Review Article

"Analytical Techniques for Development Planning"

A REVIEW OF TIMS' MULTISECTOR MODEL FOR PAKISTAN'S THIRD PLAN (1965-70)

by

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INTRODUCTION

In the present decade there has been a great proliferation of multisectoral models for planning. Part of the incentive has certainly been the potentiality of their application in formulating the actual plans. By now there have been so many different types of multisectoral models that it is useful to attempt some kind of classification according as whether or not they embody certain well-known features. The advantage of such a classification is that one gets a general idea about the structure of the model simply by knowing where it belongs in the list of classification.

One broad principle of classification is based on whether the model simply provides a consistent plan or whether it also satisfies some criteria of optimality. A multisectoral consistency model provides an allocation of the scarce resources (*e.g.*, investment and foreign exchange) in such a way that the sectoral output levels are consistent with some given consumption or income target, consistency in this context meaning that the supply of each sector's output is matched by demand generated by intersectoral and final use at base-year relative prices. To the extent that the targets are flexible, there may be many such feasible plans. An optimizing model finds the "best" possible allocation of resources among sectors, the "best" being understood in the sense of maximizing a given preference function subject to the constraints that ensure that the plan is also feasible.

A second principle of classification is based on whether the model is a single-period exercise (for the terminal year of the plan period) or a multiperiod

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All page references are to [12] unless otherwise mentioned.

exercise (for each of the years of the plan period). A terminal-year exercise only indicates the pattern of resource allocation over the entire plan period that would ensure feasible (optimum) levels of output in the terminal year of the plan whereas a fully intertemporal model also provides the actual timing of such allocations by specifying the amounts required in each of the plan years to ensure feasible (optimum) levels of output.

A third principle of classification, particularly relevant for Pakistan, is based on whether the model is interregional or national. An interregional model recognizes the existence of non-homogeneous economic regions within the nation and explicitly takes into account the interregional trade flows and the differences in the regional production structures and consumption behaviours. A national model treats the entire national economy as a homogeneous unit and hence ignores these points.

Wouter Tims' *Analytical Techniques for Development Planning: A Case Study of Pakistan's Third Five-Year Plan* [12] contains one of the very few multisectoral planning models applied to Pakistan[1]. Using the above classification scheme it can be described as a national, terminal-year, consistency model. A few words about the extent to which the model suffers from not being of the alternative types are useful.

Although a simple consistency model cannot match the attraction of an optimizing model, determining the feasibility of a plan is itself an important achievement. In addition, Tims (with the help of his reduced form equations system) is able to generate a large number of alternative feasible plans by varying the composition of his targets. To a certain extent this is a substitute for a fully optimizing model because it enables one to evaluate various trade-off ratios between sets of resources and targets which are useful guides in formulating a more desirable plan.

Again, a fully intertemporal model would be operationally more useful than a terminal-year model insofar as the former provides actual phasing of the allocation of resources while the latter only indicates the sectoral shares of resources over the entire plan period. But an intertemporal model also places demand for additional statistical information on the distribution of time lag between investment and capacity output. This is an area in which information is notoriously absent.

A serious weakness of Tims' model, however, derives from its being a national and not an interregional model. In order to make a reasonable approximation of reality it was necessary that the model should have at least

[1]In fact Tims' is the first multisectoral planning model completed. The other two multisectoral models for planning in Pakistan that are known to the present writer are both of the optimizing variety. These are: A. R. Khan [2 ; 3] and S M. Naseem [8].

a statement would undoubtedly facilitate the understanding of the working of the model and help the discussion about its structure and assumptions.

For convenience, we deviate somewhat from Tims' notation. For sector i

X_i = Domestic production,
X_{ij} = Current input supplied to sector j,
C_i = Final consumption demand,
I_i = Demand for fixed capital formation (*i.e.*, allocation of i to various sectors for fixed investment purposes),
I'_i = Fixed investment requirement (*i.e.*, sector i's demand for inputs from various sectors for fixed investment purposes),
N_i = Stock addition,
E_i = Exports,
V_i = Value added,
M_i = Total import requirement for use as current inputs,
T_i = Indirect taxes, and
$l_i E_s$ = Import substitution (where E_s = total import substitution and l_i = proportion of import substitution to be done by expanding the output of sector i).

Subscripts i, j stand for the producing sectors of the economy (i, j = 1, 2,. . . .7) while other lower-case letter subscripts indicate the items denoted by the corresponding upper-case letters (exception: the subscript for investment is k and not i for obvious reasons). The upper-case letters without subscripts denote totals (exception: Y, not V, is the sum of values added, *i.e.*, gross domestic product). The unexplained lower-case Roman letters denote fixed coefficients while the unexplained Greek letters denote constants.

The first seven equations of the model determine the balance between domestic production and total use of the outputs of the seven producing sectors.

$$(1\text{-}7)\quad X_i = \sum_j X_{ij} + C_i + I_i + N_i + E_i + l_i E_s$$

In Tims' model, l_i is defined to be positive only for two sectors, consumption goods and intermediate goods. Note that imports do not appear as negative final demand so that the flows on the right are domestic and not total flows.

[4]The "structural equations" in Annex IV state the particular value of each equation in the model but do not show the general form. They are also very cumbersome for the understanding of the system because every single equation is shown.

For intersectoral current input flows a linear but non-homogeneous relation is postulated with respect to the outputs of the using sectors so that fixed incremental Leontief coefficients are obtained. This is an important deviation from the more usual assumption of simple proportionality between current input flows and the output levels of the using sectors. Tims defines 39 positive current flows while the other 10 are zeroes.

