BIBLIOGRAPHY

Bronfenbrenner, Martin «A Simplified Mahalanobis Development Model.» **Economic Development and Cultural Change,** IX (October, 1960).

————————. «The Mahalanobis Development Formula.» **Indian Journal** of Economics, XLI, Part I I I (January 1962).

Chakravarty, S. **The Logic of Investment Planning**(Contribution to Economic Analysis, 18.) Amsterdam 1959. North-Holland Publishing Company.

Chenery, H., «Comparative Advantage and Development Policy,» **American Economic Review**» (March, 1961).

Chenery, H., and Bruno,M. «Development Alternatives in an Open Economy : The Case of Israel.» **Economic Journal** (March, 1962).

Komiya, R. «A Note on Professor Mahalanobis' Model Of Indian Economic Planning» **Review of Economics and Statistics** (February, 1959).

Mahalanobis, P.C. Some Observations on the Process of Growth of National Income.» **Sankhya** (1953).

————————«The Approach of Operational Research to Planning in India.» **Sankhya** (1955).

Millikan, Max (ed.), **National Economic Planning,** National Bureau Of Economic Research, Columbia University Press, New York, 1967.

Finally it should be noted that it is dangerous to generalize the development strategy suggested by the model, since there is some relation between the type of procedure adopted and the characteristics of the economy[22]. Therefore,, while large countries such as India may be tempted to follow more autarchic policies; small countries, such as the Arab countries, will be forced to pay more attention to comparative advantage because they cannot hope to produce the whole range of manufactures and capital goods domestically.

22— Hollis B. Chenery, «Comparative Advantage and Development Policy,» **American Economic Review,** Vol. 51 (March 1961), pp. 18-51.

funds is based on the closed two sector model which shows that the larger the allocation of investment to this sector, the higher is the long-term rate of growth.[18]. However, this argument cannot be used if a large amount of capital goods from abroad can be imported as assumed in the four sector model.

(8) Another deficiency of the model that will be discussed here (and which is a major one) is that the model assumes that investment is a single homogenous fund. The model might be useful even with capital consisting of a collection of heterogenous capital goods as long as we assume constant relative prices. But this is just which is not permissible to do.[19]

(9) Finally, the model was not used to examine the significance of alternative long-term programs,[20] and in fact it could have been used for that purpose only with substantial modifications.

V — Policy Implications

There are three major policy implications in the model that has been discussed in the preceeding pages,. These are :

1 — Increasing the rate of investment is the only fundamental remedy for unemployment in India.

2 — From the long run point of view, the larger the investment in capital goods industries, the largers will be the income generated in the long run.

3 — The tendency toward using a balanced growth strategy through target setting in key sectors, stress on avoidance of bettlenecks, and attempts to equate supply of and demand for labor and capital.

In its concentration on the saving-investment relationship and the possibilities of substitution between capital and labor, the model has serious deficiencies as a basis for development policy. The model excludes questions of equal concern to policy makers such as the changing structure of demands in the role of foreign trade, and the allocation of resources.[21].

The absence of such important parameters (whether direct, i.e., those which are fixed by government; or indirect, i.e., those which can only be influenced by government) will make the process of manipulation of the model rather difficult and sometimes impossible. This process of manipulation is important since it is the one that gives information as to the size and direction of the impact of any change in parameter — and may thereby help to decide about policies which affect that parameter.

---

18 — Bronfenbrenner has showed that an extension of the two sector model to an open economy will not necessarily give the same result. See Bronfenner, **op. cit.,** p. 51.

19 — Chakraverty **op. cit.,** p. 49.

20 — H. Chenery and M. Brune. «Development Alternatives in an Open Economy : The Case of Israel.» **Economic Journal** (March, 1962).

21 — This deficiency is also shared by many current growth models.

Investment in new processes is the mechanism by means of which the process of structural change (or structural breake as it is often called) takes place. this is the truly dynamic problem of a change in the production functions which is given no account in the model.

(5) The model has a uniform one — period lag in the production of all goods, and thus the gestation lags which are an essential part of investment planning in economic growth are not appropriately considered. Investment is tripartite : finished (in production,) started (being built), and in execution (goods in process). the introduction of such lags will result in slowing down the rate of growth compared to a situation where these lags are absent, or alternatively that the same rate of growth requires more savings with them without these lags. [15], [16]

(6) The parameters of the model are defined in incremental terms and are assumed to be constant. This assumption might be appropriate in the case of capital widening types of investment, but it may not be so in other types as irrigation, housing, etc. These investment projects will certainly raise productivity but will not be accompanied by a future increase in employment.

