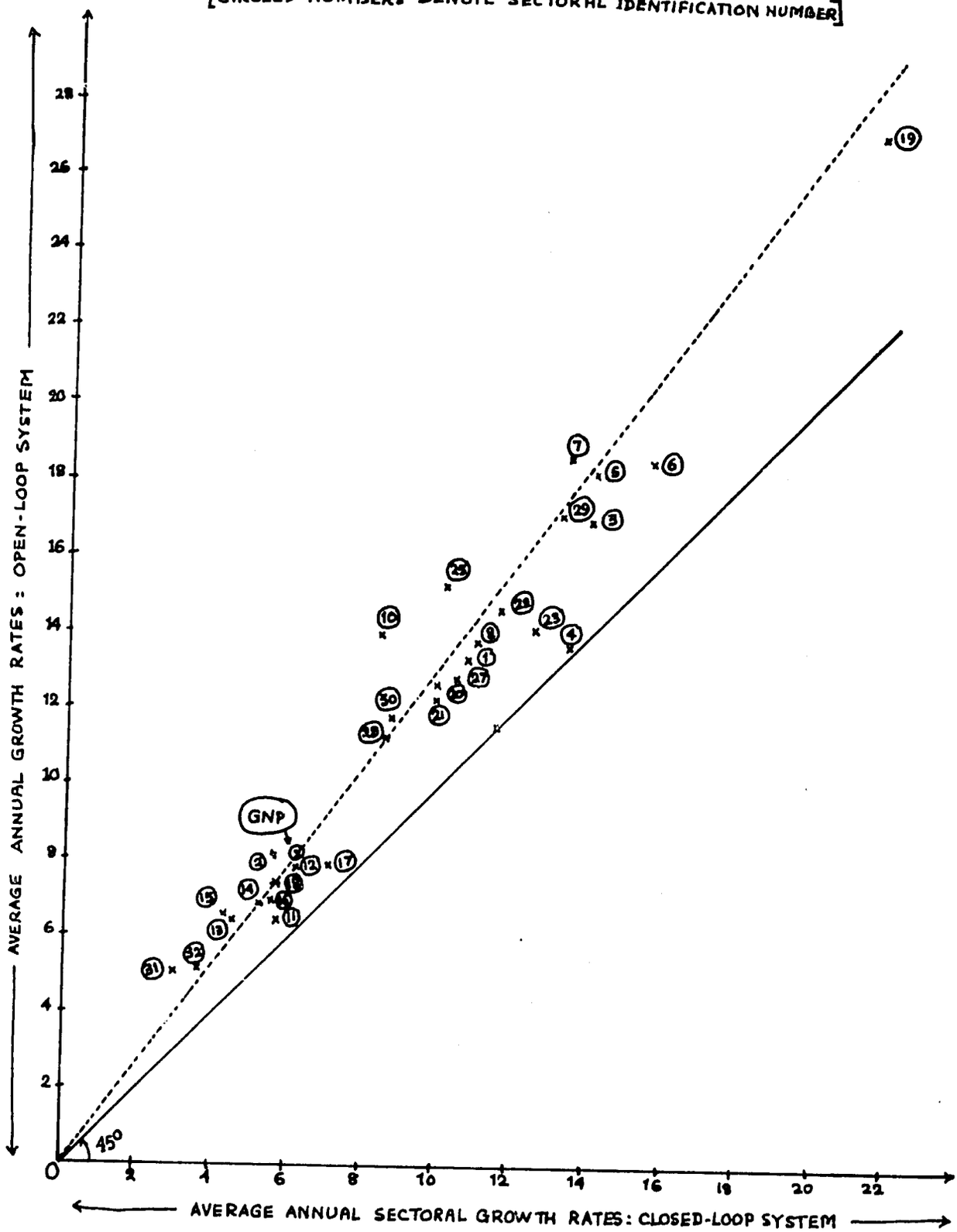
---

27. See, e.g. Lewis [1962], pp. 38-45 and 233-47; Vanek [1967], pp. 119-24.

CHART I

SCATTER DIAGRAM OF AVERAGE ANNUAL SECTORAL GROWTH RATES IN THE REFERENCE SOLUTIONS

[CIRCLED NUMBERS DENOTE SECTORAL IDENTIFICATION NUMBER]



foreign aid in relation to that under the trade constraint only.

A careful scrutiny of the chart brings out the following broad conclusions.

In the first place, almost all the sectoral outputs adjust at a lower level of activity. It is in judging the extent of this decline that the ray of over-all growth rate helps considerably. The structure of adjustment is governed by the changes in the pattern of final demand components viz., private and government consumption, imports and exports along with the inter-industry use and investment requirements induced by them.

The two exportable sectors of Jute Textiles (17) and Plantation (11) whose domestic output level is sustained by the export requirements are seen to be near the 45° line, indicating that their growth rate is insensitive to the savings limitation. Belonging to the same category is the investment-goods sector of Transport Equipment (4). At a high level of economic activity in the open-loop system, the domestic output of Transport Equipment is limited by imports which provide 23% of the total supplies. The domestic demand for this sector drops in the closed-loop system, but the domestic output stays practically at the same level as in the PTL system because of the elimination of competitive imports and the sector turning into an exportable one.

The second broad group consists of agriculture and related industries (sectors 2 and 12 to 18 except 17) and service industries (31 and 32) clustering near or towards the origin from the GNP point on the ray. They occupy 92% of the total weight in the final consumption basket.

To the third broad group belong the remaining industries covering large-scale manufacturing, mining, and metals with growth

rates exceeding the over-all level. The outputs of the non-traded sectors of the sources of power (viz., Electricity (29)and Coal (30)) as well as the social overheads (viz., Road and Rail Transport (22) and (28)), move in line with the over-all growth rates as these industries lie very near the ray of aggregate growth. The rates of domestic production in Iron Ore (7), Other Metals (10), and Rubber Products (25) are fairly sensitive to the demand pattern arising from the savings limitation, as they are located above the ray of over-all growth. On the other hand, the capital-goods producing sectors of Electrical Equipment (3), Non-Electrical Equipment (5), and Iron and Steel (6), as also Chemical Fertilizers (19), Petroleum Products (23), and Chemicals (27) sustain their growth rates showing less than proportionate decline in relation to the over-all growth rate. Of these, the former group of three industries provides indispensable inputs for new capacity creation in all the sectors, whereas the latter group of three is an interrelated one, mainly supplying inputs to agriculture which, in turn, possesses a considerable weight in domestic demand as well as in exports.

Having examined how the target-year level of output-mix is optimally adjusted in response to the two gaps of savings and foreign exchange, the next related question concerns its implications for the allocation of investment. This problem has two aspects, viz.:

(a) Decision regarding the aggregate magnitude of investment;

(b) The sectoral allocation of the aggregate;

both of which are endogenously determined in our model for both the variants. Table V in Appendix B presents the relevant details for the Reference Solutions.

Given the specified marginal savings propensities (s_1 = 0.05

and s_2 = 0.45), exogenous savings (see Table I, Appendix B), and foreign assistance ($0.5 billion), the closed-loop system can be seen to sustain a level of induced investment about 40% lower than that indicated by the purely-trade-limited version over a fifteen-year planning horizon. This clearly shows the magnitude of a required shortfall in planned investment while optimally adjusting to the institutional and behavioral limitations on raising the domestic resources.

Coming to the sectoral allocation of investment, it is governed by the capital intensity (determining the comparative advantage) and the scale of output emerging from the changes in the pattern of final demand while moving from the open-loop to the closed-loop system. Table V in the Appendix B presents the detailed results. It appears (from columns (2) and (4)) that the relative importance of various sectors within each system tends to remain broadly unchanged between the two versions. However, the order of absolute shortfall in the allocation to various sectors in the TS vis-a-vis the PTL system (shown in column (5)) reveals considerable inter-sectoral differences as also deviations in relation to the over-all reduction in the aggregate gross investment. Compared to a 40% decline in the aggregate capital formation over the planning period, six out of thirty-two sectors undergo a reduction in the sectoral level of induced investment between 40% and 50%, whereas another set of fourteen industries shows a decrease ranging between 30% and 40%. Together, these twenty sectors cover agricultural and related industries along with those supplying investment goods, power, and transport. The remaining industries outside this range are either export-oriented or those with low fixed capital requirements combined with a decline in final demand less than proportionate to a fall in the over-all growth rate.

IV IMPLICATIONS OF VARIATIONS IN FOREIGN ASSISTANCE

The last section concentrated on bringing out detailed structural differences between the open-loop and the closed-loop system for the two Reference Solutions. This section seeks to explore the differential response mechanisms of the systems to variations in foreign assistance. Every change in the optimal combination of domestic and foreign trade activities may be regarded as a structural change emerging at that particular level of net foreign capital inflow. We would thus be tracing successive structural adjustments in the two systems. The analysis is confined only to the aggregate level. The macroeconomic results for the two systems are presented in Tables VI and VII, whereas the analysis of savings in the open-loop solutions appears in Table VIII in Appendix B.

It may be appropriate to start the discussion by tracing the nature of relationships between the aggregate target year variables like gross investment, personal consumption, and savings on the one hand and the aggregate GNP on the other. They would provide an over-all picture of the differences between the structural adjustments in the two systems. Figures I and II present the relevant curves for the two systems with the level of foreign assistance indicated at each point. Their examination discloses the following broad features.