(8-46) $X_{ij} = a_{ij} X_j + \alpha_{ij}$

Consumption of i is similarly a linear but non-homogeneous function of total consumption expenditure.

(47-53) $C_i = c_i C + \gamma_i$

Investment requirement for sector j is given by the relationship

$$(54\text{-}57)\ I'_j = b_j (g_j^{n_j + \frac{1}{2}} - g_j^{n_j - \frac{1}{2}}) (V_j - l_j v_s E_s) + b'_j (g_j^{n_j + \frac{1}{2}} - g_j^{n_j - \frac{1}{2}}) l_j v_s E_s$$

where b_j and b'_j are capital coefficients respectively for production and import substitution in sector j, g_j is the annual growth index for sector j (*i.e.*, 1 + annual growth rate), n_j is the investment output lag (in years) and v_s is the value-added coefficient for import substitution. Note that there are only four such equations because Tims combines investment requirements for the three manufacturing industries together with those for construction for want of separate capital coefficients for these sectors. For this further aggregated sector l_j is 1 and for all others l_j is zero[5]. Finally, it may be noted that the capital coefficient for sector j is higher the higher the level of import substitution because the assumption is made that $b'_j > b_j$.

Investment demand for i sector's products for fixed capital formation is given by

(58-61) $I_i = \sum_j k_{ij} I'_j$

where k_{ij}, the element in the i-*th* row and j-*th* column of the capital proportionality matrix, indicates the proportion of fixed investment in sector j supplied by sector i. Since only four domestic producing sectors — investment goods,

[5]Note also that although Tims says (p. 92) that his investment equation is of the form (neglecting for the moment the import substitution).

$$I'_j = b_j V_j (g_j - 1)\, g_j^{n_j}$$
$$= b_j V_j (g_j^{n_j+1} - g_j^{n_j})$$

in his calculations in Table XVI (p. 93) and in subsequent computations he uses the lag structure we specify above in (54-57). In view of the fact that his n_j's are average lags, what Tims actually does seems more appropriate than what he says he does.

construction, transport, and other services (trade) — supply fixed capital, there are only four equations of this type. Ordinarily in a purchasers' price system like Tims', transport and trade sectors would not supply anything to fixed capital formation because the transport and trade margins on investment goods would be allocated as inputs to the producer of these goods and not to the user of these goods. But since in equation 82 below his imported investment goods are at *c.i.f.* prices, the trade and transport required to take them to the users are shown as inputs purchased by the users from domestic trade and transport producing sectors. Although Tims does not make it quite explicit, this is the only possible explanation.

Stock additions for domestic production and for import are fixed proportions respectively of domestic production levels of the corresponding producing sectors and imports.

$$(62\text{-}66) \quad N_i = q_i X_i$$

$$N_m = q_m M$$

Stock additions for domestic production are required only of four sectors, agriculture and the three manufacturing industries. Note that only product stocks are considered, stocks of current inputs being completely ignored.

Sectoral values added are obtained by subtracting domestic and imported current inputs and indirect taxes from gross values of product.

$$(67\text{-}73) \quad V_j = X_j - \sum_i X_{ij} - M_j - T_j$$

The sectoral origins of M_j are not specified. Since it is valued at *c.i.f.* price, we could christen this composite input bundle "foreign exchange". Note that values added are in general not proportional but a linear non-homogeneous function of the gross value of output.

Demands for imported current inputs are specified as:

$$(74\text{-}80) \quad M_j = m_j X_j + \mu_j$$

while demands for imported consumption and investment goods are given respectively as:

$$(81\text{-}82) \quad M_c = m_c C + \mu_c$$

$$M_k = \Sigma k_{mj} I'_j$$

Indirect taxes on domestic producing sectors are given as

$$(83\text{-}89) \quad T_j = t_j X_j + \tau_j$$

while those on consumption, investment and exports are given as

(90-92) $T_c = t_c C + \tau_c$

$T_k = \Sigma_j t_{kj} \; I'_j$

$T_e = t_e (E - E_s) + \tau_e$

The last six equations define totals for imports (M), exports (E), balance-of-payments (B), gross domestic product (Y), investment (I) and savings (S).

(93) $M = \Sigma_j M_j + M_c + M_k + N_m$

(94) $E = \Sigma_j E_j + T_e + E$

(95) $B = E - M$

(96) $Y = \Sigma_j V_j$

(97) $I = \Sigma_j I'_j + \Sigma_j N_j + N_m$

(98) $S = I + E - M$

Note that throughout his book Tims gives the name of gross national product to what really is gross domestic product[6]. Note also that exports in equation (94) should not include indirect taxes on exports (T_e) since E_j are presumably at *f.o.b.* prices. This is because equation (94) is an expression for foreign-exchange earnings (and savings) and export tax does not constitute any part of these. Balance-of-payments (or rather trade) should also exclude indirect taxes on exports and be defined as $B = \Sigma_j E_j + E_s - M$.

The number of variables in the model are:

Sectoral outputs	7
Intersectoral current flows	39
Consumptions	7
Investment by origin	4
investment by destination	4
stock addition	5
Exports	5
Values added	7
Taxes	10
Imports	9
Import substitution	1
Balance of trade	1
Savings	1
Totals of GDP, M, E, I and C	5
Total:	105

[6]*See* Anisur Rahman [9] for reasons why GDP should be called GDP and not GNP.

so that seven variables have to be specified exogenously. In Tims' model these seven variables are:

agricultural output,
four non-agricultural exports,
gross domestic product, and
savings.

