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Investment criteria in economic development

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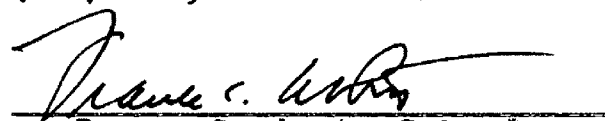
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PART ONE

THE CRITERIA

INTRODUCTION

"There is scarcely any inquiry more curious, or, from its importance, more worthy of our attention than that which traces the causes which practically check the progress of wealth in different countries."[1] As interesting as the subject of economic development may be, there was no large body of literature on the subject until after World War II.

The revival of interest in economic development over the past ten or fifteen years has been addressed to two main questions.[2] What determines the rate of economic growth? And what is the best allocation of resources to promote the growth objective? The first question is focused on the most important problem, capital accumulation. The second question is concerned with the specific allocation of inputs among alternative projects and techniques.

Allocation of capital among alternative techniques and projects is a process forced upon the underdeveloped

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[1] T. R. Malthus, Principles (2d ed. reprint; New York: Augustus Kelly, 1951), p. 309.

[2] H. B. Chenery, "Comparative Advantage and Development Policy," American Economic Review (March, 1961), p. 18.

country because the stock of available resources is limited. The problem can now be defined: Given the stock of resour- ces, determine which projects and techniques will contribute most toward the development effort of the country. This problem has led to the formation of investment criteria.[3]

Investment criteria are either means of judgment or tests of the allocation of resources among the alternatives to see which set will yield the greatest advantage in the development of the country. Although the problem of capi- tal allocation is of secondary nature to that of capital accumulation, the establishment of priorities has been re- garded in the literature on economic development as an acute problem of development theory and policy.[4]

Before discussing the types of investment criteria, it is helpful to distinguish between the two alternatives that are considered in the apportionment of capital, the choice of projects and the choice of techniques. The choice of projects is related to the selection of the output mix of the economy. Jan Tinbergen has defined a project as follows: "A project may be described as the input of a bunch of production factors with the consequences of obtain-

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[3]G. M. Meier and R. E. Baldwin, *Economic Development* (New York: John Wiley & Sons, 1959), p. 343.

[4]A. O. Hirschman, *The Strategy of Economic Develop- ment* (New Haven: Yale University Press, 1959), p. 76.

ing a package of products."[5] On the other hand the choice

of techniques is concerned with the best way of producing

the output given the factor prices. The choice of techni-

ques is a technological problem that exists within a parti-

cular project.[6] The two concepts are related by the fact

that the overall growth of a country will not only depend

upon the choice of projects but also upon the choice of

techniques.[7]

Investment criteria can be divided into two types,

those considering economic factors and those considering

non-economic factors. The criteria concerned with economic

factors can be further separated into those criteria which

use partial equilibrium analysis and criteria using general

equilibrium analysis. The criteria using partial equilibrium

analysis differs in that the partial equilibrium criteria

contain a _ceteris_ _paribus_ assumption.[8] Finally, the econo-

mic criteria may be subdivided into static and dynamic cri-

teria.

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[5]Jan Tinbergen, "The Relevance of Theoretical Criteria,"
Investment _Criteria_ _and_ _Economic_ _Growth_ (Cambridge: Massachu-
setts Institute of Technology Center of International Studies,
1955), p. 3.

[6]A. K. Sen, _The_ _Choice_ _of_ _Techniques_ (Oxford: Black-
well, 1960), p. 11.

[7]B. Higgins, _Economic_ _Development_ (New York: Norton
& Company, 1959), p. 344.

[8]W. Galenson and H. Leibenstein, "Investment Criteria,
Productivity, and Economic Development," _Quarterly_ _Journal_
_of_ _Economics_, LXIX, No. 3 (August, 1955), p. 344. A. K. Sen,
_op_. _cit_., p. 52.

CHAPTER II

FACTOR INTENSITY

Partial equilibrium criteria contain a _ceteris_ _pari-_
bus assumption that is required by their nature. Galenson
and Leibenstein give two views of the assumption:

> . . . tastes, size and composition of the population,
> the state of the arts and expectations remain the
> same. Or, another way of looking at it is that an
> "efficient" allocation requires an accurate forecast
> of tastes, population, and the state of the arts in
> the future.[9]

The usefulness and necessity of the _ceteris_ _paribus_ assump-
tion will be examined in Part Two.

Before presenting factor intensity criteria, it may
be helpful to explain that the key idea contained in them
is embodied in the ratios of output to capital and of labor
to output. In one case the ratio of capital to labor is
used.

The relevant ratio in the case of capital intensity
is the ratio of output to capital invested. J. J. Polak
and Norman S. Buchanan suggested the criterion in which the
ratio of output to capital is maximized. This criterion
has been termed the rate of turnover criterion.

J. J. Polak presented two short views of the rate of

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[9]W. Galenson and H. Leibenstein, _loc._ _cit._

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turnover criterion in an article dealing with balance of payments of war damaged countries. The two ideas are:

> It may be said with general validity that the rate of turnover of investment projects undertaken, should, if possible, be large. This conclusion is obviously a special case of the general economic law that productive processes should be less roundabout when capital is scarce than when it is more abundant.[10]

> Investment projects which will show a high rate of turnover of capital are less likely to lead to a foreign exchange problem than those with a low rate of turnover.[11]

Polak would advocate minimizing the capital-output ratio.

Norman S. Buchanan has an idea similar to that of J. J. Polak. Although Buchanan states his criterion in a slightly different manner, given the existing prices of output the criterion is the same as that of Polak. Specifically Buchanan stated the criterion as a method of determining priorities.[12] Also, Buchanan developed his concept while dealing with problems of external balance.

The explicit statement of the criterion was:

> If investment funds are limited, the wise policy, in the absence of special consideration, would be to undertake first those investments having a high value

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[10] J. J. Polak, "Balance of Payments Problems in Countries Reconstructing with the Help of Foreign Loans," Quarterly Journal of Economics, LVII (February, 1943), p. 219.