The aggregate private consumption curve in the open-loop system is steeper than that for the closed-loop system for a given level of foreign capital inflow as also for a given level of GNP. This implies that foreign aid increases private consumption faster in the PTL version than in the TSL variant. The PTL system, with the non-scarcity of domestic resources, reacts to additional foreign capital inflow by adding maximally to consumption more than to investment. The situation is reversed in the savings-limited

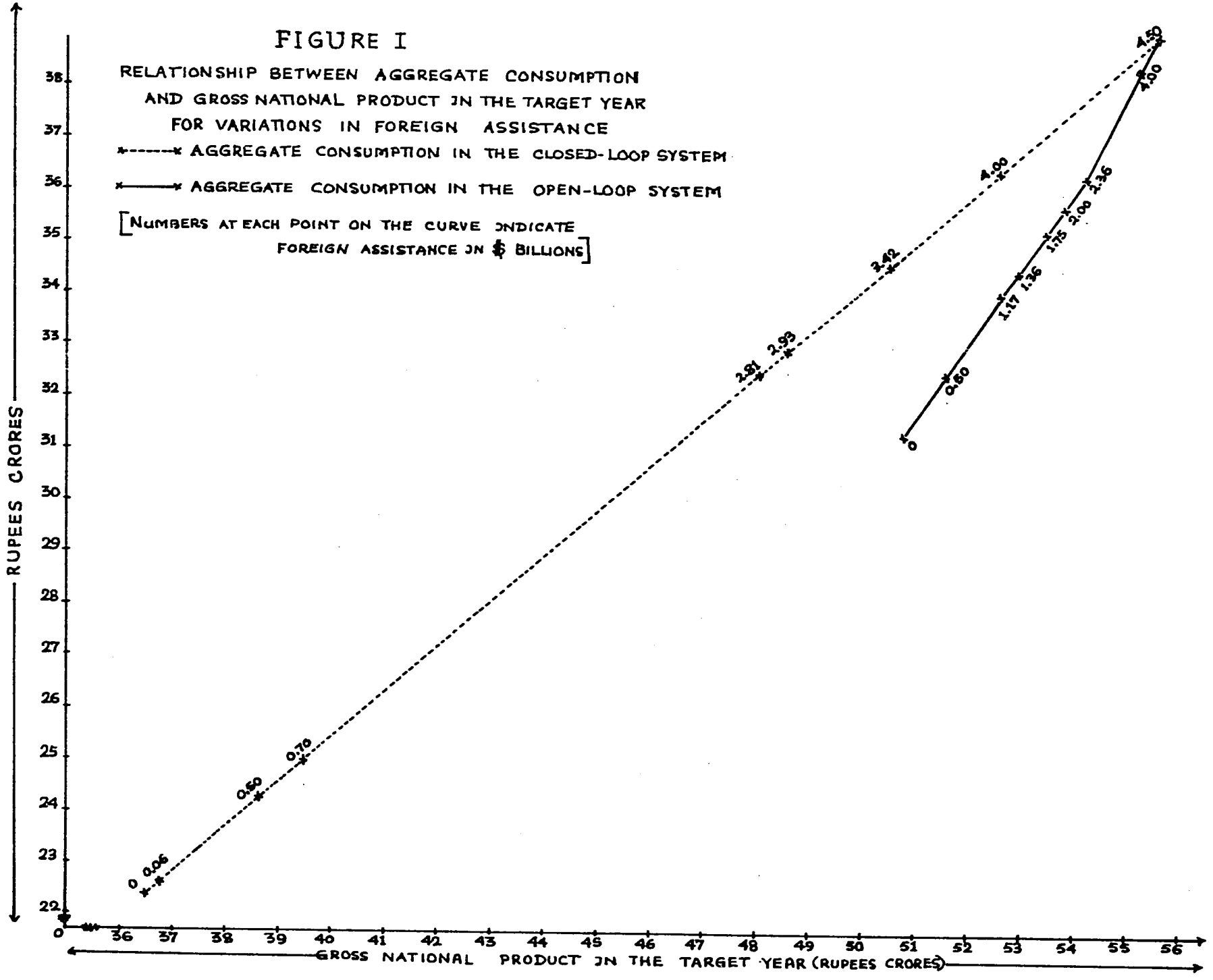


FIGURE I
RELATIONSHIP BETWEEN AGGREGATE CONSUMPTION AND GROSS NATIONAL PRODUCT IN THE TARGET YEAR FOR VARIATIONS IN FOREIGN ASSISTANCE
AGGREGATE CONSUMPTION IN THE CLOSED-LOOP SYSTEM
AGGREGATE CONSUMPTION IN THE OPEN-LOOP SYSTEM
[NUMBERS AT EACH POINT ON THE CURVE INDICATE FOREIGN ASSISTANCE IN $ BILLIONS]
RUPEES CRORES
GROSS NATIONAL PRODUCT IN THE TARGET YEAR (RUPEES CRORES)
0
0.06
0.50
0.70
2.81
2.93
3.42
4.00
4.50
0
0.60
1.17
1.36
1.75
2.00
2.36
4.00

closed-loop system. This is clear from observing the aggregate gross investment curves in the two versions. The open-loop model produces a flatter gross investment curve than the closed-loop variant. In fact, the aggregate gross investment, being already at a high level in the absence of savings limitation in the open-loop system, declines slightly as foreign assistance is increased from nil to $1.17 billion and then slopes upward. In contrast to this, the savings-supplementing character of foreign aid in a domestic resource-scarce closed-loop version gives a continually upward and steeper slope to the gross investment curve. The major factors behind this differential behavior of the gross investment curves may be spotted by investigating the financing elements of gross investment, viz., exogenous and personal savings and foreign assistance. Exogenous savings remain fixed between the two systems. In the savings-limited closed-loop system, the additional foreign aid may be seen from Figure II, to increase the absolute availability of personal savings and hence investment. On the other hand, a downward-sloping implied personal savings curve is indicated by the open-loop version. At the level of foreign aid amounting to $4.5 billion, the savings constraint becomes non-binding at the GNP of Rs. 55,600 crores[28], and thereafter the closed-loop system merges into the open-loop system. Before this point is reached, and most of the feasible ranges of foreign aid in practice would be in this region, our discussion has shown that the macroeconomic variables respond differently to variations in the foreign capital inflow in the two systems. This necessitates a detailed inquiry into the impact of foreign assistance on the two systems under investigation.

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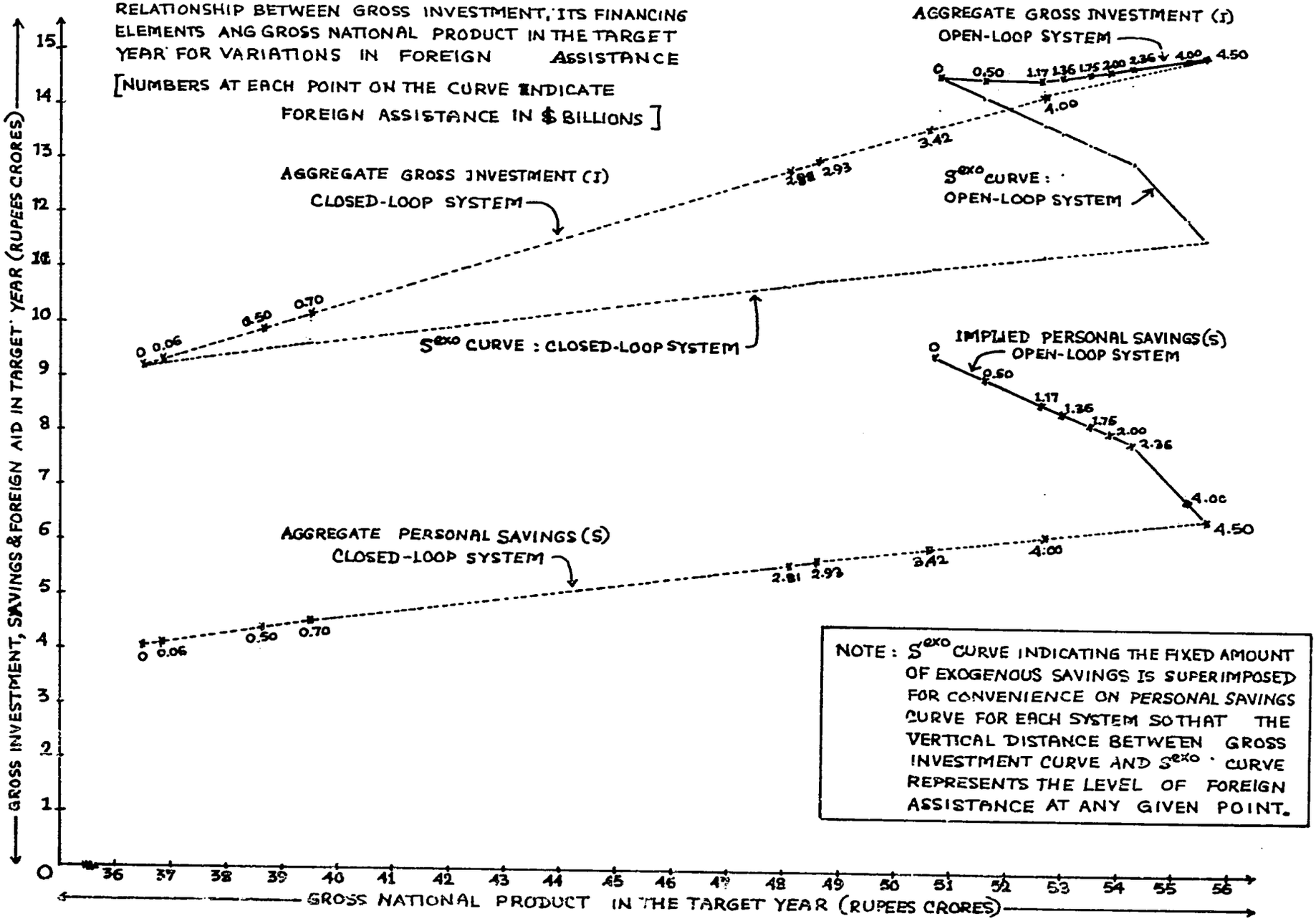
28. This solution was found too late for inclusion in tables in Appendix B.