The 98 equations can be written as

$$A_1Z_1 + A_2Z_2 + \triangle = 0$$

and a solution obtained as

$$(RF)\ Z_1 = A_1^{-1}(-A_2)\ Z_2 + A_1^{-1}(-\triangle)$$

where Z_1 = Column vector of 98 endogenous variables,

Z_2 = Column vector of 7 exogenous variables,

A_1 = 98 × 98 coefficients matrix,

A_2 = 98 × 7 coefficients matrix

$\triangle$ = Column vector of constants

The solution RF expresses the 98 endogenous variables as linear functions of 7 exogenous variables. In Annex IV some of the important rows of the reduced form matrix $A_1^{-1}(-A_2)$ are shown. These are used to carry out a large number of numerical experiments. Since the reduced form equations are shown without the constant terms they can be used only to estimate increments, not levels, of variables.

The model may be interpreted as belonging to the group of two-gap models of planning. As is shown by equation 98, the two gaps (savings-investment and foreign exchange) are identically equal. But this equality is *ex-post*. *Ex-ante* the two gaps may differ but they are brought into equality by adjusting the level of import substitution as can be seen from a comparison of equations 94 and 98. An expansion (reduction) in the level of import substitution both reduces (widens) the foreign-exchange gap by saving (spending) on imports and widens (reduces) the savings-investment gap by making the capital coefficients in consumption and intermediate goods sectors higher (see equations 54-57 above).

Using the reduced form equations, Tims carries out four types of exercises, each with a number of alternative numerical values for the major parameters and targets, as preliminary to applying the model to the Third Plan. The exercises are of varying degrees of interest. To give a brief description:

Exercise I estimates sectoral elasticities of growth for the non-agricultural sectors from an assumption of 1 per cent growth in GDP and two alternative growth elasticities for agriculture — a high one of 0.67 and a low one of 0.42. An important finding is that sectoral elasticities vary inversely with the elasticity of agricultural sector and that the elasticity for intermediate-goods manufacture is extremely sensitive to variations in agricultural elasticity. The reason for such behaviour is found in the structure of the model. As agricultural growth is lowered the exportable surplus in agriculture is reduced so that import substitution must be enhanced to maintain the equality between savings-investment and foreign-exchange gaps. Since intermediate goods sector is assumed to do most of import substitution, its output must expand sharply.

Exercise II is an analysis of the macro-economic implications of alternative compositions of agricultural and non-agricultural growth. A major finding is that the cost of growth in terms of investment is higher if the share of non-agricultural sectors is higher. This is partly because the capital coefficient in agriculture is lower, and partly because lower agricultural growth necessitates higher import substitution (according to the mechanism described above) which is particularly capital using. *Ex-ante* trade gap is higher for industrially oriented growth (*see* above for explanation) which has to be closed by costly import substitution.

Exercise III quantifies the mechanism of equalizing the savings-investment gap and the foreign-exchange gap. Again what the major finding demonstrated is that a given rate of growth can be achieved with a lower savings-investment gap, a lower *ex-ante* foreign-exchange gap and a lower requirement of import substitution if the elasticity of agricultural growth is higher.

Exercise IV is on a method of setting the targets in a feasible manner. Feasibility in this context means that the values of certain endogenous variables do not exceed some permissible limits. If targets for GDP, savings, agricultural output and non-agricultural exports are set independently, it is quite possible that the required savings-investment gap and foreign-exchange gaps would be too large to be bridged by expected levels of foreign assistance. The problem is then to set each target in relation to all the others as well as to such "constrained" endogenous variables. Tims derives a second (and further) reduced form equations system for this purpose. In this system five of the exogenous variables (GDP, savings and the three manufactured exports) and two of the strategic endogenous variables (import substitution and foreign-exchange gap) are expressed as functions of marginal savings rate, agricultural export surplus and a constant representing invariant agricultural production (5.5 per cent increase per year) and services exports (increase of 100 million rupees over the Third Plan) through a smaller reduced form equation system derived from the original reduced form system. Once constraints regarding certain strategic

endogenous variables and minimum targets are introduced, it is found that there is relatively small range of choice for other exogenous targets.

The final set of numerical experiments is concerned with the application of the model to Pakistan's Third Five-Year Plan. The model is solved by setting the income target and agricultural output growth at the levels postulated by the Third Plan and by using its assumed marginal savings rate. Exogenous export variables are specified at somewhat different levels than in the Plan. Some sensitivity analyses are also made for variations in agricultural growth and consumption rates.

3. A CRITICAL ANALYSIS OF SOME SPECIAL FEATURES OF THE MODEL

In this section we discuss some of the features of the model and analyse their consequences.

3.1 The Demand for Current Inputs

Tims departs from the more usual and simpler assumption of the Leontief-type of models about proportionality between the amount of current input of the type i and the output level of the using sector j ($X_{ij} = a_{ij} X_j$). Instead he assumes that the relationship is linear but non-homogeneous so that the incremental input coefficients are fixed and the elasticity of input use tends to one as the output level of the using sector tends to be very large. In defence of his assumption Tims provides the following arguments: (a) "In most of the developed countries the assumption of constant (average) technical coefficients is a valid one", because "the structure of a developed economy does not generally show large changes, and the technology used.... is fairly homogeneous. In a developing country... structural change may be rapid and may alter the composition of the national product over a short period of time. Also, new and modern production techniques are introduced alongside traditional ones"; and (b) "If the model is constructed on the basis of a highly disaggregated input-output table, fixed coefficients may apply but in the present case only seven sectors are distinguished. As a result of lumping together sectors with different production functions, which over time may have different rates of growth, the technical coefficients must be changing as well" (pp. 71-72).