[11] Ibid., p. 228.

[12] N. S. Buchanan, International Investment and Domestic Welfare (New York, 1945), p. 24, as quoted in A. K. Sen, op. cit., p. 25.

of annual product relative to the investment necessary to bring them into existence.[13]

In summary, the rate of turnover criterion advocated by Polak and Buchanan was one of determining the projects and techniques of the investment program by means of maximizing the ratio of output to capital. Both men were taking as given that a country would find it advantageous to maintain external balance in the foreign trade sector of the economy. A. K. Sen has presented a model which illustrates the rate of turnover criterion and it is worthwhile to present the model now as it will be utilized in the following chapters.[14]

Notation and Assumptions:

x = Quantity of labor employed in making "corn" with one machine (produced by one man-year in the capital goods sector;

$f(x)$ = Corn output per year per machine;

Y_n = Total corn output of the 'advanced' sector from year 1 to year n;

A_n = Aggregate corn output of the 'advanced' sector from year 1 to year n;

S_n = Total corn surplus produced in year n;

S^* = Initial surplus of corn obtained from the backward sector to start the advanced sector;

I_n = Employment in the capital goods sector in year n.

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[13]_Ibid._

[14]A. K. Sen, _op. cit._, p. 34-36.

(1) Corn units are so chosen (compared with units of of labor and time) that the corn wage rate per year is one.

(2) Machines are produced by labor unassisted by other machines and they last forever. There is no working capital.

(3) There are no current inputs other than labor.

(4) The output of the 'backward' sector is unaffected by the outflow of labor from it, so that the total output of the community is the output of the 'advanced' sector plus a constant.

(5) The wage bill is entirely consumed and the surplus is reinvested.

(6) There are constant returns to scale and diminishing returns to machines, given the employment level.

The Model

1.1 $I_n = S_n$

1.2 $S_o = S^*$ Therefore $I_c = S_o = S^*$ by equation 1.

1.3 $Y_1 = S^* f(x)$

1.4 $S_1 = S^* \cdot (f(x) - x)$

1.5 $Y_2 = Y_1 S^* f(x) = S^* f(x)(1 + f(x) - x)$

1.6 $S_2 = S^*(f(x) - x) \cdot (1 + f(x) - x)$

     .

     .

1.7 $Y_n = S^* f(x) \cdot (1 + f(x) - x)^{n-1}$

1.8 $S_n = S^* f(x) \cdot (1 + f(x) - x)^{n-1}$

1.9 $A_n = \sum_{i=1}^{m} Y_i S^* f(x) \dfrac{(1 + f(x) - x)^{n-1}}{f(x) - x}$

Following the Polak-Buchanan criterion, we want to find the most desirable capital intensity, $1/x$. Actually present or immediate output is to be maximized relative to

the amount of capital. Taking equation 1.3 from above, the object will be to maximize Y_1 with respect to x. Y_1 will be a maximum when the first derivative fulfills the necessary condition, dY_1/dx being equal to 0, and when the sufficient condition, d^2Y_1/dx^2 is less than 0. In other words, it is a matter of finding the right x to satisfy both conditions.

There have also been several proposals which utilize the concept of labor intensity. The preference for labor intensive technizques is due to the large surplus of labor that usually exists in the 'backward' (usually agricultural) sector of the economy. Since the surplus is there, many economists have advocated using it.

Kurt Mandelbaum was one of the first advocates of labor intensive techniques. He arrived at the idea when he was discussing the surplus labor existing in the agricultural sector of an underdeveloped country. Two solutions were presented.[15] The surplus labor could emigrate to another country. Although the solution seems to be practical, Mandelbaum said it was impossible to accomplish because of the number of people involved and because of restrictive immigration laws of many of the advanced nations. The second alternative presented was "to use the economically unemployed labor on the spot."

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[15] K. Mandelbaum, Industrialization of Backward Areas (Oxford: Blackwell, 1945), pp. 2-3.

Mandelbaum recognized that labor was not a perfect substitute for capital in many projects such as public utilities. The resulting idea was to concentrate in industries which are usually called 'light' industries. Mandelbaum defined 'light' as those industries in which labor costs are the most important or are very high.[16] It was also recommended that in starting an industry the articles made be of a simple variety to manufacture.

The historical fact that as a country continues to develop capital intensive techniques may be used increasingly was also pointed out by Mandelbaum. W. A. Lewis had a similar idea in an article that was published in 1954.[17]

A. J. Brown had also proposed the initial use of labor intensive techniques when there was a shortage of capital in the country in his work, Industrialization and Trade.

It was advocated that industries with a low capital intensity relative to labor intensity should be selected initially, but only to be followed by industries of a labor intensive type. Actually Brown suggested a repetitive sequence of capital intensive and labor intensive techniques.[18]

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[16]Ibid., p. 15.

[17]Cf. W. A. Lewis, "Economic Development with Unlimited Supplies of Labor," The Manchester School of Economics and Social Studies, XXII (May, 1954).

[18]A. Vaidyanathan, "Survey of the Literature on Investment Criteria," Indian Economic Journal, IV (October, 1956), p. 126.

It was assumed that capital was scarce, relative to labor.

Vaidyanathan states that Brown derived the criterion from the study of history of development of the advanced nations of the world and from the assumption that there exists an abundance of labor and an acute shortage of capital.[19]

In this chapter considering factor intensity criteria, two concepts or proposals have been presented. They are the rate of turnover criterion advocated by Polak and Buchanan and the labor intensive criterion advocated by Mandelbaum and A. J. Brown. The two criteria deal with the choice of techniques that will be most beneficial to a developing nation.

The factor intensity criteria have been derived from the assumptions that capital is in short supply and labor is abundant. J. J. Polak and N. S. Buchanan derived their rate of turnover criterion with the additional assumption of the developing nation having balance of payments problems. Kurt Mandelbaum derived his proposal of labor intensive techniques from a study of the surplus labor in the backward sector of the economy. A. J. Brown also has made the same assumption about surplus labor in the backward sector and applied his interpretation of history to the problem of the choice of techniques.