Moreover, when prices change, these parameters may change accordingly even if the technological process of production remains unchanged, and the logical applicability of such parameters is questioned. Such parameters, therefore, should depend not only on technological conditions, but also on prices. [17]

(7) The model assumes that the entire national income is produced domestically. The economy is, or should become, independent of outside sources for fundamental goods. This is, of course, subject to question.

The above argument could be applied not only to capital goods in particular, but to any (except luxury) goods. Then, is he saying that self-sufficiency is always better than international specialization and cooperation for India ?

This problem of international integration of the economy is essential to the whole problem of investment planning since it will determine the economic policy towards new industries, and whether some new economic activities will pay their way. Such considerations will determine in **what** direction should the economy be changed, and **how** and **when** should investment be distributed among industries.

The decision that the capital goods sector should receive 1/3 of total investment

15 — **Ibid.,** Chap. IV., pp. 61-79.

16 — This could be proved as follows : If the gestation period is δ, and the capital-output ratio is σ, then, $I_t = \sigma [Y_{t+\delta+1} - Y_{t+\delta}] = \sigma \Delta Y_{t+\delta+1}$
But $\Delta Y_{t+\delta} = g$ $)^{\delta} Y_t$ then $I_t = \sigma g(1+g)^{\delta} Y_t$.
On the other hand $S_t = \alpha Y_t$ For equilibrium we should have $S_t = I_t$
and thus $\alpha Y_t = \sigma g(1+g)^{\delta} Y_t$ $\therefore g = \frac{\alpha}{\sigma(1+g)^{\delta}}$

17 — Komiya, **op. cit.,** p. 30.

Maximize $\Delta Y = y_1 + y_2 + y_3$ (the objective function)
subject to the constraints

$$2{,}86\,y_1 + .8\,y_2 + 2.22\,y_3 \leq 37{,}500$$
$$327\,y_1 + 320\,y_2 + 593\,y_3$$

and the non negativity requirements :

$$y_1 \geq 0\,,\quad y_2 \geq 0\,,\quad \text{and}\quad y_3 \geq 0$$

The solution to this problem shows that only production in sector 2 is efficient in the sense that for maximum national income all productive activities should take place in sector 2. Moreover, the situation will be characterized by a labor scarcity and capital abundant economy which is contrary to the common sense belief about India. Therefore, something must be wrong in the formulation of the model.

While Mahalanobis mentioned that production in sector 1 should be discouraged and that of sector 2 has to be encouraged, he did not mention how these are allowed for in calculating the parameters. Komiya's view is that it is more reasonable to maximize income before taxes and subsidies and assumed (arbitrarily) that factor requirements are 10% higher for sector 2 and 10% lower for sector 1.

The solution of this problem shows with the given supplies of factors, the increase in income is higher then that given by the 5% goal assumed in the model. [12], [12].

(3) The lack of any considerations of factor prices problem. The solution of a price imputation problem is the dual of the linear programming problem discussed above. The original model gives a zero price (which is equal to the marginal product) for capital. Even when we allow for differences in the costs of production among different sectors, the price imputed to labor is still unreasonably high. This suggests either that there is something wrong in the construction of the model or that the estimates of the parameters used are not correct or perhaps both. [13]

(4) No attempt is made in the model to show the time path of the variables in a dynamic sense where the structure of the system itself is changing over time. [14]

---

11 — **Ibid.**, p. 33.

12 — This solution shows that production in sector 3 (services) is still inefficient. But if such consideration is important, it must be explicitly incorporated into the model. Any model which pays no explicit attention to the major objectives to be achieved by the plan cannot form a working theoretical basis for economic planning. The model can thus be defended by such welfare reasons.

13 — Komiya, **op. cit.**, p. 34.

14 — S. Chakraverty. **The Logic of Investment Planning.** (Contributions to Economic Analysis, 18.) Amsterdam, 1959. North-Holland Pulb. Co., Ch. 2 see also, R.S. Eckus, «Planning in India,» in Max Millikan (ed.) **National Economic Planning,** National Bureau of Economic Research, Columbia University Press, New York, 1967, pp. 305-13.

Which will give us values of Y_1, Y_2 and Y_3.

The final point that will be discussed in this section is related to the type of aggregate production function assumed in this model and the nature of technical change.

Since the parameters β_i's (the incremental output — capital ratios) and θ_i's (the net investment required per engaged person in each sector) are assumed to be given and fixed during the plan period, then the aggregate production function for each sector is one of fixed proportion production function. These functions are different for different sectors because the parameters are different) and all, of course are homogenneous and linear.

For the very same reason (constancy of the parameters) technical change is not allowed for in the model. Techincal change could be presented as an outward shift of the production function. But this is not permissible under our assumption. However, it could be introduced easily by allowing the β_i's and θ_i's to vary over the planning period.