Let us examine the two justifications provided above. The reason structural change or technical advance may be considered to be more rapid in an underdeveloped country than in a developed country is that in the former two techniques of producing the same thing usually exist, a traditional one and a modern one, and there is a rapid increase in the share of the modern technique. Otherwise, within a given technique, technological change is perhaps more rapid in a developed country. New methods of production are introduced at a more rapid rate in the developed economies than in the developing ones.

Standard of obsolescence is also higher in the former. Thus for homogeneous techniques and products the assumption of constant average input coefficients is probably more unrealistic for a developed economy than for an underdeveloped economy[7].

If the main worry was the changing shares of traditional and modern techniques, then it probably would have been better to explicitly treat them as separate sectors, or to define the input coefficient of the aggregate sector as a weighted average of the coefficients of the different techniques, weights being the (exogenously estimated) shares of various techniques in aggregate sectors' output during the relevant time period[8]. To the extent the assumption of proportionality is not found objectionable for individual techniques, the coefficients for aggregate sectors would also satisfy the proportionality assumption.

To the extent Tims' worry was to take into account the direction of technical change within each technique, the task is no more difficult than it would be in a developed country. Tims might have tried to estimate such changes on the basis of independent information about the likely pattern of change in product composition and input use.

His argument that the intertemporal stability of input coefficients is inversely related to the level of aggregation used in sector classification also sounds unconvincing. In a highly aggregated sector classification scheme, many changes in techniques will take place for individual products within each aggregate sector, but such changes will tend to average out making it likely that the aggregate sector's input coefficients would be more stable than those for the individual products included in the aggregate sector. While attempts at rigorous proof have not been made[9], empirical findings support the hypothesis that the coefficients would be more stable for a higher level of aggregation[10].

We have shown that the arguments Tims provides in justifying his procedure are at best of doubtful validity. One must, however, recognize that his problem is a very real one. Input coefficients do change over time so that the use of some base-year coefficients may result in a poor predictive value of the model. However, his assumptions about the form of the input functions and his method of estimating the functions are not easy to justify. The actual pro-

[7]There exist a number of studies on the stability of input coefficients in developed countries but none known to the present writer about underdeveloped countries. The developed country studies show large changes over time. *See*, for example, Beatrice Vaccara [14] and Per Sevaldson [11].

[8]For a detailed discussion, *see* Khan and MacEwan [4].

[9]Robert Repetto draws my attention to the similarity of our argument to the Central Limit Theorem.

[10]*See* Per Sevaldson [11].

cedure followed by Tims consists of (a) making the assumption that current-input demand functions are of the form $X_{ij} = a_{ij} X_j + \alpha_{ij}$ and (b) fitting linear regressions for each current input flow on the basis of only two observations obtained respectively from the 1960/61 and 1964/65 input-output tables[11]. When the number of observations are only two, a perfect fit can be obtained for any form of functional relationship (degrees of freedom of course being zero) so that the justification of the form of the function must be provided independently. The particular form Tims assumes does not seem to have any advantage over alternative assumptions, *e.g.*, that either the average or the marginal coefficient is changing over time. In fact, one gets the impression from what Tims says about the causes of instability in input coefficients (quoted above) that he is in favour of one of these alternative assumptions. He is worried about the introduction of new techniques, about changing shares of different techniques and so on. Such changes are rather strongly correlated with the passage of time. The kind of functions he assumes, however, makes the change in average technology dependent entirely on the level of demand or output. The changes between the two input-output tables are due, however, not only to changes in the level of output but also to changes in time. The kind of functions he proposes seems more appropriate for the description of simple assumptions about economies or diseconomies of scale rather than of technological change over time.

The reason we labour this point so much is that the particular assumptions Tims makes about the input functions make the computational burden of the model enormously greater. He has 39 additional equations. If he would assume *proportionality and make adjustments in the coefficients for future on exogenous considerations*, he could work with a much smaller model without any obvious reduction in its predictive value[12].

3.2 Sector Classification and Accounting System

As already stated, the model uses a highly aggregated framework with only seven producing sectors. One wonders why this should have been done when the basic information — the input-output table—was available for as many as 54 sectors. It seems to the present writer that the number of sectors could be increased by a factor of 2 or 3 without increasing the computational burdens if some special dubious assumptions about input functions could be dropped or if the model could be formulated in incremental terms. Results on a further disaggregated basis would be much more useful to a practical

[11]It should be pointed out that even these two observations are not quite independent because inevitably a number of flows are estimated, at least partly, on the assumption of certain proportions in both years.

[12]Note that he could do that even under his assumption if the model were formulated in incremental terms. I am puzzled why he does not do that particularly in view of the fact that his reduced form model and his numerical exercises are all in terms of increments.

planner. One possible explanation of the highly aggregated framework may be in the comparative paucity of data on capital coefficients, but a greater disaggregation of the manufacturing sectors should have been possible since reasonable information on capital assets for these sectors is available from a number of sources including the Censuses of Manufacturing Industries[13].