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[19]Ibid.

CHAPTER III

SOCIAL MARGINAL PRODUCTIVITY

A. E. Kahn has put forth a criterion which is called the Social Marginal Productivity criterion. The device used to measure the effects of investment projects in this case is the social marginal productivity of capital in its different uses.

Kahn has defined the social marginal productivity of capital in terms of the whole economy as:

> . . .the total net contribution of the marginal project to the national product, and not merely that portion of the contribution (or of its costs) which may accrue to the private investor.[20]

It was also pointed out that the social marginal productivity of capital is not correlated with the rate of turnover of capital. SMP is different from the rate of turnover criterion when there is a difference between social cost and private cost. If private cost equals social cost, the SMP criterion is the same as the rate of turnover criterion. The author further more explicitly connected his idea with opportunity cost. He said:

The relative abundance of factors is a significant

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[20]A. E. Kahn, "Investment Criteria in Development Programs," Quarterly Journal of Economics, LXV (February 1951), p. 39.

determinant of SMP. Where capital is scarce (compared to another area) its SMP will be higher and each investment will have to meet the more stringent of a higher opportunity cost.[21]

In other words, the alternative output sacrificed due to the use of factors in a particular project must be subtracted from the additional output contributed by the particular investment project in question, the cost of the factors being their social opportunity cost. In the case of underdeveloped countries where there is a surplus of labor, the opportunity cost of labor may be zero or nearly zero. The former problem will be discussed in Part Two.

Although Kahn presented the idea of social marginal productivity of capital, he gave no method for calculating a figure representing it. Instead he said that he favored the social marginal productivity criterion with two restrictions put on it. The restrictions that Kahn put on the criterion are:[22]

(a) Avoidance of inflationary financing of additional sales in the home market; and

(b) Sufficient concentration on type I investments (projects yielding additional export or import displacing goods or services) to the extent that it has been necessary to avoid foreign financing.

To find a calculation of social marginal productivity of capital, one must turn to the works of H. B. Chenery or Jan Tinbergen and Benjamin King.

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[21]Ibid.   [22]Ibid., p. 50.

Chenery sets up a model which illustrates the effects of an investment program and embodies the type of statistical data which he thinks may be available.[23] The model is presented below.

2.1 $U = U(Y, B, \ldots\ldots D)$ Welfare function of an indefinite number of variables

  U = index of social welfare

  Y = effect of the project on national income

  B = total net effect on the balance of payments

  D = effect on the distribution of income

2.2 $\Delta U = \dfrac{\partial U}{\partial Y}\Delta Y + \dfrac{\partial U}{\partial B}\Delta B + \dfrac{\partial U}{\partial D}\Delta D + \ldots\ldots$

  Only the factors Y, B, and D are considered due to limitations on the statistical data in underdeveloped countries.

2.3 $\Delta U = SMP = \Delta Y + r\Delta B$ Incremental U is defined as social marginal productivity

  Chenery defines the term r with two different definitions: mathematically, it represents the amount of increase in national income which would be equal to an improvement of one unit in the balance of payments under specified conditions or it is the average overevaluation of currency at existing rates of exchange taking account of the effect on imports and exports due to the investment program and also the position of the balance of payments at the start of the period.[24]

The term r is equal to zero if the balance of payments is in equilibrium. Chenery stated that r would be

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[23]H. B. Chenery, "The Application of Investment Criteria," Quarterly Journal of Economics, LXV (February, 1953), pp. 80-86.

[24]Ibid., p. 81.

"appreciably" above zero in the case of an underdeveloped country.

Chenery also attempts to cover himself by trying to lessen the effects of the _ceteris_ _paribus_ assumption of partial analysis by using "corrections" for some of the factors. The following corrections are to be applied to ΔY:[25]

(1) Tariffs, taxes, and subsidies are to be eliminated.

(2) The value of output due to external economies must be added on.

(3) Only the social cost of utilized resources is to be used, not producer payments.

The model will now be presented along with Chenery's definition of terms.[26]

K = increment to capital

V = social value added domestically which in turn is equal to X + E - Mi;

    X = increased market value of the output (after allowing for subsidies and protection;

    E = added value of output due to external economies;

    Mi = cost of imported materials

C = total cost of domestic factors which in turn is equal to L + Md + O;

    L = labor cost;

    Md = cost of domestic materials;

    O = overhead cost (all other costs including the replacement of capital);

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[25]_Ibid._, p. 82.   [26]_Ibid._

B = total balance of payments effect which in turn is
equal to $aB_1 + B_2$:

    a = combined amortization and interest rate on
    current borrowing;

    B_1 = effect of the installation of the investment
    on the balance of payments;

    B_2 = effect of the operation of the investment
    project upon the balance of payments.

The Model:

$$2.4 \quad SMP = \frac{X + E - Mi}{K} - \frac{L + Md + O}{K} + \frac{r}{K}(aB_1 + B_2)$$

In the above equation, factors were added together
and substituted into equation 2.3 on page 13.

$$2.5 \quad SMP = \left(\frac{V}{K} \cdot \frac{V - C}{V}\right) + \frac{Br}{K}$$ Like terms have been com-
bined and the expression has been simplified. The first
term of the equation represents what Chenery calls the per-
centage margin of social value over cost and the last term
of the equation represents the balance of payments premium.
If you examine the three individual parts of the equation,
V/K is the marginal capital turnover ratio, $(V - C)/V$ is net
social value added per unit of investment, and Br/K is the
balance of payments premium per unit of investment.[27]

Chenery has set up the table below illustrating the
calculation of SMP for some industrial projects in Greece.
The data he used was derived from reports of the ECA Mission
to Greece. The figures were said to be based on engineering

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[27]Ibid., p. 83.

estimates and present prices instead of expected future
prices were used.[28]

TABLE I

SMP FOR SELECTED INDUSTRIES

	Lignite mining	Nitrogen fertilizer	Cement	Glass	Sulphuric acid
Investment in thousands of dollars	$23350	$17000	$6750	$280	$1450
(a) V/K	.83	.67	.93	.86	.52
(b) C/K	-.36	-.29	-.37	-.43	-.11
(c) Br/K	.33	.35	.07	-.04	.00
(d) (V-C)/V	.56	.56	.60	.50	.79
SMP	.80	.73	.63	.39	.42

SMP can be figured two ways from the table. SMP equals
(a x d) + c or a + b + c. The project with the greatest
social marginal productivity was lignite mining in this
case.