FIGURE II

RELATIONSHIP BETWEEN GROSS INVESTMENT, ITS FINANCING ELEMENTS ANG GROSS NATIONAL PRODUCT IN THE TARGET YEAR FOR VARIATIONS IN FOREIGN ASSISTANCE

[NUMBERS AT EACH POINT ON THE CURVE INDICATE FOREIGN ASSISTANCE IN $ BILLIONS]

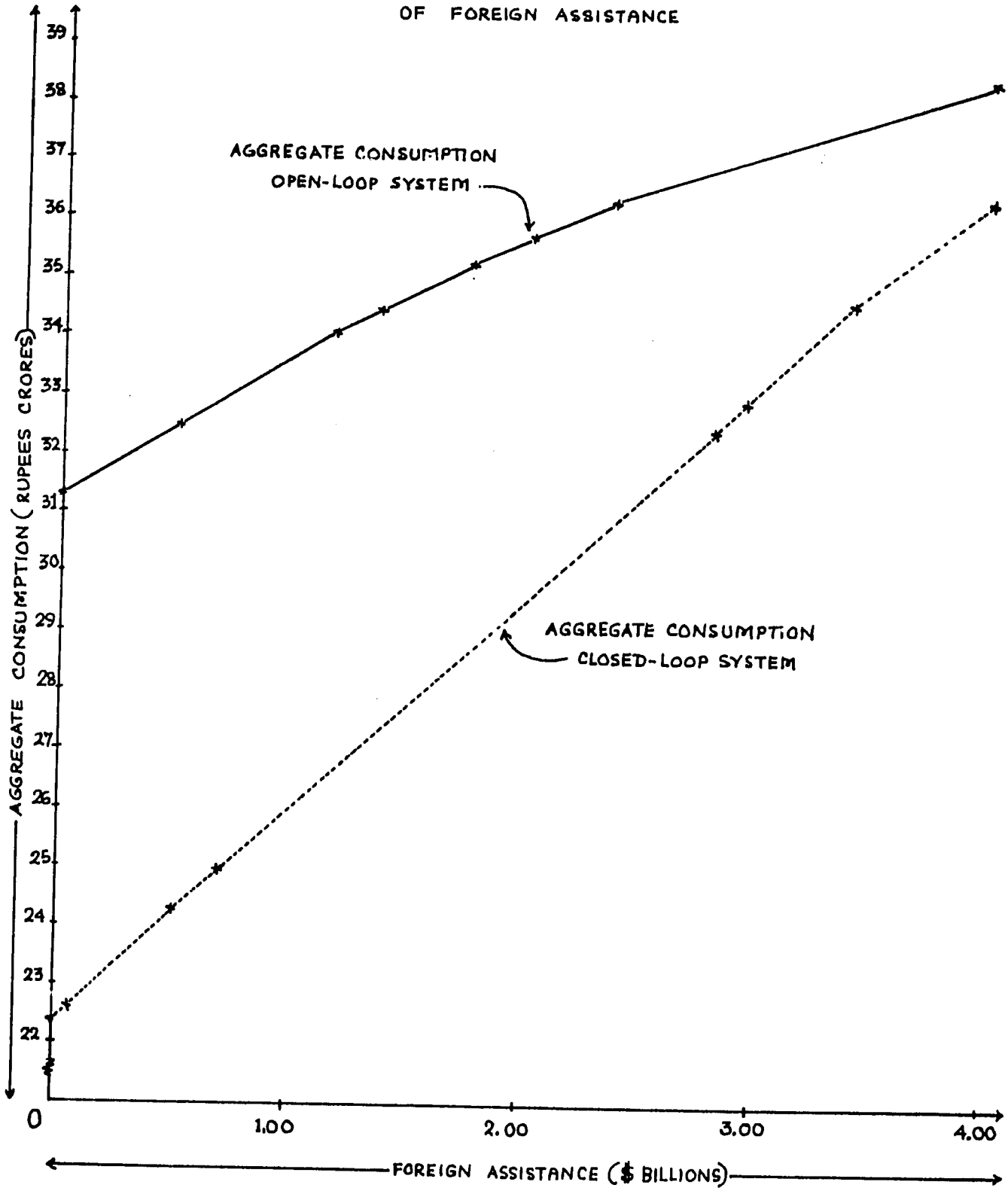


An additional dollar of foreign aid in the open-loop version breaks the trade bottleneck only and raises the aggregate growth rate by maximally contributing to the composite private consumption-basket. As we go from one extreme with no foreign aid to the other extreme, the resources may be expected to be released from exports and the least profitable domestically produced importables and allocated to more profitable uses with a view to maximizing aggregate consumption. The previously unprofitable import-processes, because of a very high scarcity value of foreign exchange at low levels of foreign assistance, enter the optimal structure as this scarcity is relaxed gradually with the expansion of foreign capital inflow. This would be reflected in a steady decline in the aggregate incremental capital-output ratio (ICOR). The confirmation of this phenomenon is available in Figure III(C) for the open-loop model in a downward sloping curve of ICOR. The increasing availability of foreign resources also enables the economy to devote a continually declining proportion of GNP to gross investment while raising the aggregate growth rate (see Figure III(A) and III(B) for the open-loop solution).

We now turn to the solutions of the closed-loop model for the impact of foreign aid. A marginal dollar, by breaking the trade bottleneck, raises the disposable income and consequently the aggregate savings performance to finance the higher level gross investment. Simultaneously, it also acts as a supplement to the domestic savings and breaks the savings bottleneck itself. The combined interaction of these two forces results in an additional dollar contributing more than proportionately to the aggregate gross investment. (It may be noted for comparison that the additional domestic savings effort, by itself, adds only as much to gross investment as to savings

FIGURE III (A)

AGGREGATE CONSUMPTION FOR VARYING LEVELS OF FOREIGN ASSISTANCE



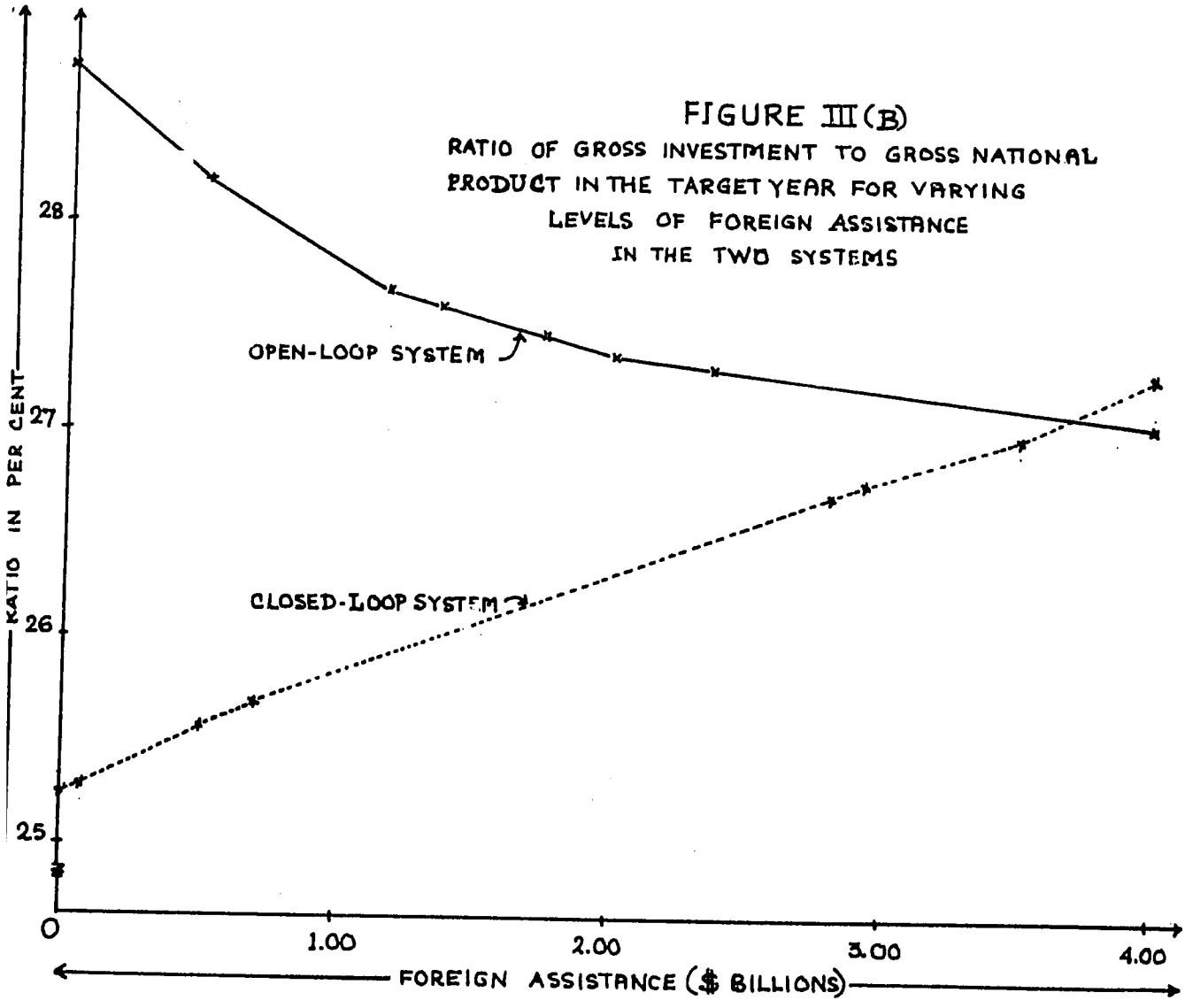


FIGURE III (B)

RATIO OF GROSS INVESTMENT TO GROSS NATIONAL PRODUCT IN THE TARGET YEAR FOR VARYING LEVELS OF FOREIGN ASSISTANCE IN THE TWO SYSTEMS