Tims does not provide much information on the sector classification scheme. It is, however, obvious that at least in a few outstanding cases almost perfect substitutes get included in separate sectors, *e.g.*, home-pounded rice is the product of the agricultural sector while milled rice is the product of consumer-goods sector. This introduces arbitrariness in the individual inputs of the substitutes because all that is really known is that in each use a given quantity of all taken together is required. We have argued elsewhere[14] that such a procedure makes the meaningful projection of demand impossible, and that a better procedure is to aggregate such close substitutes into one sector and obtain as coefficients for the aggregate sector the weighted average of the coefficients of the constituent goods, weights being proportional to their estimated output shares.

The input-output accounting underlying the model is somewhat different from the usual kind. Imports do not show up as negative final demand even for purely accounting purposes and hence the current flows for intersectoral and final uses from the producing sectors consist only of domestically produced parts while all imported inputs are lumped together. We argue below that this kind of accounting introduces great arbitrariness in estimating certain final consumption items.

Since aggregate imported inputs are related to the output levels of the using sectors, the model does not distinguish the sectoral origin of imports. As a consequence we have no way of knowing the total demand for or supply of a sector's products. Moreover a model of this type does not provide the planner with the information of the required allocation of foreign exchange among broad types of goods (*e.g.*, how much import of agricultural goods, how much of intermediate goods, and so on).

3.3 Treatment of Import Substitution

Since imports are related to the output level of the using sectors, one may get the impression that all imports are being treated as non-competitive. This, however, is not true because of the very special treatment of import substitution. The fixed incremental import coefficients are *ex-ante* coefficients. The *ex-post* coefficient for a sector would be smaller to the extent import substitution

[13]Tims seems to have some kind of estimates of capital coefficients on a much more disaggregated basis. *See* his Chapter 7.

[14]*See* Khan and MacEwan [4].

consists of the products used as inputs into that sector. Note that one unfortunate feature of this otherwise ingenious device is that there is no way of knowing the *ex-post* import coefficients because we do not know the composition of *ex-ante* imports.

Import-substitution possibilities in investment-goods industries have been built into the model by arbitrarily reducing the coefficients k_{mj} in equation 82 (Section 2 above) and making compensatory increase in the coefficients k_{ij} in equation 58-61. The endogenous import substitution is to be done only by two sectors — consumption goods (35 per cent) and intermediate goods (65 per cent). Thus, import substitution is specified according to sectoral origin while *ex-ante* imports are specified according to sectors of destination and not according to sectoral origin. The import substitution of a product cannot exceed the base-year level of imports of that product. Note that there is nothing in the model itself that ensures this. Unless one has additional information about the classification of the base-year imports by types, one cannot ensure this even by using the target setting model (exercise IV) to set the exogenous variables in a feasible way to satisfy these constraints[15].

It is well known that in the base year there were significant amounts of imports of agricultural goods and that most of these imports (particularly the foodgrains) can be substituted by domestic production. It is, therefore, curious that the model does not premit any import substitution in agricultural goods. Yet it provides for rather large increase in the export surplus of agriculture.

Finally, an important source of error deriving from the special treatment of import substitution requires some discussion. The input-output framework used by Tims is basically at purchasers' prices, *i.e.*, each industry is assumed to pay the trade and transport costs on all its sales of output, and the value of these services together form the trade and transport input into that industry. But imports are shown at *c.i.f.* prices and the domestic trade and transport inputs required to take imports from the port of entry to the users are shown as purchases of such inputs by the users of the imported inputs. Thus, the observed domestic flow of trade/transport (X_{tj}) has two components.

$$X_{tj} = X'_{tj} + X''_{tj}$$

where X'_{tj} = Purchase by sector j as costs on the sales of its output, and

X''_{tj} = Purchase by sector j as margins on imported inputs used by itself.

The observed input function, under Tims' assumptions, would be of the type:

[15]Note that one could get around this problem by saying that if import substitution of product i exceeds its base-year imports then the difference should be interpreted as required export expansion. The detailed model in Chapter 7 gets around the problem in a different way.

$$X_{tj} = X'_{tj} + X''_{tj}$$

$$= a'_{tj} X_j + \alpha'_{tj} + \lambda_j M_j$$

where λ_j is the trade/transport margin on the import bundle used by sector j. We therefore have :

$$X_{tj} = a'_{tj} X_j + \alpha'_{tj} + \lambda_j (m_j X_j + \mu_j)$$

$$= (a'_{tj} + \lambda_j m_j) X_j + (\alpha'_{tj} + \lambda_j \mu_j)$$

$$= a_{tj} X_j + \alpha_{tj}$$

The basic assumption of Tims' model is that a_{tj} and α_{tj} are fixed so that X_{tj} is determined uniquely by X_j. But we have shown that *ex-post* m_j will vary with the level of import substitution. Consequently the assumption of fixed a_{tj} will not hold. As import substitution takes place, import demand in some sector j would be less than $m_j X_j + \mu_j$ and hence the demand for trade and transport as given by the model would be an overestimate. The actual extent of such overstatement can be quite substantial if import substitution goes on at a rapid rate[16].

It seems that all these problems could be avoided and the process of import substitution made more explicit if the more usual classification of imports into competitive and non-competitive were adopted. Non-competitive imports could be specified the same way imports in the present model are while sectoral allocation of competitive imports could be made on the basis of fixed proportions based on *a priori* judgment about comparative advantage. The import-substitution variable could be dropped completely and the burden of adjustment could be placed on competitive imports. The whole procedure would come out more explicitly if imports were also shown as negative final demand, *i.e.*, if the input-output flows were *total* rather than *domestic* flows.