A second approach to the social marginal productivity
criterion is the approach developed by Jan Tinbergen and
Benjamin King at the Netherlands Economics Institute. Their
method was not aimed at initial application to an underde-

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[28]Ibid., p. 84.

veloped country but a country which had progressed to a certain degree of economic development where the statistical data required for the criterion could be obtained.[29]

Their assumptions not only differ from H. B. Chenery's in the case pointed above but also in the fact that the variable to be computed is not social marginal productivity but real national income in the future with and without the project under question. Benjamin Higgins has said:

> The method consists of comparing real national income for all future periods, appropriately discounted to account for national time preference, and with appropriate accounting prices, with and without the investment project or projects in question. No cost calculations are necessary, because any inputs involved in a project have an immediate effect on national income, if they must be withdrawn from other uses.[30]

Higgins also observes that the Tinbergen-King formulation is more general and more precise than the type advocated by Chenery. The equations of the Tinbergen-King concept are presented below:[31]

$$3.1 \quad Y^h = pv^h - p^i i^h - \partial pb^h - m^i K^{ih}$$

Y^h = the net contribution to NNP of project h

p = the price index of the national product

v^h = the quantity of gross product for project h

p^i = the import price level

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[29]Higgins, op. cit., pp. 653-664.

[30]Ibid., pp. 663-664. The primary source was not available to the author.

[31]Ibid., p. 664.

i^h = the required volume of imports for project h

b^h = the real value of the capital stock created by the project

m^i = the interest rate for foreign debts

K^{ih} = the amount of foreign debts incurred for the execution of project h

3.2 $Y^o = pv^o - pi^c - \dot{O}pb^o$

v^o = the quantity of gross product produced in the rest of the economy

i^o = volume of imports for the rest of the economy

b^o = the real value of the capital stock in the rest of the economy

Equation 3.1 above shows the additional product that will be created in the future by the project. Equation 3.2 above shows the national product in the future that is produced without the project under question. The two can then be compared to get some idea of the gain resulting from the project.

The Tinbergen-King formulation is similar to the formulation of Chenery's in that both use the marginal technique for measurement and both try to deal with the effects of the investment project on the whole economy. There are several differences between the two. The quantity to be measured is different; Chenery uses social marginal productivity and the Tinbergen-King criterion uses national product. There seems to be little difference between the two forms of the criterion. Although Chenery's final formulation of SMP

does not embody changes in national income explicitly, the changes are considered in his equations 2.2 and 2.3 on page 13. Chenery's criterion embodies cost calculations while the Tinbergen-King criterion embodies measurements in real terms. Chenery's criterion considers the effect of the installation and the operation of the investment project on the balance of payments. The Tinbergen-King criterion does so for every area of the economy.

Two ideas for establishing priorities for investment projects have been presented in this chapter. A. E. Kahn has proposed that social marginal productivity be used as the measure for decision-making to decide whether an investment project should be undertaken. Hollis B. Chenery has suggested a method of calculation of SMP The Tinbergen-King concept, although it does not use the social marginal productivity measure as does Chenery's, has the same theory behind it, to measure the effect of an investment project on the whole economy.

CHAPTER IV

THE REINVESTMENT QUOTIENT

W. Galenson and H. Leibenstein have proposed a criter-
ion which they call the marginal per capita reinvestment
quotient. The crucial quantity in this case is the surplus
created that is available to be reinvested.

In stating their assumptions, the two economists say
that they believe the relevant quantity to be maximized is
per capita output within some time horizon, and such maxi-
mization is assumed to be the goal of the underdeveloped
country.[32] With the goal in mind, they state:

> Then the correct criterion for allocating investment
> must be to choose for each unit of investment that
> alternative that will give each worker greater pro-
> ductive power than any other alternative.[33]

In other words, the criterion is put forth in terms of the
rate of investable surplus that is formed per period. Galen-
son and Leibenstein believe that the rate that investment
takes place deserves primary consideration because it deter-
mines capital accumulation. They also stated that emphasis
should be placed on labor productivity instead of on capital
productivity, since the long run problem will lie in the

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[32]W. Galenson and H. Leibenstein, op. cit., p. 351.

[33]Ibid.

productivity of labor.[34]

Before it is possible to understand the Galenson-Leibenstein criterion, the idea of the marginal reinvestment quotient must be examined. The determinants of the quotient are:[35]

(1) gross productivity per worker

(2) "wage" goods consumed per worker

(3) replacement and repair of capital

(4) increments in output resulting from non-capital type innovations such as skills and health

(5) declines in mortality

(6) declines in fertility

(7) the direction of investment

The first six items in the list above determine per capita reinvestment per period. The seventh item deals with allocation.

The two authors state that the amount of capital per worker depends upon the surplus available for reinvestment per period, the initial investment, and the size of the labor force. So the amount of wage goods is subtracted from the gross productivity per worker to arrive at the reinvestable surplus. On the productivity side, replacement and repair of capital must be accounted for along with increases in output due to non-capital type innovations.

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[34]Ibid., p. 350.   [35]Ibid., p. 364.

In considering the labor force, the theory is that the larger the size of the reinvestable surplus created, the lesser will be the rate of population growth. The extent that fertility will decline depends on the direction of the investment. The authors have the idea that fertility tends to decline more in urban rather than rural agricul-tural environments.

The concept of the marginal per capita reinvestment quotient can best be shown by the use of a couple of models. Galenson and Leibenstein use the following model to illus-trate the idea:[36]

> Assume: the total amount invested in any period is
> the difference between total gross value
> added and the real consumption of labor.

r = per capita reinvestment quotient

p = net output per machine

e = number of workers per machine

c = the cost of a machine

w = the real wage

$r = \dfrac{p - ew}{c}$ (The definition of the quotient)

Employment in any period which is provided by the combina-tion of workers and machines can be derived from the follow-ing expression.

$$E_{t+1} = E_1 \cdot \left(1 + \frac{p - ew}{c}\right)^{t}$$ E = employment
t = time

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[36]Ibid., p. 357.