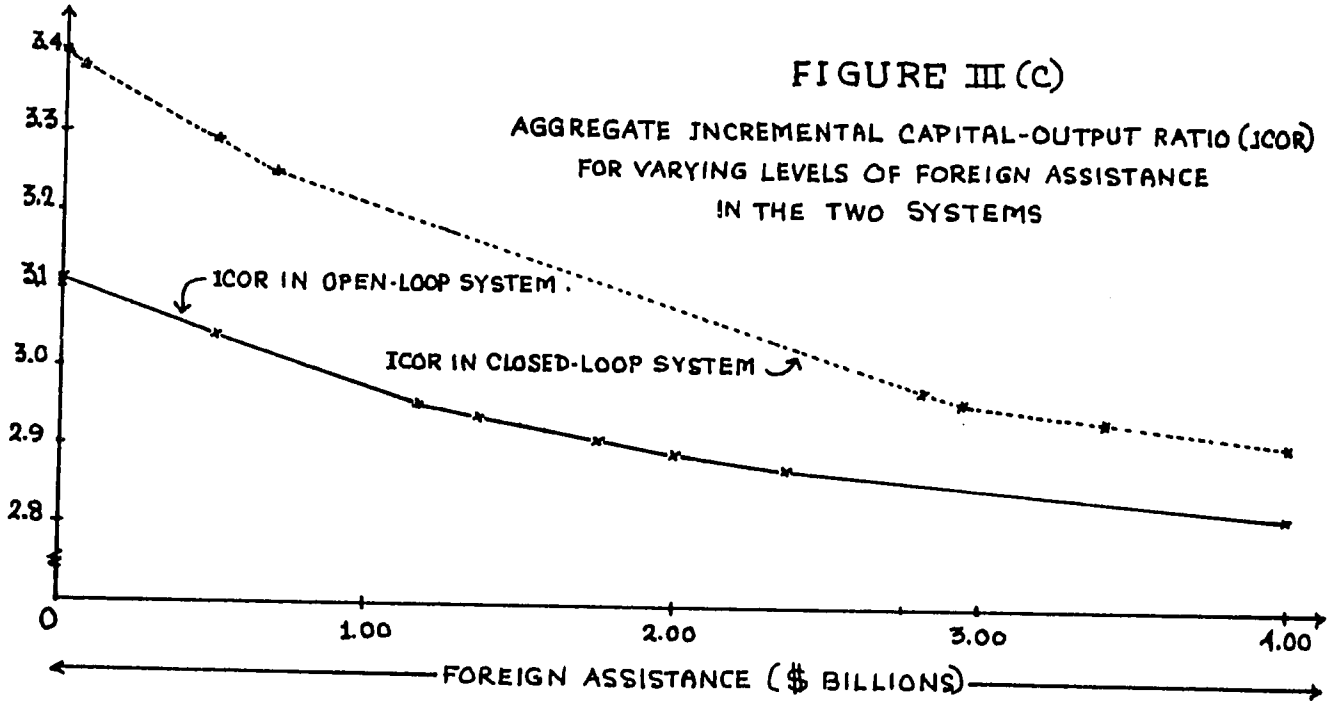


FIGURE III (C)

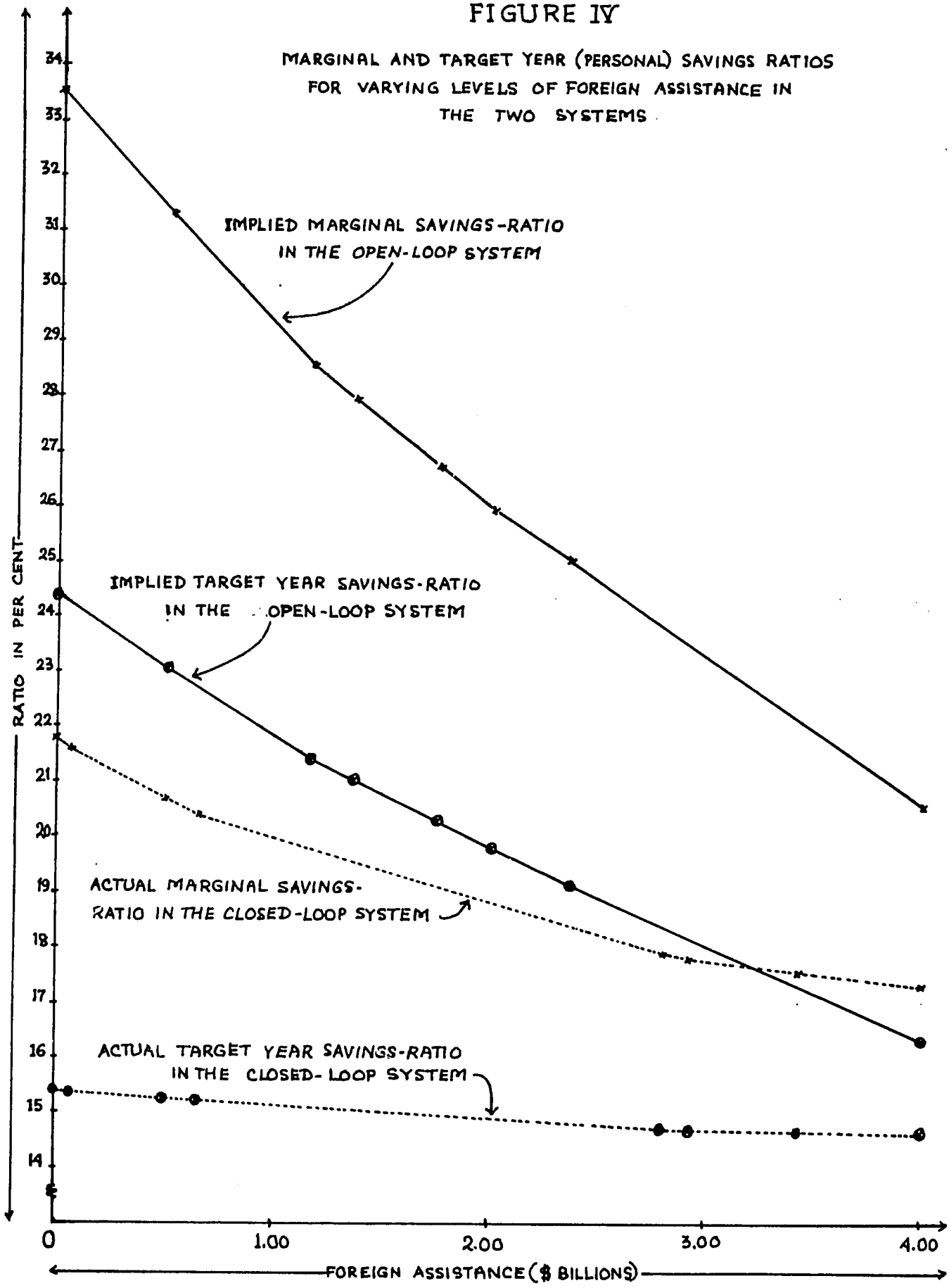
AGGREGATE INCREMENTAL CAPITAL-OUTPUT RATIO (ICOR) FOR VARYING LEVELS OF FOREIGN ASSISTANCE IN THE TWO SYSTEMS

because only the savings bottleneck is affected.) This multiplier effect of foreign assistance on gross investment is revealed in an upward sloping curve for the ratio of gross investment to GNP in the target year (see Figure III(B), closed-loop solutions). Thus the dual effect of foreign aid in a closed-loop system of breaking the savings and trade bottlenecks simultaneously enables the economy to attain higher growth rates by devoting a higher proportion of GNP to the domestic capacity creation. This is in sharp contrast to the open-loop growth process where this rate has been observed to be downward-sloping, although it must be remembered that for the same amount of foreign assistance, the open loop PTL process achieves a higher growth rate than the closed-loop TSL version. As in the case of the open-loop model, the aggregate ICOR in the closed-loop model also exhibits an expected steadily declining tendency as foreign aid is expanded. From Figure III(C), it is also clear that for a given level of foreign assistance, the aggregate ICOR in a closed-loop system remains consistently higher than that in the open-loop system. Thus the reduction in the aggregate growth rate that takes place because of the savings bottleneck results not only from a lower ratio of gross investment to GNP but also from changes in the output-mix leading to an increase in the aggregate ICOR.

How do variations in foreign aid affect the other primary resource of domestic savings? By construction, this resource is non-scarce in the open-loop system. We have already seen in this case from Figure II that the absolute availability of personal savings goes on declining with an expansion in foreign aid. It is, therefore, no surprise to find in Figure IV that the marginal and target year (personal) savings-ratios for the open-loop variant exhibit a continuously downward-sloping tendency. On the other

FIGURE IV

MARGINAL AND TARGET YEAR (PERSONAL) SAVINGS RATIOS FOR VARYING LEVELS OF FOREIGN ASSISTANCE IN THE TWO SYSTEMS



hand, foreign aid has been shown to increase the absolute availability of personal savings in a closed-loop framework because it breaks the trade and the savings bottlenecks simultaneously. It is interesting to note that its relative burden in the form of an aggregate marginal (personal) savings ratio may be seen to be gradually declining from Figure IV. A similar downward-sloping movement, though in a much less pronounced form, may also be observed in the same figure for the target year (personal) savings-ratio. Thus, two-fold influences of foreign aid on personal savings in a closed-loop version may be detected. A given increase in foreign aid brings about an improvement in the absolute personal savings performance, but it raises the aggregate disposable income and private consumption more than proportionately so that the marginal (personal) savings-income ratio is steadily reduced. Secondly, it also makes possible a reduction in the target year (personal) savings-ratio while enabling a gradual stepping up in the target year ratio of gross investment to GNP. This brings out explicitly, the savings-supplementing role of foreign assistance in all its aspects.

Comparison of the (personal) savings-ratios between two systems indicates that the open-loop ratios remain consistently higher and decline faster than their closed-loop counterparts for expanding levels of foreign assistance. This implies that the conflict between the social and the individual preferences goes on narrowing with higher availabilities of foreign capital inflow.

Our analysis so far indicates that shapes of the curves for certain important macroeconomic variables as well as key ratios in adjusting to varying levels of foreign capital inflow differ very significantly. It is obvious, therefore, that the corresponding policy prescriptions for optimal adjustment to changes in foreign

aid availability (because of uncertainty in aid prospects, etc.) would also change radically as between the two systems. Consequently in the event of mis-specification in representing a system, the resulting mis-allocation of resources due to wrong policies would be correspondingly great. This emphasizes the importance of correctly specifying a given situation as belonging to either of the two systems.