3.4 Estimating Consumption Demand

The kind of multisectoral models we are discussing generally abstract from price changes. The output levels they predict are the *equilibrium* ones that would ensure that relative prices remain unchanged. Thus when we estimate consumption demand for various sectors' products we have to do so on the basis of the assumption that relative prices are unchanged.

Tims makes the consumption of i a linear but non-homogeneous function of total consumption expenditure. This is a special form of the Engel curve and its applicability will have to be determined by empirical verification[17]. One

[16]Note that a similar overestimation is made for indirect taxes for identical reasons.
[17]Such an Engel curve can be justified only for relatively few consumption goods.

thing however has to be made sure in fitting such functions to actual data — either observations must be used for unchanged relative prices (which is approximately ensured by the cross-section data) or if prices have been changing (which will usually be the case if time-series data are used), the effect of price change must be separated from that of income or consumption change.

Tims fits each of his consumption to the two observations obtained from input-output tables for 1960/61 and 1964/65. It should be emphasised that as a general procedure this is totally inadmissible because during this period changes in the pattern of consumption have resulted not only from the changes in total consumption expenditure but also from the changes in relative prices. Note that estimating everything at constant prices does not help in this respect. Changes in the composition of demand in real terms thus estimated would still be influenced by relative price changes between 1960/61 and 1964/65. What Tims does in effect is to fit a very special form of Engel curve to only two observations from time-series data without corrections for the inevitable price effects generated by relative price changes.

It would appear to have been more appropriate to use expenditure elasticities estimated from cross-section data. That he did not do this is particularly surprising in view of the fact that he later makes uses of such elasticities in making a more detailed study of industrial growth and import substitution (*see* below).

As an example of the differences which would result from this change, we note that the expenditure elasticity of demand that Tims gets by applying his function to the two sets of input-output observations for agricultural goods (foodgrains, livestock products, fruits and vegetables, tea, tobacco, *etc.*) is 0.67 whereas the expenditure elasticity he himself derives in Chapter 7 primarily on the basis of cross-section Pakistani and Indian studies for various types of agricultural goods is over 0.9 (income elasticity of 0.85, p.153). The low expenditure elasticity according to Tims' method seems to be the result of fitting the Engel curve to time-series data over a period during which the economy was experiencing disequilibrium growth with lagging agriculture and rising agricultural prices relative to general prices. Positive income effect was partly offset by negative price effect so that the overall effect gives a low elasticity of 0.67[18].

[18]Tims himself notices that his method gives a lower elasticity for agricultural goods, but thinks it is due to the fact that observed consumptions in the input-output tables deviate from real consumptions since the former are residually estimated and hence contain an unknown quantity of stock changes, which could not be separated for want of information. Fluctuations in stock changes could, therefore, easily influence expenditure elasticities measured according to Tims' method (*see* p. 80). Even if Tims had accurate statistics about stock changes and real consumptions, his method would be inadmissible for reasons we discuss above.

The peculiar accounting technique also makes the projection of consumption demand somewhat arbitrary and difficult. The consumption flows are domestic flows only and hence will be influenced by the pace of import substitution. The estimation of Tims' type of functions on the basis of his kind of information would give higher (lower) elasticities if historically the rate of import substitution has been high (low) and would be quite inappropriate for projection purposes if the planned future rate of import substitution is different from that in the past.

A final difficulty in projecting consumption demand arises out of the fact that public and private consumption have been lumped together. Using Engel relations to predict public consumption is inappropriate. It is better treated exogenously with the composition determined according to the pattern in the recent past. The composition of public consumption is different from that of private consumption and insofar as its share of total consumption in future may change, making prediction for the two taken together would be very misleading.

3.5 Investment Demand Functions

Investment is made endogenous in the model by the assumption of post-terminal growth rates for the using sectors. The growth rates, exogenously specified for each sector, imply certain assumption about sectoral elasticities.

Tims recognizes that the assumption of post-terminal growth rates may create discontinuities if they differ significanytl from those yielded by the model for the Third-Plan period. In such cases he suggests that the post-terminal growth rates "must be revised, inserted in the equations and the entire process repeated until no discontinuities appear any more" (p. 92). One can easily recognize that such a trial-and-error method is very costly and time-consuming because it requires solving the entire model over and over again.

Another problem that Tims does not go into concerns the intersectoral consistency of the post-terminal growth rates. Since the sectoral growth rates for the post-terminal period are specified exogenously there is no way of ensuring that they would be consistent in the sense that the supply and demand for each sector would be equalized at unchanged relative prices. In fact the sectoral elasticities implied by Tims' assumed post-terminal growth rates (Table XVI, p. 93) are somewhat different from the sectoral elasticities implied by his exercise I (Table XVII, p.110). His post-terminal growth rate for transport (and perhaps for other services) is too low in relation to overall growth rate as compared to the guidelines of his exercise I.

One, therefore, wonders whether the more usual alternative method of making investment endogenous in the terminal-year models, *viz.* the use of

stock-flow conversion factors, would not be a more satisfactory procedure. In this method one simply assumes that investment in each sector grows in some smooth fashion — either exponentially (in which case the exponential rate of growth of *investment* has to be specified)[19] or linearly (in which case no growth rate for investment needs to be specified)[20]. Note that in any case Tims makes the assumption of linear growth in investment over time (p. 130).