IV — Technical Deficiencies of the Model

(1) The consideration of the demand side of economic planning is almost entirely absent from the model. He assumes the entire economic problem to be one of supply. This means that the government will absorb or distribute any surplus that may arise. [8]

In this model the supply of consumer's goods is determined only from considerations of supply conditions quite independently of the possible level of demand for them. While he was well aware of this and mentioned the need for checking the balance between demand and supply, he did not incorporate it explicitly into the planning model as additional equations.

In addition, the equality between demand and supply of capital and intermediate goods should be taken care of if there is to be a consistent economic plan. There is no explicit considerations of these relationships in the model, however.

It should be noted that the model will be more realistic, the more restricitions are explicitly taken into account, and it will have little economic meaning if important restrictions are not considered or if the solution does not give a consistent and feasible plan.[9]

(2) The model is satisfied with 5% annuel increase in national income, and, therefore, is not an optimizing model. Expressing the model in linear programming form, national income could be maximized under the given conditions of the supplies of new investment and labor.[10]

---

8 — Komiya, **op. cit.**, pp. 31-32, see also Bronfenbrenner, **op. cit.**, pp. 45-7.
9 — Komiya, **op. cit.**, p. 32.
10 — **Ibid.**, p. 33.

Numerically, we have [6] :

Initial national income is Rs 108,000 m. per annum. The target for increase in national income is 5% $\simeq$ 108,000 $[(1+.05)^5-1]$ = Rs 29,000 m

Total Investment funds are Rs. 56.000m. over five years out of which 1/3 is directed to the capital goods sector (or Rs 18,500 m.) and the rest (Rs 37,500 m.) is directed to the other three sectors. Also, the target for new employment is 11 m. workers.

When the funds directed to the capital goods sector are determined, and since the labor and capital requirements are known parameters [7], then it is easy to determine the increase in income and employment in this sector :

The increase in income produced in the capital goods sector = Rs 18,500 $\div$ a_R = Rs 3,700 m.

The increase in employment in this sector = Rs. 3,700 m. $\times$ b_1 = 0.9 m.

The planning problem is now reduced to one of distributing the remaining investment funds of Rs. 37,500 m. among the last three sectors in such way as to increase income by Rs. 25,300 m. and employment by 10.1 m.

This could be found as a solution of the next three simultaneous equations to find the value of y_s hich will satisfy them :

$$\begin{aligned} y_1 + y_2 + y_3 &= 25,300 \\ 2,86y_1 + 8y_2 + 2.22y_3 &= 37,500 \\ 3,27y_1 + 320y_2 + 593y_3 &= 10,1 \end{aligned}$$

A solution of this system of equations could be found through the use of the usual techinques of matrix algebra :

$$\begin{bmatrix} 1 & 1 & 1 \\ 2,86 & 8 & 2.22 \\ 327 & 320 & 593 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \begin{bmatrix} 25,000 \\ 37,000 \\ 10,1 \end{bmatrix}$$

6 — R. Komiya, «A Note on Professor Mahalanobia's Model of Indian Economic Planning,» **Review of Economics and Statistics** (February 1959).

7 — It should be noted that Komiya's presentation is slightly different from that of Mahalanobis in the sense that he uses as parameters the K/O and L/O instead of the parameters originally used by Mahalanobis and represented by B s and Θ s above. While we could transform one set of parameters to the other, Komiys's procedure is used here to make it easier to understand some of the criticisms to the model presented in the next section.

minimal value for λ_R. Mahalanobis suggested a minimum of $\lambda_R = 0,33$ [4]

(For higher minimal rates of growth, the value of λ_R is correspondingly higher) [5]

Also, if N is defined as the additional number of persons engaged over the plan period, then :

$$N = n_R + n_1 + n_2 + n_3$$

Now, define α as the ratio of net investment to net national income at factor cost (thus it is the average propensity to save) and is assumed to be constant. If A is total investment over the whole plan period and θ is the net investment required per engaged person in each sector, then :

$$A = n_R\theta_R + n_1\theta_1 + n_2\theta_2 + n_3\theta_3 \qquad (3)$$

Since λ_R is given, then $n_R\theta_R = \lambda_R A$ and so we have :

$$A = \lambda_R A + n_1\theta_1 + n_2\theta_2 + n_3\theta_3 \qquad (3)$$

Then, if E is the total increase in income over the whole plan period, and if g is the constant rate of growth which he assumes given and equal to 5%, we get :

$$E = \beta_R\theta_R n_R + \beta_1\theta_1 n_1 + \beta_2\theta_2 n_2 + \beta_3\theta_3 n_3 = Y_0\left[(1+g)^5 - 1\right] \qquad (4)$$

In order to use this model, we must substitute statistical estimates for the different algebraic symbols in the above equations.