With this survey of the features of the adjustment mechanisms involved in the two growth systems, let us examine the marginal productivity of foreign assistance in each given by the numerical value of the slope of the aggregate consumption curve in Figure III(A). As we have observed in the last section, this is given by the shadow price (P_f) of the balance of trade constraint in the open-loop system and by the sum of P_f and the shadow price (P_s) of the savings constraint in the closed-loop framework. This is presented in the following table in the appropriate common intervals to facilitate the comparison of the relative impact of the same amount of foreign aid on the two systems.

MARGINAL PRODUCTIVITIES OF FOREIGN AID
IN TERMS OF AGGREGATE CONSUMPTION

Foreign Aid Interval $ Crores	Open-Loop Model (Rupees)	Closed-Loop Model (Rupees)
0-5	3.1446	5.6565
6-135	3.1446	4.9302
136-174	2.9800	4.9302
175-235	2.5368	4.9302
236-280	2.0547	4.9302
281-292	2.0547	4.5657
293-341	2.0547	4.5429
342-399	2.0547	4.4033
400	1.7321	3.9655
450	1.6900	1.6900

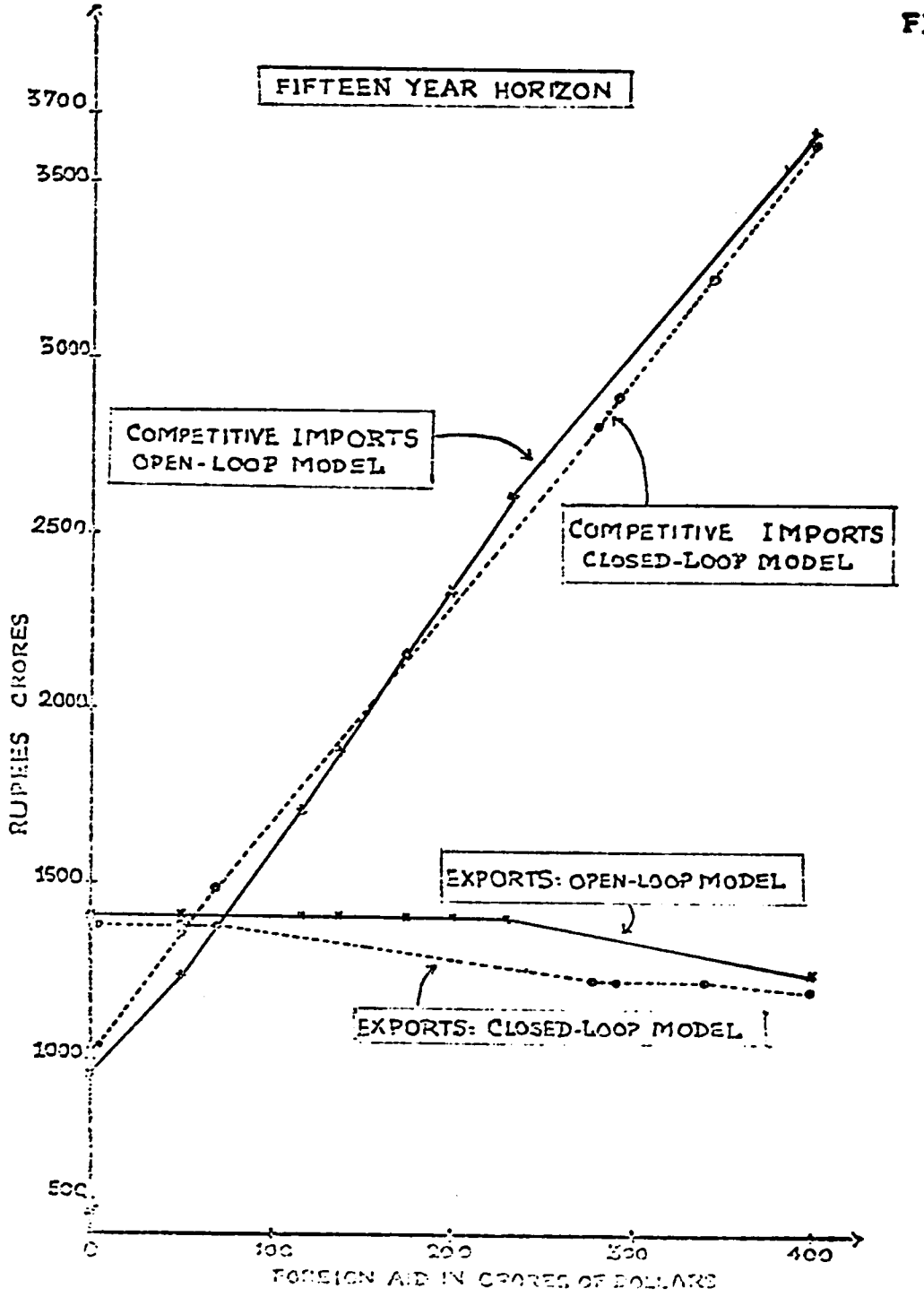
Note that for a given level of foreign aid, the marginal productivity of foreign assistance is higher in the closed-loop framework than that in the open-loop solution (except at a high end point of $4.5 billion when the closed-loop system merges into the open-loop variant). Moreover, it may be observed to decline faster in the purely-trade-limited or open-loop system where foreign exchange is the only scarce primary factor than in the closed-loop system in which two scarce resources--domestic and foreign--interact in a complementary manner to bring about the final marginal effect of foreign assistance.

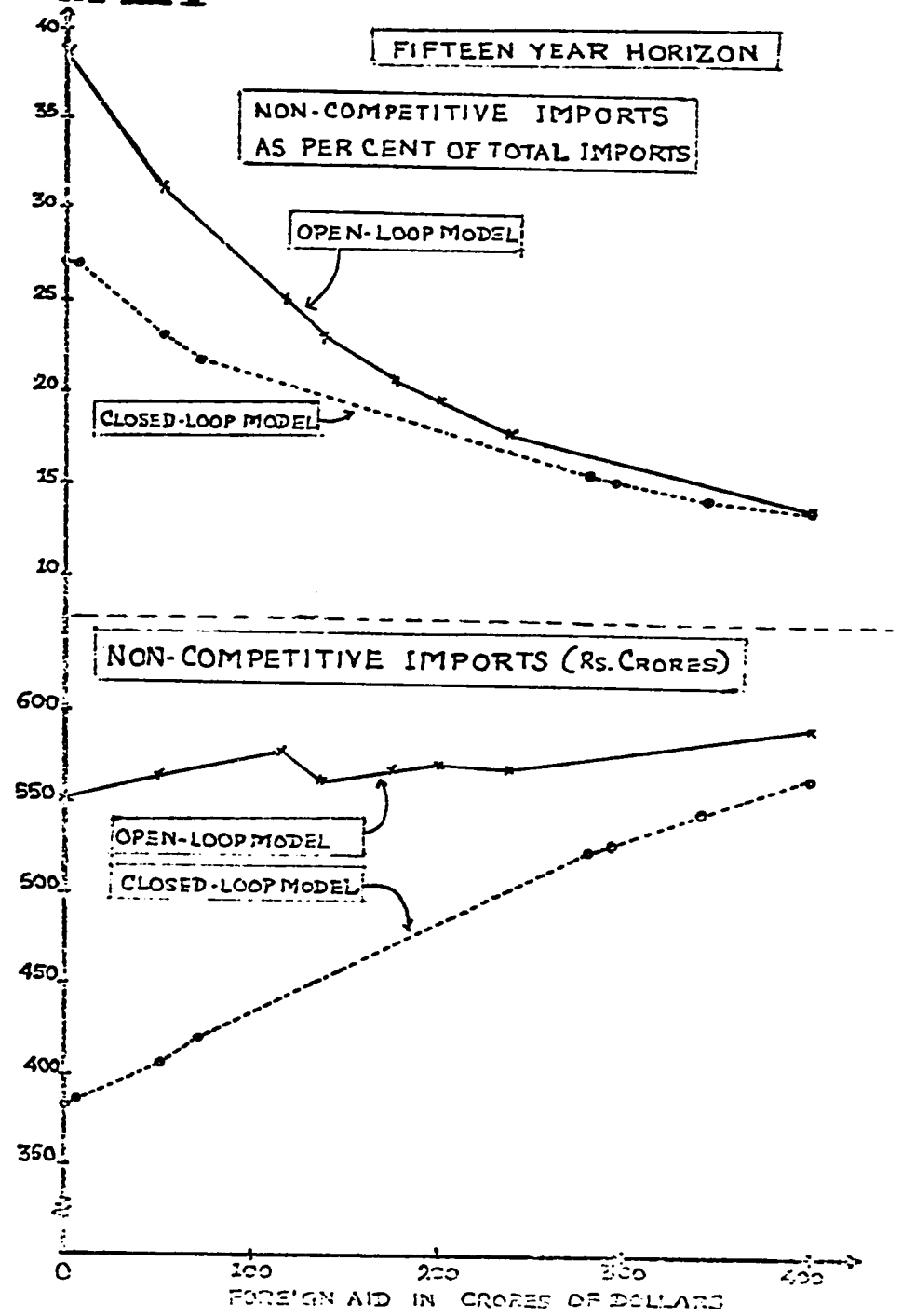
Coming to the relationship between the foreign aid expansion and the resulting trade-structure, the aggregate competitive and non-competitive import outlays and export earnings are plotted in Figure V.

The most prominent feature is that through a very wide range of foreign aid from zero to $4.00 billion, the aggregate export earnings change only marginally within a given system as well as between the two systems. Majority of export processes continue operating at the ceiling level throughout the entire range of variations in the foreign capital inflow. Consequently, aggregate import outlays expand by the same amount as foreign assistance. The ratio of non-competitive imports to total imports indicates the composition of the domestic output-mix. Its downward sloping nature reflects a shift from the domestic production of foreign-exchange intensive commodities at low levels of foreign aid to the corresponding competitive imports in the interest of efficiency as foreign exchange scarcity is gradually relaxed.