Returning to the Sen model used in Chapter II, the Galenson-Leibenstein criterion can also be demonstrated. Given their stated objective, the quantity to be maximized is the surplus or in the case of the model itself the rate of growth is the relevant quantity to be maximized. Using the definitions and assumptions presented in the Sen mode... in Chapter II, the expression is:[37]

$$G = \frac{Y_n - Y_{n-1}}{Y_{n-1}} \qquad G = \text{growth rate of income}$$

$$= \frac{S_{n-1} \cdot f(x)}{Y_{n-1}} \qquad \text{(by substitution)}$$

$$= f(x) - x$$

[corn output per year per machine (produced by one man year in the machine making sector) minus the quantity of labor employed to produce corn per machine. Wage units paid equal the real wage bill.]

G will be a maximum when dG/dx is equal to zero and when d^2G/dG^2 is less than zero.

In this chapter the marginal reinvestment quotient criterion developed by Galenson and Leibenstein has been presented. They verbally describe the criterion as:

The larger the proportion of output of an industry or a society, which is reinvested rather than consumed, the more rapid the process of capital accumulation--hence the growth of employment opportunities in the industries.[38]

The model is oriented to the future in that the growth rate,

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[37]Sen, op. cit., p. 36.

[38]Galenson and Leibenstein, op. cit., p. 358.

defined in terms of per capita income, is to be maximized within some time horizon in the future. The criterion also tries to offer a partial solution to the problem of surplus labor existing in the backward sector of the economy. By maximizing the surplus to be reinvested, Galenson and Leiben-stein apparently feel that the population in the backward sector will be held down. Lastly the Galenson-Leibenstein criterion stresses the productive power of labor rather than capital.

CHAPTER V

THE MARGINAL GROWTH CONTRIBUTION

The marginal growth contribution was developed by Otto

Eckstein in an article published in 1957. The criterion is

unique in that it synthesizes the social marginal productiv-

ity criterion and the reinvestment quotient criterion, and

secondly, the criterion utilizes welfare economics to include

the consumers' time preference.

Before defining the marginal growth contribution, the

assumptions of the Eckstein model will be presented in order

to visualize how the conclusions are derived. To develop a

"setting" or "place" for his model, Eckstein makes the fol-

lowing assumptions:[39]

(a) the selection of projects which will increase the
rate of saving and thereby the rate of growth is
reasonable;

(b) consumers' time preferences are given, and the
capital market is rejected as a device to deter-
mine the rate of saving;

(c) the criterion must reflect both the direct contri-
bution to consumers' welfare and the indirect
contribution to the capital stock.[40]

The statement in (c) above is the key to the marginal

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[39] Otto Eckstein, "Investment Criteria for Economic
Development and the Theory of Intertemporal Welfare Economics,"
Quarterly Journal of Economics, LXXI (February, 1957), p. 66.

[40] By "direct contribution" Eckstein apparently means
a project's contribution to immediate consumption. By "indir-
ect contribution" he means the contribution to the consumption
stream brought about by the growth of the capital stock.

growth contribution criterion. It is with that assumption that one concept already discussed, the reinvestment criterion, and a new one embodying welfare economics enter into the analysis.

In order to understand the workings of the marginal growth contribution criterion (MGC)[41] it is necessary to present Eckstein's assumptions.[42]

(1) The planning authority wishes to maximize a social welfare function based on individual preferences;

(2) the optimal distribution of income is obtained through taxes and subsidies which have no impact on marginal choices and collective services are financed in a similar way;

(3) there are no external economies or diseconomies;

(4) all markets function as perfectly competitive ones except the capital market;

(5) $\underline{K}$ is the amount of capital at the disposal of the planning authority;

These first five assumptions or conditions are related to a Bator type welfare model.

(6) Firms maximize profits and have non-decreasing marginal costs;

(7) all households purchase consumer goods and supply factor services in accordance with their time preference and their marginal rates of substitution are diminishing;

Conditions 6 and 7 are necessary for determinacy in consumption and production respectively.

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[41]Hereafter called MGC.

[42]Eckstein, op. cit., pp. 66-68.

(8) The planning authority expresses the collective judgment about the society's time preference by means of an interest rate, i;

(9) the authority can project future prices accurately;

(10) there is a choice among n projects;

(11) each project has a reinvestment coefficient, a_j, which indicates the share of the project's contribution that goes into saving;

(12) the economic life of all projects is equal to T;

(13) Y_{Rt} is the net income made possible by the reinvested capital, K_{Rt}, in period t;

(14) a part of the output of projects financed out of reinvested capital will be available for further reinvestment. Assume a reinvestment coefficient, a_R, for the subsequent stages.

Conditions 8-14 inclusive are directly related to the introduction of the time dimension.

(15) Each project has a production function

$$Y_j = Y_j(K_j), \quad (J = 1, \ldots, n)$$ relating its net

contribution to real income to the capital invested in the project, and the function increases at a decreasing rate;

(16) the marginal productivity of capital is B;[43]

Conditions 15 and 16 are general background constraints.

With the assumptions, definitions, and symbols in mind, Eckstein derives the criterion by maximizing the present

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[43]B can apparently be taken as a variable or as a constant. In his later examples in the tables Eckstein apparently assumes that the production function for reinvested capital displays no diminishing returns--the marginal productivity of capital is constant, so that B may be arbitrarily assigned a fixed value.

value of the future consumption stream. The expression to
be maximized is:[44]

$$4.1 \quad H = \sum_{t=1}^{T} \sum_{j=1}^{m} \frac{(1-a_j)}{(1+i)^t} Y_j + \sum_{t=1}^{\infty} \frac{(1-a_R) Y_{Rt}}{(1+i)^t}$$

The first term of the equation expresses the relation
of the net contribution to future real income for the econo-
mic life of all projects to the consumers' time preference.
The second term of the equation expresses the relation of
the reinvestment component to the consumers' time preference
summed from the first to infinity.