It is possible to treat E, A, and N as variables. But the values of the ratios $\beta_R, \beta_1, \beta_2$ and β_3 and $\theta_R, \theta_1, \theta_2$ and θ_3 behave as parameters and are given in the sense that their values are assumed constant and are not sought to be influenced by planning during the plan period.

The allocation ratios of investment λ_i on the other hand, (and excluding λ_R which is given) are at the choice of the planners, and must then be obtained as solutions of the set of simultaneous equations given above. The rate of increase of income and employment may be treated as variables to which desired value may be assigned. The model would then enable us, with the help of numerical estimates of the various parameters, to study how the allocation ratios λ_i should be chosen so that the desired aims can be realized.

---

4 — Mahalanobis, **op. cit.**, p. 29.

5 — M. Bronfenbrenner. «A Simplified Mahalanobis Development Model» **Economic Development and Cultural Change,** Vol. IX (Octobre, 1960), p. 49.

term growth of the economy is going to depend on it [2] It was, therefore, decided to increase the rate of investment in India to 10 or 11% during the plan period.

The long run aim, as Professor Mahalanobis saw it, should be to produce capital goods within the country rather than to import them. The proper strategy would, therefore, be to bring about a rapid development of the industries producing investment goods in the beginning through increasing appreciably the proportion of investment in the basic heavy industries.

The technical methods used in the plan formulation can now be briefly explained. The total amount of investment available having been provisionally settled, one may proceed (provisionally, of couse) to distribute the investment to groups of industries or to individual industries and services. In each industry, the amount of investment having been (provisionally) settled, it would be possible (with the help of technological coefficients) to estimate the expected output in physical terms and in money value, the expected contribution to national income, and the expected volume of employment generated. Adding these up we can get the total income and employment which may be reasonably expected to be generated by any particular way of allocation of investment.[3]

III — The Structure of the Model

The model divides the Indian economy into four sectors : the capital goods sector, and the industries producing consumer goods and services are divided into three additional sectors : namely factory production of consumer goods setor (C-1); the production of consumer goods (including agricultural products) in small and household industries sector (C-2); and services such as health education, etc. sector (C-3). The allocation of investment funds among these sectors is given by :

$$\lambda_R + \lambda_1 + \lambda_2 + \lambda_3 = 1 \qquad (1)$$

where each λ_i represents the fraction of total investment going to each specific sector.

The value of λ_R is taken from his two sector model. In that model he argued that in the initial stage of development the larger the percentage of investment in consumer goods industries, the larger will be the income generated. This has to be expected since the incremental output capital ratio (which is defined as β) is expected to be larger in consumer goods industries than in capital goods industries ($\beta_c > \beta_i$). But there is a critical range of time and as soon as this is passed, the larger the investment in capital goods industries, the larger will be the income generated.

For these long-term growth considerations, the minimal growth rate will require a

---

2 — This point will be developed in some detail in the next section.

3 — Mahalanobis, **op. cit.,** p. 21.

THE MAHALANOBIS PLANNING MODEL

BY

SAKR AHMED SAKR*

Assistant Professor of economic,
Kuwait University.

1 — Introduction :

Its was almost twenty years ago when professor P.C. Mahalanobis presented his two planning models that were used for the formulation of the Indian second and third five year plans. The former was a 2 sector model, to demonstrate the allocation of investment between the sectors and the over-all growth rates. It distinguishes consumer goods and investment goods, the later usable to creete capacity in either sectorgiven these, and some other conditions, if followed that the long run rate of growth depends on the reletive allocation of investment to the capital goods producing sector. The latter four sector model, was intended to indicate the investment allocations which would achieve prescribed growth rates and employment levels.

In this paper, the four sectors model will be discussed and analyzed in order to show the purpose, the structure, and the technical defeciencies of the model. Finally, the policy implications of using the model in planning in other less developed countries will be discussed.

II — The Purpose and Uses of the Model

The model was used as the theoretical and statistical basis for the formulation of the Indian Second Five Year Plan. The two major objectives of this plan were to increase national income as much as possible while progressing towards full employment. [1]

In India, as in most underdeveloped countries, unemployment is chronic because of the lack of capital goods and, therefore, the only fundamental remedy is to increase the rate of investment. This could be done through expanding the production in the small scale and household industries which is labor intensive and capital light sector. The demand for such products could be increased through an increase in investments in heavy industries and the expenditure on services.

The increase in the rate of investment is also important in the sense that the long

Dr. Ibrahim Abu-Lughod Professor of Political Science, Associate Director of African Studies, Northwesters University.

1 — P.C. Mahalanobis. «The Approach of Operational Research to Planning in India,» **Sankhya.** (December, 1955), p. 17.