One empirical aspect of Tims' investment functions should be discussed at this stage. Tims uses the same fixed capital coefficient for consumer goods, intermediate goods, investment goods and construction sectors. He justifies this procedure on the basis that the study from which he obtains the incremental capital coefficients[21] does not distinguish between these sectors. Nevertheless, he might better have made some attempt to disaggregate these coefficients[22]. For instance, it is commonly known that the fixed capital coefficient is remarkably low for construction[23]. It is probably in the neighbourhood of 0.5 and even after including the working capital coefficient (which is probably significant since work in progress is large, but is completely neglected by Tims) is nowhere near 2.6 which Tims uses.

3.6 Needed Aid or Given Aid

In Tims' formulation of the model domestic saving is given exogenously so that the required foreign assistance to bridge the foreign-exchange gap is obtained endogenously. It has been pointed out by a number of people that the great disadvantage of this kind of models is that there is no stipulation that the required foreign assistance would be forthcoming. It is true that Tims' target setting model could be used to specify exogenous variables in such a way that the "constraint" on trade balance is satisfied. But this is at best a cumbersome alternative to the straight-forward treatment of foreign-exchange gap as exogenous. The general principle should be to specify those variables as exogenous about which the planning authority has relatively less freedom. A sensible planning authority should be able to exercise considerably greater degree of freedom with respect to domestic saving than with respect to foreign assistance.

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[19] *See*, for example, Alan Manne and Ashok Rudra [6].

[20] *See* J. Sandee [10].

[21] *See* Bergan and Tims [1].

[22] Note also that Tims has some information on capital coefficients on a disaggregated basis (Table XL, p.167). It is puzzling why he does not make any use of them in deriving the investment equations. Perhaps he trusts the estimates he uses in his model more than these others, but it is difficult to see why he should not have broken it down into separate coefficients for the three types of manufacturing and for construction by using the detailed sectoral coefficients as additional information.

[23] *See* Khan and MacEwan [5, pp. 458-459] for Pakistan and Indian estimates.

It should be noted, however, that the needed-aid type of model is probably a useful device for aid negotiations. Moreover, the governments of the developing countries usually have certain amount of freedom with respect to foreign aid insofar as their international policies, domestic economic performance, and the quality and terms of negotiations can significantly influence the quantity of aid forthcoming.

3.7 "Industrial Growth and Import Substitution"

In Chapter 7, Tims provides a somewhat more detailed analysis of the problem of import substitution. Again he makes the reader work harder than is necessary by not providing him with an explicit statement of the model in algebraic terms.

He uses the static Leontief type of input-output model which distinguishes 54 production sectors. He drops the assumption of non-homogeneous input functions and uses instead the standard Leontief assumption of proportionality between current input and output levels of the using sectors. The same is done for import functions as well. Note, however, that he need not assume that these coefficients are constant over time.

He also drops the peculiar assumptions about consumption functions and uses instead the expenditure elasticities derived mainly from cross-section studies.

His method may be described in the following steps: Step 1: Using total consumption of his Third-Plan model discussed above he obtains a sectoral classification of consumption by using expenditure elasticities. He also splits investment and exports of the Third-Plan model into new sectors with the help of additional information. Thus, he obtains the vector F of final demands for the terminal year of the Third Plan according to the new and detailed sector classification. Step 2: Using the static input-output framework, equilibrium outputs are predicted for 1969/70, $X = (I-A)^{-1}F$, where X = vector of outputs, A = matrix of current input coefficients, and I = identity matrix. Step 3: Using the import coefficients matrix, M, the vector of imports according to sectors of origin are obtained, $MX = U$ where U is the vector of imports. Total imports are found to be too high to satisfy the constraint on the balance of payments, so import substitution must be undertaken. Step 4: Each category of imports is classified into competitive and non-competitive. A further screening of the competitive imports is made on the basis of certain feasibility criteria and the remaining competitive imports are arranged in order of *net import substitution per unit of gross value of output* (*i.e., c.i.f.* cost of import per unit of the output at domestic market price less direct and indirect requirement of imported inputs to expand gross output by one unit). Import substitution is recommended in those industries for which this is the highest.

It seems that the dichotomy of the use of models is quite unnecessary. If Tims were willing to abandon the dubious assumptions of linear non-homogeneous functions for current inputs, consumption, imports, *etc.*, his Third-Plan model could easily utilize this detailed framework without increasing (perhaps at the same time reducing) the computational burden. Since he also has some kind of information on the capital coefficients for the detailed sectors, investment functions could be estimated and made endogenous.

A final word about Tims' criterion of import substitution. One immediately wonders why Tims maximizes net import substitution (net saving of foreign exchange) per unit of gross value of output and not per unit of some scarce resource, say investment. It seems to the present writer that there is no particular virtue in Tims' criterion while the alternative one of maximizing the saving of foreign exchange per unit of investment is undoubtedly a better one. To obtain the latter, Tims' net import substitution coefficient has to be divided by the total direct and indirect capital-output ratio. This could easily change the ranking[24].

3.8 The Numerical Results

A final comment about the numerical results of the model is in order. Tims does not say how sacrosanct these numbers are. It would be a pity to process such a huge amount of data only to say at the end that the numerical results are merely illustrative and Tims rightly does not take that position. He, however, should have indicated whether they should be regarded simply as orders of magnitude or as quantitative predictions with insignificant variance. While the level of aggregation, the rudimentary character of the data, and the tentative nature of the functional relations used in the model all tend to suggest that the numerical results should best be regarded as orders of magnitude, one gets the feeling that Tims' reporting at times tend to regard them as more sacred than they really are.