The following conditions are put upon equation 4.1
above:

4.1.1 $Y_j = Y_j(K_j)$, $(j = 1, \ldots, n)$ production func-
tion of the projects relating capital invested to real income.
It increases at a decreasing rate.

4.1.2 $Y_{Rt} = Y_{Rt}(K_{Rt})$, $(j = 1, \ldots, n)$ production
function for the reinvested capital form the initial projects,
where $\dfrac{\partial Y_{Rt}}{\partial K_{Rt}} = B$ the marginal productivity of the re-
invested capital

4.1.3 $\sum\limits_{j=1}^{m} K_j \leq K$ This condition is a capital constraint
which states that the sum of the amounts
of capital used in all projects must be
less than or equal to the amount of
capital at the disposal of the planning
authority.

The next step is to solve for K_{Rt}, the amount of

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[44] Eckstein, op. cit., p. 68.

capital in period t through previous reinvestment.

$$4.2 \quad K_{Rt} = K_{R,t-1} + \sum_{j=1}^{m} a_j Y_j + a_R Y_{R,t-1} , \quad \text{if } t \text{ is less than or equal to } T.$$

The above expression is a first order difference equation that has the solution:

$$4.3 \quad K_{Rt} = \sum_{j=1}^{m} \frac{a_j Y_j}{a_R B} \left[(1+a_R B)^t - 1 \right]$$

If t is greater than T,

$$4.4 \quad K_{Rt} = K_{R_{t-1}} + a_R Y_{R_{t-1}}, \quad \text{which has the solution,}$$

$$4.5 \quad K_{Rt} = K_{RT} (1+a_R B)^{t-T} , \quad \text{or}$$

$$4.6 \quad K_{Rt} = \sum_{j=1}^{m} \left[(1+a_R B)^t - (1+a_R B)^{t-T} \right]$$

The next step is to maximize the Lagrangean expression:

$$4.7 \quad \phi = H - \sum_{j=1}^{m} \lambda_j \left[Y_j - Y_j(K_j) \right] + \mu \left[\sum_{j=1}^{m} K_j - K \right] + \sum_{t=1}^{\infty} \lambda_R \left[Y_{Rt} - Y_R + (K_{Rt}) \right]$$

The result of the maximization is that the following marginal condition must hold:

$$4.8 \quad \mu = \frac{\partial Y_j}{\partial K_j} \left(\sum_{t=1}^{T} \frac{(1-a_j)}{(1+i)^t} + \frac{a_j(1-a_R)}{a_R} \left[\sum_{t=1}^{\infty} \frac{(1+a_R B)^t}{(1+i)^t} - \sum_{t=1}^{T} \frac{1}{(1+i)^t} \right] - \sum_{t=T+1}^{\infty} \frac{(1-a_R B)^{t-T}}{(1+i)^t} \right)$$

The above expression is Eckstein's expression for the marginal growth contribution. However, he goes one step further and simplifies the formula to:

$$4.9 \quad \mu = MGC = \frac{\partial Y_j}{\partial K_j} \sum_{t=1}^{T} \frac{(1-a_j)}{(1+i)^t} + \frac{\partial Y_j}{\partial K_j} a_j(1-a_R) \left[\frac{(1+i)^{T}-1}{i(1+i)^{T-1}} \right] \frac{B}{1-a_R B}$$

Eckstein has the following explanation of the equation:

> The first term of the formula measures the project's direct contribution to consumption, and is the conventional efficiency criterion except for its exclusion of the share of output to be reinvested. The second term measures the present value of the future consumption stream made possible by the increased growth of capital.[45]

The next thing that must be done is to examine the effect of the rate of interest (the collective judgment of society's time preference) on the MGC. Eckstein has prepared the following table to illustrate the effect.

TABLE II

INTEREST EFFECTS ON THE MGC

Values held constant: $a_R = .15$, $B = .20$, $T = 21$.

i	"Efficient" project[a] $a_j=0$, $dY_j/dK_j = .30$ MGC	"High reinvestment" project[b] $a_j=.30$, $dY_j/dK_j = .10$ MGC	Efficiency Component	Reinvestment Component
4%	4.38	9.00	1.02	7.98
5%	4.04	4.27	.94	3.33
6%	3.74	2.74	.87	1.87
7%	3.48	2.26	.81	1.45

(a) a project with a high marginal productivity of capital and no reinvestment.

(b) a project with low marginal productivity of capital and a high rate of reinvestment.

These conclusions may be drawn from the table.[46] The MGC is highly sensitive to the interest rate. At a low rate of interest the project with a high rate of reinvestment is favorable. At a high rate of interest, the project with the high productivity of capital is favorable. Secondly, the interest rate is less than the growth rate. The MGC is infinite. Thirdly, in the case of the project with the high rate of reinvestment, the reinvestment component is more sensitive to the interest rate.

In considering the reinvestment potential of a project, it should be remembered that the potential depends on the marginal productivity of reinvested capital (defined as B) and the rate of reinvestment in subsequent stages (defined as a_R). Eckstein has made a table which isolates these variables both in the initial stage and the later stages, and relates them to the interest rates.[47] (Table III).

The table shows the combinations of an efficient project (one with a high marginal productivity of capital) matched with a reinvestment policy which is either efficient (one with a high marginal productivity of capital) or one which is oriented toward growth (a high reinvestment coefficient). The same thing is done for a project which has a

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[45]Ibid., p. 69.   [46]Ibid., p. 70.

[47]Ibid., p. 73.