The relative invariance of export-earnings implies that the dynamic comparative advantage operates not, as we would normally

FIGURE V


FIFTEEN YEAR HORIZON
COMPETITIVE IMPORTS OPEN-LOOP MODEL
COMPETITIVE IMPORTS CLOSED-LOOP MODEL
EXPORTS: OPEN-LOOP MODEL
EXPORTS: CLOSED-LOOP MODEL
RUPEES CRORES
3700
3500
3000
2500
2000
1500
1000
500
0
100
200
300
400
FOREIGN AID IN CRORES OF DOLLARS


FIFTEEN YEAR HORIZON
NON-COMPETITIVE IMPORTS AS PER CENT OF TOTAL IMPORTS
OPEN-LOOP MODEL
CLOSED-LOOP MODEL
40
35
30
25
20
15
10
NON-COMPETITIVE IMPORTS (Rs. CRORES)
600
550
500
450
400
350
OPEN-LOOP MODEL
CLOSED-LOOP MODEL
0
100
200
300
400
FOREIGN AID IN CRORES OF DOLLARS

expect, by substituting competitive import processes for export processes but by replacing the import-slack processes by the corresponding competitive import-processes with a rising foreign assistance and vice versa when foreign aid is reduced.

The following table gives the composition of the import-structure in the Reference Solutions and the changes that take place as foreign aid is varied in both the directions. It indicates the import processes which drop out (when aid is reduced) or enter the structure (when aid is increased) for the open- and closed-loop versions.

CHANGING IMPORT STRUCTURE FOR
VARYING AVAILABILITIES OF FOREIGN AID

Foreign Aid $ Crores	Import Processes	Foreign Aid $ Crores	Import Processes
0-50	4,9,23,24,25,26	0-6	15 drops out
136	19 enters	50	6,9,15,19,24,26
175	6 enters	281	5 replaces 15
236	27 enters	293	25 enters
400	5 enters	342	23 enters
		400	10 replaces 25

In the open-loop model, at every change in the economic structure with an expansion of foreign aid, a new import process is added without removing any import-process already in the structure (the slack import-processes are mostly removed). Crude Oil (24) and Petroleum Products (23) turn out in the Reference Solution to be the sectors with high shadow prices because of the import-restrictions. This explains why competitive imports of Petroleum Products-intensive

Chemical Fertilizers (19) become profitable before Iron and Steel (6) despite a lower capital intensity of the former. The same reason applies to the appearance of the import process in Chemicals (27) before that in Non-Electrical Equipment (5). Similarly, in the closed-loop system, the import-restrictions in Crude Oil (24) and Rubber (26) make the domestic production processes of Rubber Products (25) and Petroleum Products (23) inefficient earlier than the relatively more capital intensive sector of Other Metals (10)

In this connection we may examine the behavior of the sectors Iron and Steel (6) and Chemical Fertilizers (19) where, it may be recalled, imports are restricted to at most 15% of the total supplies to reflect the import-substitution drive. For the open-loop version, domestic production of Chemical Fertilizers remains efficient up to the foreign aid of $1.36 billion, whereas for Iron and Steel the cross-over point is higher at $1.75 billion. In the closed-loop system, however, both the sectors are unprofitable throughout the entire range of foreign aid as import limits continue to be operative. A measure of the cost of import-substitution per unit of gross output can be computed by the formula

$$C_m = (P_i/d_i^M \; P_f) - 1$$

where P_i is the shadow price of domestic production in the ith sector (Rs)

P_f is the shadow price of foreign exchange (Rs. per $)

d_i^M is the foreign exchange outlay per unit of imports.

The numerator of the quotient on the right-hand side measures the domestic cost, and the denominator indicates the c.i.f. import cost so that C_m reflects the relative excess of the former over the

latter. Note that whenever the import ceiling constraint is non-binding, the domestic cost is less than or equal to the c.i.f. international price, and we define C_m to be zero. The following table presents the calculations for Iron and Steel (6) and Chemical Fertilizers (19).

UNIT-COST OF IMPORT-SUBSTITUTION
FOR VARYING LEVELS OF FOREIGN AID

Foreign Aid $ Crores	Sector 6	Sector 19	Foreign Aid $ Crores	Sector 6	Sector 19
50	------	------	6	36.12%	34.18%
136	------	------	50	36.49%	34.44%
175	------	14.17%	281	38.74%	35.78%
236	------	29.97%	293	38.68%	35.73%
400	30.10%	34.38%	342	38.50%	32.77%

Note that as foreign exchange availability expands, and the scarcity price of foreign resource is reduced, the policy of import-substitution becomes correspondingly more costly. Barring slight fluctuations resulting from changes in the output-mix in the closed-loop model, this effect is obvious. Secondly, Iron and Steel Industry shows a lower unit cost of import-substitution than Chemical Fertilizers in the open-loop model despite its higher capital intensity, whereas the situation is reversed in the closed-loop system. As we have already noted in the open-loop system, the import-restrictions on Crude Oil (24) and Petroleum Products (23) raise the cost of these inputs which go into Chemical Fertilizers in larger quantities than in Iron and Steel, so that the former becomes relatively more expensive. The same import-restrictions become relatively less important

in the closed-loop system because of a downward shift in the demand for foreign exchange. Consequently, relative capital-intensity becomes an important factor in determining the extent of comparative disadvantage involved in import-substitution.

V CONCLUSIONS AND SUGGESTIONS FOR IMPROVEMENT

An attempt has been made in this paper to bring out the interaction between domestic and foreign resources in economic growth of an underdeveloped economy by suggesting an appropriate multi-sectoral closed-loop model for analysis and carrying out some experiments with the Indian data.

The presently available purely-trade-limited models provide an upper limit to the aggregate growth rate with foreign exchange as the only scarce factor. The domestic savings are assumed to be optimally adjusted to the gross investment requirements. If, however, they pose a binding constraint because of institutional and behavioral limitations, the closed-loop model becomes relevant in this situation. The main impact of the savings limitation is reflected in a downward adjustment in the aggregate growth rate. This immediately indicates that if the target year growth rate is regarded as fixed, the closed-loop system would reveal higher foreign aid requirements than the open-loop variant.

In analyzing the effects of variations in net capital inflow, it is observed that a marginal dollar releases the trade-bottleneck only in the open-loop system, whereas it directly and simultaneously breaks the savings and the trade bottlenecks in the closed-loop system. This reveals a multiplier effect of foreign assistance on gross investment in the closed-loop version and consequently results in a higher marginal productivity of foreign assistance than in the open-loop system.

The additional foreign aid with unchanged domestic savings specifications has been shown to make possible for the closed-loop system, in addition to higher growth rates, inter alia, (i) a higher level of aggregate personal savings, (ii) a declining marginal savings ratio, and (iii) a downward-sloping savings ratio in the target year despite a rising target year ratio of gross investment to GNP. This uncovers the savings-supplementing role of foreign assistance in all its aspects.

It is demonstrated how comparative advantage of a domestic production process according to capital intensity is modified by the imported-input requirements in the open-loop system. Because of the downward shift in the demand for foreign exchange in the closed-loop system, the comparative cost-structure falls more in line with the direct and indirect fixed-capital requirements. It is also shown that the deliberate policy of import-substitution is likely to be less unprofitable at lower levels of foreign aid availability if the government can effectively mobilize the domestic savings to maintain a high quantum of investment.

The two alternative systems we have considered in this paper have been found to lead to two different sets of policy prescriptions in optimally adjusting to varying levels of foreign aid. The importance of a correct representation of an actual situation as belonging to either of the two systems is, therefore, obvious.

Finally, we may briefly mention the areas in which this study requires further improvements.

First, the treatment of the final consumption-basket in a proportional form is obviously simplifying the reality drastically, especially when the incomes are undergoing structural changes. Introduction of Engel elasticities and variations around them on the lines

of Bruno ([1966],[1967]) provide a better alternative.

Second, the step demand functions for the major exporting sectors of Plantations and Jute Textiles where India supplies a major share of the world market would be useful for assessing the costs and benefits of pushing up exports in these traditional sectors. A more detailed disaggregation of the exporting sectors would also be helpful.

Third, the growth rate of the Indian economy being inextricably bound with the vicissitudes of agriculture, this sector needs more attention than is given in this study. The technological transformation of this decentralized sector dependent on the vagaries of the monsoons may be handled with incremental production processes on the lines of Sandee [1960] with appropriate bounds to incorporate the limitations imposed by the institutional and time factors.

Fourth, the recent unprecedented droughts and their after-effects have dislocated the process of economic development. In this situation a more recent base year may reflect better the possibilities of future growth.

Finally, there has been a mixture of the pricing procedures in the data used for these experiments. It is desirable to have all the information uniformly in market prices.

Despite all these limitations, however, it is hoped that our experiments have served the suggestive purpose of highlighting the structural differences between the presently formulated models and the closed-loop system developed in this paper and the importance of the latter for a successful planning.

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APPENDIX A: LIST OF SECTORS

1) Construction, Urban and Industrial
2) Construction, Rural
3) Electrical Equipment
4) Transport Equipment
5) Non-Electrical Equipment
6) Iron and Steel
7) Iron Ore
8) Cement
9) Other Metals
10) Other Minerals
11) Plantations
12) Leather and Leather Products
13) Animal Husbandry
14) Food Industries
15) Foodgrains
16) Cotton and Other Textiles
17) Jute Textiles
18) Other Agriculture
19) Chemical Fertilizers
20) Glass, Wooden, and Non-metallic Mineral Products
21) Forestry Products
22) Motor Transport
23) Petroleum Products
24) Crude Oil
25) Rubber Products
26) Plantation Rubber
27) Chemicals
28) Railway Transport
29) Electricity
30) Coal
31) Housing (Residential)
32) Others

APPENDIX B: DETAILED TABLES GIVING EMPIRICAL RESULTS

NOTATION TO THE TABLES:

1)	C	Optimal level of consumption in target year (Rupees Crores).
2)	I	Level of total gross investment in target year (Rupees Crores).
3)	ΔI	Incremental gross investment over the base year (Rupees Crores).
4)	I_I	Level of induced fixed investment in the target year (Rupees Crores) obtained by subtracting inventory and exogenous investment from total gross investment.
5)	S	Personal savings in target year (Rupees Crores).
6)	ΔS	Incremental personal savings over the base year (Rupees Crores).
7)	V	Level of gross national product (GNP) in target year (Rupees Crores).
8)	ΔV	Incremental GNP over the base year (Rupees Crores).
9)	W	Level of disposable income in target year (= C + S) (Rupees Crores).
10)	ΔW	Incremental disposable income over the base year (Rupees Crores).
11)	T	Level of transfer payments in target year (Rupees Crores) obtained as an excess of wage plus non-wage income over the disposable income.
12)	I/V	Ratio of 2) to 7) in per cent.
13)	$\Delta K/\Delta V$	Aggregate incremental capital-output ratio.
14)	S/W	Ratio of 5) to 9) in per cent.