4. THE STRATEGY OF REGIONAL GROWTH

So far our discussion has been based entirely on the last three chapters and the appendices of Tims' book — the parts dealing with the models and their applications. In the first four chapters of the book the author presents a description of the organization of planning in Pakistan, and briefly discusses the statistical basis, the major policy issues, and the economic setting of the Third Plan. Much of this is straight-forward description embodying the author's close personal knowledge derived from long participation in the planning process of the country.

[24]Using only the direct capital-output ratios from sources similar to those Tims uses (A. Manne and T. Weisskopf [7]) we find petroleum to be most desirable as compared to cement according to Tims.

When it comes to the discussion of the problem of regional growth, however, Tims bases his comments on unproved hypotheses rather than factual evidences. His argument runs as something like the following: (a) To remove certain bottlenecks from East Pakistan's agriculture and transport sectors, large investment projects with long gestation lags will have to be undertaken. He is not quite explicit about the desirability of immediately starting upon these projects, but seems to suggest that these are indispensable if growth is to be ensured in the long run. (b) Thus given the level of effort, output in East will grow rather slowly in the short run. (c) To ensure that disparity gradually diminishes, output in East must grow at a higher rate than output in West. To satisfy this criterion in the short run, West's development effort has to be curtailed.

This is a very artificial interpretation of the objective of regional parity. The objective of gradually removing regional disparity need not be interpreted so rigidly and inflexibly as to require that disparity in any period is less than in the previous period. What must be ensured is that disparity is substantially reduced over the longer period and rendered negligible by the end of the perspective-plan period. The best way of achieving this objective may be to undertake *now* the massive investment projects to which Tims refers with the result that there will be little reduction (perhaps some further increase) in disparity *in terms of per-capita output* in the next few years but quite rapid reduction in disparity in per-capita output in the relatively longer run when these investment projects produce output and help overcome the bottlenecks. What must be ensured, however, is that the disparity *in the rate of investment* is removed immediately and actually a bigger share of national investment is diverted to East Pakistan. Once this is achieved, the political problem of not achieving an immediate reduction in disparity in per-capita output would not at all be great.

Tims also points to "a fallacy in the concept of per-capita income disparities". "Material welfare in a region is not only determined by the production within that region", says Tims, "but also by the net transfers received from outside" (p. 30). According to him regional resource transfer should, therefore, be considered as an important instrument of regional policy. Clearly he is arguing for *consumption* subsidy from the fast-growing region to the slow-growing region and not for resource transfer for *investment* purposes because the latter would reduce disparity in per-capita output anyway.

In order to argue for such a policy, one has to prove that the policy of reducing regional disparity in output per head involves some cost in terms of aggregate national production, *i.e.*, the slow-growing region is also the less-productive region. Tims provides no such argument. In fact none of the

available evidence suggests that removing regional disparity reduces national output[25].

Moreover, the policy of consumption subsidy would be unacceptable to both the regions in the longer run: the fast-growing region is unlikely to accept such transfer for long because unlike resource transfer to the other region for investment purposes, such transfer does not bring in any direct returns, while the slow-growing region, with such a policy, would become economically more and more vulnerable with the passage of time.

5. CERTAIN CONCLUDING REMARKS

In the above we have tried to indicate certain methodological and empirical problems in Tims' model. We have shown how the accounting framework and some important functional relations deviate from the simpler assumptions of the usual Leontief-type model. We have also tried to demonstrate that some of these special assumptions and procedures give quite misleading results while others are of dubious value.

Since a reviewer inevitably emphasizes the weaker aspects with a view to suggesting improvements, we have not said much about the positive contribution of the exercises done by Tims. It must be remembered that his is the first multisectoral model applied to Pakistan's planning problems[26]. Such a framework is indispensable for the proper planning of the sectoral allocations of resources and for the specification of priorities. Tims' is, therefore, the first attempt to provide a sensible basis for sectoral planning. It convincingly demonstrates the superiority of a multisectoral approach in planning and indicates the interrelations which must explicitly be taken into account to formulate a balanced plan.

Clearly, a great many ways exist in which the model can be made more useful to the planner and the author himself points out a number of them in the epilogue. Particularly important are specifying more sectors and major regions, introducing optimization and constantly directing effort towards the improvement of the underlying data. Tims' exercises, for all their weaknesses, have laid a solid foundation for these improvements and have attracted the attention of other economists in the country to build upon his foundations.

This book embodies the results of the planning exercises carried out by a practical planner who often had to work against deadlines so that many of

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[25]The Third Plan actually recognizes that East Pakistan is the more "productive" of the two regions by using a lower aggregate capital coefficient for it than for West Pakistan. Also, *see* [2] and [3] for some numerical results.

[26]The basic model was available in mimeographed form nearly three years before the publication of the book under review. *See* Tims [13].

the possibilities had to be abandoned to turn the product out in time. Such models often have a great deal of built-in indivisibility. Once the basic system is formulated and solved, it is extremely difficult to make specific improvements because even the slightest change in assumptions would require the recalculation of the whole thing and this is particularly difficult when all the large-scale computations have to be done abroad.

Concerning the need to specify more sectors, the dichotomy between his basic model and his more detailed import-substitution model is unfortunate. The present writer cannot help believing that Tims must have formulated the two models at different points of time to solve different and largely independent problems confronting the Planning Commission. While synthesizing such independent efforts into a single basic and detailed model would in this case be a more satisfactory procedure from the standpoint of building planning models, an interesting aspect of the present arrangement of the book is that it provides some kind of a "running commentary" of the actual stages in which planning exercises were carried out at Pakistan's Planning Commission around the time the Third Plan was formulated.

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