TABLE III

MGC OF ALTERNATIVE INVESTMENT POLICIES

	Interest rate		
	3%	5%	8%
Efficient project[48] plus an efficient reinvestment policy.(a)	8.60	5.35	3.76
Efficient project plus a "growth" reinvestment policy.(b)	co	5.52	3.64
"High reinvestment" project plus efficient reinvestment policy.(c)	9.71	4.29	2.18
"High reinvestment" project plus a "growth" reinvestment policy.(d)	10	4.51	1.87

(a) $a_1 = .05$, $T = 21$, $dY_1/dK_1 = .30$

(b) $a_R = .05$, $B = .30$

(c) $a_R = .15$, $B = .30$

(d) $a_1 = .30$, $dY_1/dK_1 = .10$, $T = 21$

high reinvestment coefficient. The various combinations are then calculated with three interest rates. As the interest rate increases, ceteris paribus, the MGC diminishes.

To select the proper interest rate, Eckstein presents

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[48]Since the definition of efficient project has been slightly changed from the previous example, see the text for the new definition.

the diagram which follows:
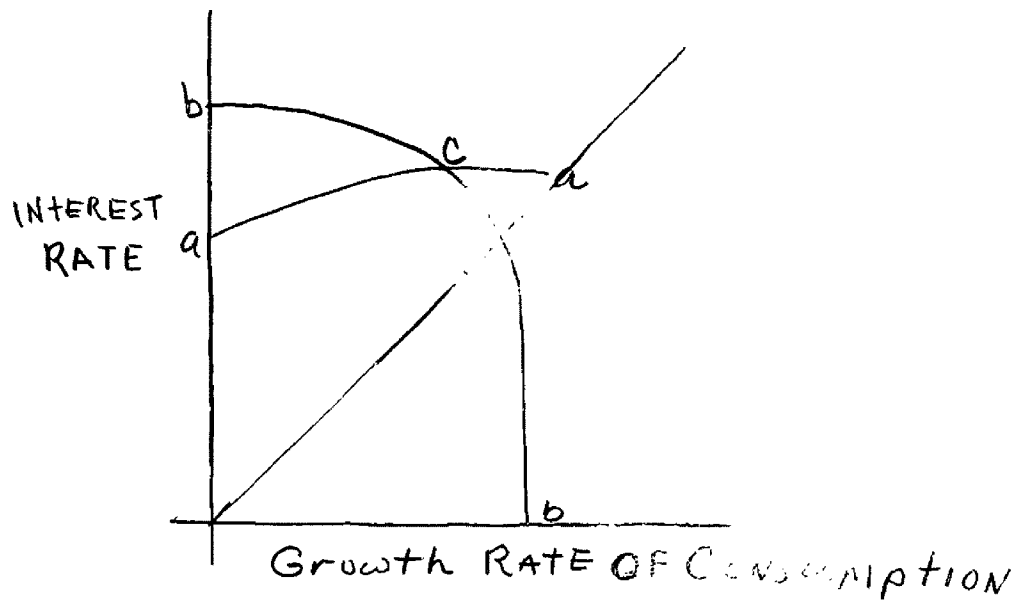
Figure 1.

For the curves aa and bb his explanation is:[49]

> Curve aa is derived from the demand for consumption
> goods, given a rate of population growth and a pure
> rate of time preference. The higher the growth rate
> the more rapidly the marginal utility of consumption
> falls, and the higher should be the interest rate.

> Curve bb represents the influence of the interest
> rate on the choice of the project--hence on the rate
> of capital accumulation and growth.

It seems to the author that curve aa needs more ex-

planation. Judging by the equations upon which Eckstein

bases the above diagram, the explanation would appear to

be as follows: Curve aa relates certain possible levels of

social time preference (socially determined interest rate)

to various possible rates of growth of consumption output.

All the socially determined interest rates in aa are rates

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[49]Ibid., p. 73.

which maximize the welfare function for a given rate of in-
dividual time preference and the particular rates of con-
sumption growth which correlate to the particular interest
rates. Any of these interest rates, "i", maximizes the
welfare function at that point because it assures that the
marginal rate of substitution in consumption between succes-
sive periods is the same as the marginal rate of substitution
in production which is the necessary condition for such
maximization.

Curve bb represents the feasibility of projects or
what is possible to undertake, given the parameters or
constraints stated in Eckstein's explanation of curve aa,
supra. The vertical portion of the curve represents the
area when bottlenecks appear, such as the supply of trained
labor and managers being exhausted.

The intersection of the two curves at point ? repres-
ents an equilibrium between what is wanted and what is feas-
ible.

In summation of the concept presented in this chapter,
Eckstein has used welfare economics and a synthesis of the
social marginal productivity criterion and the reinvestment
criterion to develop his marginal growth contribution cri-
terion. Two things have been shown: the decision about a
project will depend in part upon the empirical assumptions
made, and a value judgment is necessary to deal with the
problem of time preference. An interest rate was the expres-

sion of the society's time preference and a device was sug-
gested to find the optimal interest rate and the optimal
rate of growth of consumption.

CHAPTER VI

BENEFIT-COST ANALYSIS

The United Nations has proposed the use of the benefit-cost analysis used in the United States for water resource development to aid an underdeveloped country in deciding on the priority of projects. The suggestion was made by J. T. Lund in a series of lectures delivered in Pakistan sponsored by the Government of Pakistan, the International Bank for Reconstruction and Development, and the United Nations.[50]

A derivation of the benefit-cost criterion can be found in the work of Otto Eckstein.[51] The criterion was derived from classical welfare economics where the objective was to maximize an increase in economic welfare contributed by a project subject to the constraint of limited funds for expenditure on the project. Eckstein presents the following derivation of the benefit-cost criterion:[52]

B_j = total benefit of a project.

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[50]J. T. Lund, "appraising Costs and Benefits of Development Programs," Formulation and Economic Appraisal of Development Projects (United Nations, Asian Center on Agricultural and Allied Projects: New York, 1951).

[51]Otto Eckstein, Water Resource Development (Cambridge: Harvard University Press, 1958). This is one of his many works on the subject.

[52]Ibid., p. 70-75.

His definition of total benefit is the balue of the goods
and services that result from the project in question.
Total benefits are then the values that accrue from the
output of the project in question.

C_{jg} = cost of a project; cost is defined as the
"value of the goods and services used to set up, maintain,
and operate a project." C_{jg} can be thought of as total
direct private cost of establishing the project.