NOTATION TO THE TABLES (Continued):

15)	$\Delta S/\Delta W$	Ratio of 6) to 10) in per cent.
16)	S/I	Ratio of 5) to 3) in per cent.
17)	$\Delta S/\Delta I$	Ratio of 6) to 3) in per cent.
18)	$I_{I/I}$	Ratio of 4) to 2) in per cent.
19)	P_f	Shadow price of foreign exchange (rupees per dollar).
20)	P_S	Shadow price of savings constraint (Rupees).
21)	γ_1	Annual rate of growth of consumption in per cent.
22)	γ_2	Annual rate of growth of GNP in per cent.
23)	F	Level of maximum permissible import surplus ($ Crores)
24)	F/V	Ratio of 23) to 7) in per cent.
25)	F/I	Ratio of 23) to 2) in per cent.

TABLE I.a

AGGREGATE EXOGENOUS VARIABLES AND INITIAL CONDITIONS

	(Rupees Crores)	
	1960-1961	1975-1976
Government Expenditures	1,380	4,900
Government Savings	135	3,540
Corporate Savings	90	500
Foreign Aid	520	381
Depreciation Allowances	460	1,090
Aggregate Private Consumption	12,604	-----
Aggregate Gross National Product	15,700	-----
Aggregate Gross Investment	2,232	-----
Aggregate Wage Income	10,769	-----
Aggregate Non-Wage Income	2,863	-----

Sources of Data:
a. Manne and Rudra [1965]
b. Srinivasan, Saluja, and Sabherwal [1965].
c. Perspective Planning Division [1964].
d. Perspective Planning Division [1966].

TABLE I.b

PRIVATE CONSUMPTION EXPENDITURE

Sector	Expenditure Elasticity	Proportional Basket
3	2.500	0.0036
4	2.7520	0.0048
5	3.000	0.0146
11	1.2558	0.0063
12	2.4000	0.0110
13	0.8000	0.0787
14	1.0799	0.0791
15	0.6148	0.2458
16	1.3076	0.0612
18	0.9546	0.0597
20	2.0000	0.0066
22	1.2000	0.0082
23	1.6808	0.0078
25	2.4000	0.0046
27	1.6729	0.0172
28	1.2000	0.0075
29	2.2000	0.0012
30	1.5000	0.0006
31	1.0000	0.0452
32	1.1132	0.3363

Note: The proportional basket is derived on the basis of the annual rate of growth of consumption of 3.8% over 1960-61.

Engel Elasticities are taken from Perspective Planning Division [1966].

TABLE I.c

FLOOR AND CEILING LIMITS ON EXPORTS

Sector	(Rupees Crores) 1975-76	
	Floor	Ceiling
3	---	58.0
4	---	28.0
5	---	158.0
7	15.0	38.0
8	---	8.0
11	200.0	276.0
12	---	55.0
13	---	49.0
14	---	228.0
16	80.0	120.0
17	175.0	274.0
18	---	137.0
20	---	13.0
21	---	36.0
30	---	1.0

Note: Ceiling limits 1975-76 are derived from Srinivasan, Saluja, and Sabherwal [1965] with appropriate adjustments for the post-devaluation change in the nominal exchange rate.

TABLE I.d

IMPORT CEILINGS

	1975-76
(a) Proportional form: (i.e. specified as a maximum percentage of total supply in a sector)	
Sector 6	0.15
15	0.05
19	0.15
23	0.10
25	0.05
27	0.10
(b) Absolute ceilings (Rupees crores)	
24	240.0
26	40.0

TABLE II: BASIC REFERENCE SOLUTIONS: MACROECONOMIC RESULTS

(Rupees Crores in 1959-60 Prices Unless Otherwise Mentioned)

			FIFTEEN-YEAR HORIZON	
			Open-Loop Model	Closed-Loop Model
(1)	OPTIMAL LEVEL OF CONSUMPTION IN TARGET YEAR	C	32,485	24,259
(2)	LEVEL OF TOTAL GROSS INVESTMENT IN TARGET YEAR	I	14,593	9,886
(3)	INCREMENTAL GROSS INVESTMENT	ΔI	12,360	7,654
(4)	LEVEL OF INDUCED FIXED INVESTMENT IN TARGET YEAR	I_I	9,821	5,654
(5)	PERSONAL SAVINGS IN TARGET YEAR (CLOSED MODEL)	S	x	4,375
(6)	INCREMENTAL PERSONAL SAVINGS (CLOSED MODEL)	ΔS	x	3,348
(7)	LEVEL OF GROSS NATIONAL PRODUCT IN TARGET YEAR	V	51,603	38,670
(8)	INCREMENTAL GROSS NATIONAL PRODUCT	ΔV	35,803	22,870
(9)	LEVEL OF WAGE PLUS NON-WAGE INCOME IN TARGET YEAR	W	39,355	28,633
(10)	INCREMENTAL WAGE PLUS NON-WAGE INCOME	ΔW	25,723	16,149
(11)	LEVEL OF TRANSFER PAYMENTS IN TARGET YEAR GIVEN BY $T = W - (C + S)$	T	-2,168	213
(12)	RATIO OF (2) TO (7) PERCENTAGE	I/V	27.67	25.57
(13)	AGGREGATE INCREMENTAL CAPITAL-OUTPUT RATIO	$\Delta K/\Delta V$	3.0466	3.3770
(14)	RATIO OF (5) TO (9) PERCENTAGE	S/W	x	15.28

TABLE II (Continued)

			FIFTEEN-YEAR HORIZON	
			Open-Loop Model	Closed-Loop Model
(15)	RATIO OF (6) TO (10) PERCENTAGE	$\Delta S/\Delta W$	x	20.73
(16)	RATIO OF (5) TO (2) PERCENTAGE	S/I	x	44.25
(17)	RATIO OF (6) TO (3) PERCENTAGE	$\Delta S/\Delta I$	x	43.74
(18)	RATIO OF (4) TO (2) PERCENTAGE	$I_{I/I}$	67.09	56.89
(19)	SHADOW PRICE OF FOREIGN EXCHANGE (Rs/$)	P_f	23.6440	9.9828
(20)	SHADOW PRICE OF SAVINGS CONSTRAINT (Rs)	P_S	x	3.6025
(21)	ANNUAL RATE OF GROWTH OF C	r_1	6.50	4.50
(22)	ANNUAL RATE OF GROWTH OF V	r_2	8.20	6.15
(23)	LEVEL OF IMPORT SURPLUS ($ Crores)	F	50.00	50.00
(24)	RATIO OF (23) TO (7) PERCENTAGE	F/V	0.73	0.97
(25)	RATIO OF (23) TO (2) PERCENTAGE	F/I	2.57	3.79

TABLE III: BASIC REFERENCE SOLUTIONS: PRIMAL: SECTORAL GROSS OUTPUTS, CONSUMPTION, INVESTMENT AND IMPORT-EXPORT LEVELS: FIFTEEN-YEAR HORIZON

(Rupees Crores in 1959-1960 Prices)

Sector		GROSS OUTPUT LEVELS		IMPORT (M) AND EXPORT (E) LEVELS			
		Open-Loop Model	Closed-Loop Model	Open-Loop Model		Closed-Loop Model	
				M	E	M	E
1	Construction, Urban and Industrial	7,789	5,441				
2	Construction, Rural	1,347	942				
3	Electrical Equipment	1,333	917		58		58
4	Transport Equipment	1,370	1,340	409			28
5	Non-Electrical Equipment	4,403	3,021		158		158
6	Iron & Steel	3,288	1,918			339	
7	Iron Ore	103	53		38		15
8	Cement	369	252		8		
9	Other Metals	594	32	332		488	
10	Other Minerals	322	149				
11	Plantations	504	450		276		276
12	Leather & Leather Products	592	461		55		55
13	Animal Husbandry	2,889	2,178		49		49
14	Food Industries	3,582	2,829		228		228
15	Food Grains	10,347	7,446			242	
16	Cotton & Other Textiles	2,322	1,779		120		120
17	Jute Textiles	420	364		214		214
18	Other Agriculture	6,144	4,788		137		137
19	Chemical Fertilizers	769	483			85	
20	Glass, Wood, Etc.	2,355	1,666		13		13
21	Forestry Products	1,023	756		36		36
22	Road Transport	2,523	1,738				
23	Petroleum Products	1,707	1,378	190			
24	Crude Oil	80	80	240		179	
25	Rubber Products	356	287	19			
26	Plantation Rubber	51	51	40		23	
27	Chemicals	1,724	1,252				
28	Railway Transport	2,268	1,564				
29	Electricity	1,094	681				
30	Coal	582	380		1		
31	Housing (Residential)	1,468	1,096				
32	Others	17,868	14,184				

TABLE III (Continued)

	FIFTEEN-YEAR HORIZON	
	Open-Loop Model	Closed-Loop Model
OPTIMAL CONSUMPTION	32,485	24,259
INDUCED INVESTMENT LEVELS: SECTOR 1	4,613	2,551
2	873	500
3	830	490
4	1,014	616
5	2,490	1,467
INVENTORY INVESTMENT	1,888	1,378

TABLE IV: BASIC REFERENCE SOLUTIONS: ANNUAL RATES OF GROWTH OF SECTORAL GROSS OUTPUT LEVELS, CONSUMPTION, AND GROSS NATIONAL PRODUCT OVER THE FIFTEEN-YEAR PLANNING HORIZON.

	OPEN-LOOP MODEL	CLOSED-LOOP MODEL
1	13.3	10.7
2	8.1	5.6
3	17.0	14.0
4	13.6	13.5
5	18.5	15.6
6	18.2	14.1
7	18.6	13.4
8	13.8	11.0
9	17.7	0.0
10	14.0	8.3
11	6.5	5.7
12	7.9	6.1
13	6.5	4.5
14	6.9	5.3
15	6.6	4.3
16	7.4	5.5
17	7.9	7.1
18	7.4	5.7
19	27.1	21.7
20	12.6	9.9
21	12.3	9.9
22	14.6	11.8
23	14.1	12.5
25	15.4	10.1
27	12.8	10.4
28	11.3	8.6
29	17.1	13.4
30	11.8	8.7
31	5.1	3.0
32	5.2	3.6
CONSUMPTION	6.50	4.50
G.N.P.	8.20	6.15

TABLE V: REFERENCE SOLUTIONS: SECTORAL INDUCED FIXED INVESTMENT LEVELS OVER THE FIFTEEN-YEAR PLANNING HORIZON

(Rupees Crores in 1959-60 Prices Unless Otherwise Indicated)

	Induced Investment Open-Loop Model (1)	Percentage Distribution of (1) (2)	Induced Investment Open-Loop Model (3)	Percentage Distribution of (3) (4)	Col. 3 as Per Cent of Col (1) (5)
Sector 1	922	1.43	594	1.56	64.43
2	---	----	---	----	-----
3	785	1.22	514	1.35	65.48
4	818	1.27	797	2.09	97.43
5	4,059	6.30	2,677	6.91	65.95
6	4,076	6.33	2,226	5.84	54.61
7	314	0.50	149	0.39	47.45
8	727	1.13	458	1.20	63.00
9	1,686	2.62	---	----	0.00
10	457	0.72	172	0.45	37.64
11	277	0.44	229	0.60	82.67
12	141	0.23	95	0.25	67.38
13	2,639	4.10	1,572	4.12	59.57
14	858	1.33	572	1.50	66.67
15	9,560	14.85	5,208	13.67	54.48
16	1,111	1.73	715	1.88	64.36
17	183	0.28	147	0.39	80.33
18	6,071	9.43	4,037	10.59	66.50
19	1,122	1.74	693	1.82	61.76
20	1,272	1.98	824	2.16	64.78
21	1,236	1.92	864	2.27	69.90
22	3,297	5.12	2,120	5.56	64.30

TABLE V (Continued)

	Induced Investment Open-Loop Model (1)	Percentage Distribution of (1) (2)	Induced Investment Open-Loop Model (3)	Percentage Distribution of (3) (4)	Col. 3 as Per Cent of Col (1) (5)
Sector 23	735	1.14	571	1.50	77.68
24	529	0.82	529	1.39	100.00
25	144	0.23	110	0.29	76.39
26	94	0.15	94	0.25	100.00
27	1,498	2.33	1,007	2.64	67.22
28	4,172	6.48	2,553	6.70	61.19
29	6,075	9.43	3,543	9.30	58.32
30	946	1.47	542	1.42	57.29
31	7,680	11.93	3,960	10.39	51.56
32	867	1.35	532	1.40	93.83
TOTAL	64,351	100.00	38,104	100.00	59.21

Note: Induced fixed investment in each sector is derived by multiplying sectoral incremental gross capital-output ratio by the corresponding incremental gross output over the base year level.

TABLE VI: PARAMETRIC PROGRAMMING WITH FOREIGN AID
FIFTEEN-YEAR HORIZON, OPEN-LOOP MODEL MACROECONOMIC RESULTS

(Rupees Crores in 1959-60 prices unless otherwise mentioned).

	F($ Crores)	0	50	117	136	175	200	236	400
1	C	31,303	32,485	34,085	34,486	35,239	35,715	36,308	38,438
2	I	14,604	14,593	14,579	14,636	14,698	14,736	14,818	14,957
3	ΔI	12,372	12,360	12,345	12,404	12,466	12,504	12,585	12,725
4	I_I	9,851	9,821	9,781	9,833	9,881	9,910	9,983	10,128
5	V	50,807	51,603	52,686	53,022	53,524	53,851	54,256	55,295
6	ΔV	35,007	35,803	36,886	37,202	37,724	38,051	38,456	39,495
7	I/V(%)	28.74	28.27	27.67	27.60	27.46	27.36	27.31	27.04
8	$\Delta K/\Delta V$	3.1173	3.0466	2.9554	2.9413	2.9126	2.8950	2.8797	2.8286
9	$I_{I/I}$(%)	67.45	67.30	67.09	67.18	67.23	67.25	67.37	67.71
10	P_f(Rs/$)	23.6440	23.6440	23.6440	22.4064	19.0740	19.0740	15.4495	13.0239
11	γ_1(% p.a.)	6.3	6.5	6.9	7.0	7.1	7.2	7.3	7.7
12	γ_2(% p.a.)	8.1	8.2	8.4	8.4	8.5	8.5	8.6	8.7
13	F/V(%)	---	0.73	1.67	1.92	2.45	2.79	3.26	5.43
14	F/I(%)	---	2.57	6.02	6.97	8.93	10.18	11.95	20.06

TABLE VII: PARAMETRIC PROGRAMMING WITH FOREIGN AID

FIFTEEN-YEAR HORIZON, CLOSED-LOOP MODEL MACROECONOMIC RESULTS

(Rupees Crores in 1959-60 prices unless otherwise mentioned)

	F($ Crores)	0	6	50	70	281	293	342	400
1	C	22,387	22,623	24,259	24,986	32,463	32,902	34,595	36,388
2	I	9,215	9,268	9,886	10,151	12,846	13,010	13,649	14,382
3	ΔI	6,983	7,056	7,654	7,913	10,614	10,778	11,417	12,150
4	I_I	5,028	5,091	5,624	5,860	8,242	8,387	8,955	9,603
5	S	4,079	4,109	4,375	4,493	5,606	5,677	5,946	6,246
6	ΔS	3,052	3,082	3,348	3,466	4,579	4,650	4,918	5,219
7	V	36,502	36,768	38,670	39,512	48,101	48,614	50,579	52,670
8	ΔV	20,702	20,968	22,870	23,712	32,301	32,814	34,779	36,870
9	W	26,467	26,732	28,633	29,478	38,068	38,577	40,544	42,636
10	ΔW	13,983	14,248	16,149	16,994	25,584	26,093	28,060	30,151
11	T	758	691	213	0	---	---	---	---
12	I/V(%)	25.25	25.26	25.57	25.69	26.70	26.76	26.98	27.30
13	ΔK/ΔV	3.4030	3.3770	3.2913	3.2547	2.9893	2.9786	2.9423	2.9184
14	S/W(%)	15.41	15.37	15.28	15.24	14.73	14.73	14.67	14.65
15	ΔS/ΔW(%)	21.83	21.63	20.73	20.40	17.90	17.82	17.53	17.31
16	S/I(%)	44.26	44.23	44.25	44.26	43.69	43.64	43.56	43.43

TABLE VII (Continued)

	F(R Crores)	0	6	50	70	281	293	342	400
17	$\Delta S/\Delta I$(%)	43.66	43.67	43.74	43.80	43.14	43.14	43.08	42.95
18	$I_{I/I}$(%)	54.56	54.81	56.89	57.73	64.16	64.47	65.60	66.77
19	P_f(Rs./$)	17.2567	9.9828	9.9828	9.9828	8.6377	8.6377	8.6840	8.7256
20	P_S(Rs.)	3.3614	3.6025	3.6025	3.6025	3.4169	3.3941	3.2484	2.8050
21	γ_1(% p.a.)	3.9	4.0	4.5	4.7	6.5	6.6	7.0	7.4
22	γ_2(% p.a.)	5.8	5.8	6.2	6.3	7.8	7.8	8.1	8.4
23	F/V(%)	---	0.12	0.97	1.33	4.38	4.52	5.07	5.70
24	F/I(%)	---	0.48	3.79	5.17	16.41	19.50	18.79	20.86

TABLE VIII: ANALYSIS OF IMPLIED PERSONAL SAVINGS ON THE OPEN-LOOP SYSTEM

(Rupees Crores in 1959-60 prices unless otherwise mentioned)

	F	0	50	117	136	175	200	236	400
1	W	38,822	39,355	40,076	40,291	40,660	40,894	41,172	41,890
2	ΔW	25,190	25,723	26,444	26,659	27,028	27,262	27,540	28,258
3	I	14,604	14,593	14,579	14,636	14,698	14,736	14,818	14,957
4	S^{exo}	5,130	5,505	6,008	6,150	6,443	6,630	6,900	8,130
5	S_i	9,474	9,088	8,571	8,486	8,255	8,106	7,918	6,827
6	ΔS_i	8,447	8,061	7,544	7,459	7,228	7,079	6,891	5,800
7	$S_i/W(\%)$	24.40	23.09	21.38	21.06	20.30	19.82	19.23	16.29
8	$\Delta S_i/\Delta W(\%)$	33.53	31.33	28.52	27.97	26.74	25.96	25.02	20.52
9	$S_i/I(\%)$	64.87	62.27	58.82	57.98	56.16	55.00	53.43	45.64
10	$\Delta S_i/\Delta I(\%)$	68.27	65.21	61.10	60.13	57.98	56.61	54.75	45.57

<u>Note</u>: Definitions: $S^{exo} = \bar{S}_g + \bar{S}_c + \gamma\bar{F} + \bar{D}$

$S_i = I - S^{exo}$

W = Aggregate wage plus non-wage income

ΔW and ΔS_i are increments with respect to the base year actual values.