C_{jh} = associated cost or "value of the goods and
services beyond the project cost (C_{jg}) to obtain the out-
put from the project. C_{jh} can be thought of as total social
costs minus total direct private costs.

5.1 $B_j = B_j(C_{jg}, C_{jh})$, ($j = 1, \ldots, n$), production
function stating that total benefits are a
function of project cost and associated cost.

5.2 $\sum_{j=1}^{n} C_{jg} < D$, a constraint which states that the
total amount of funds used for the
project must be less than or equal to
the amount of funds appropriated for
the project, defined as D.

The next step is to maximize and increase in welfare.
The following Lagrangean expression is used.

5.3 $\phi = B_j(C_{jg}, C_{jh}) - \sum_{j=1}^{n} C_{jg} - \sum_{j=1}^{n} C_{jh} - \lambda(\sum_{j=1}^{n} C_{jg} - D)$

When the above expression is maximized, the two following
marginal conditions must hold:

$$\frac{\partial B_j}{\partial C_{jg}} = 1 + \lambda, \quad \frac{\partial B_j}{\partial C_{jh}} = 1$$

Eckstein then formulates the rule:[53]

> Thus the benefit of the marginal expenditure of. . .
> funds must exceed 1 by a factor which depends on the
> tightness of the budgetary constraint while the bene-
> fit of the marginal expenditure of the associated cost
> should be equal to one.

While he is talking about the marginal expenditure of funds,

he is referring to C_{jg}, the total direct private cost. As

is shown on the previous page, the factor by which the mar-

ginal expenditure of project costs must exceed one, is the

value of the Lagrangean multiplier. The existence of the

positive Lagrangean multiplier assures the budget constraint

will be met.

Turning now to the suggestion made by J. T. Lund, one

finds the definitions and the resulting rules slightly modi-

fied from those of Eckstein. Lund states five steps in the

general method of measurement of benefits and costs.[54] The

five steps are:

(1) the value of any increase or decrease in the gross
national product in the future must be estimated
with and without the project;

(2) project benefits and project costs must be measured
on a comparable basis;

(3) physical units must be converted into value terms;

(4) the economic life of the project must be estimated
as well as a forecase of future applicable prices;

(5) interest, risk, and discount must be applied.

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[53]Ibid., p. 75.

[54]J. T. Lund, op. cit., p. 128.

The statement in (1) above appears to have some concept of "net benefits" in the sense that both a direct growth impact of alternative projects is considered, and the growth impact on the rest of the economy in addition to considering immediate opportunity costs is also implied. The statement in (4) above also implies some sort of a planning horizon.

Lund divides costs into two sections, project costs and non-project costs. Project costs are defined in the same manner in which Eckstein has defined them, as are the non-project costs which are defined as Eckstein's associated costs. The cost figure to be used in the denominator of the benefit-cost ratio is the difference between project costs and non-project costs.

Lund defines total benefits of a project as the sum of primary benefits and secondary benefits. Primary benefits are defined as "the value of immediate products or services of a project minus any associated costs for their realization."[55] Secondary benefits are defined as "values added over and above primary benefits, such as those resulting from subsequent processing."[56] Total benefits are arrived at by adding primary benefits and secondary benefits.

The next step is to compare project benefits to project costs. The comparison is made by a ratio of benefits to costs. Lund states that a project is justified if the follow-

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[55] Ibid., p. 129.   [56] Ibid.

ing rules are complied with:[57]

(1) the project benefits exceed the project costs;

(2) each separable segment provides benefits at least equal to its cost;

(3) the scale of development is such as to provide the maximum net benefits;

(4) there is no more economical means of accomplishing the same purpose which would be precluded from development if the project were undertaken.

Projects can be compared with each other to establish a priority among alternatives by comparing their respective ratios of benefits to costs. A rank ordering is then made possible.

Two views have been presented of the benefit-cost criterion in this chapter as well as a derivation of the criterion. Otto Eckstein has approached the problem from a welfare standpoint and derived the criterion from a set of marginal conditions which must hold. J. T. Lund has used the operational approach and has derived a set of rules instead of using marginal conditions.

There seems to be little difference except from reinvestment considerations between the benefit-cost criterion and that of Sen and Eckstein, presented in previous chapters. The opinion of the author is the criterion is nothing more than an operational approach to the marginal growth contribution criterion.

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[57]Ibid., p. 130.

CHAPTER VII

THE INDUSTRIAL REQUIREMENTS CRITERION AND
THE CAPITAL EXTENSIVENESS CRITERION

The Industrial Requirements Criterion

"The very fact that an economy is underdeveloped
implies there are special limitations to the establishment
of manufacturing industries."[58]   Kenneth Bohr has developed
a type of analysis which attempts to cope with the problem
of establishing manufacturing industries in underdeveloped
countries by analyzing certain characteristics of different
types of industries.   The underdeveloped country can then
compare its characteristics to the industry characteristics
to find which industries are possible to establish.

Bohr has made several assumptions.[59]   First of all,
he has assumed that the industrial characteristics of the
plants he considers have a certain degree of uniformity from
country to country.   It has also been assumed that the under-
developed country has a shortage of capital, a shortage of
skilled labor, a small local market, and a situation where

[58]Kenneth A. Bohr, "Investment Criteria for Manufac-
uring Industries in Underdeveloped Countries," The Review
of Economics and Statistics, XXXVI (May, 1954), p. 157.

[59]Ibid., pp. 157-158.

imported industrial equipment is relatively inexpensive to that which could be produced domestically.

The characteristics of plants selected for study were capital requirements, the necessity for skilled labor, plant size, and locational pattern. Bohr commented that the lower the first three requirements were for a particular industry, the more easily it could be adapted by an underdeveloped country.[60] The fourth characteristic was put in to illustrate the principle that the closer an industry is to its source of raw materials, the better it will be able to compete with imported goods.

In measuring the capital requirements of an industry, Bohr has used a ratio of fixed capital to value added.[61] The ratio has been computed for eleven classes of industries and then the ratios have been group themselves, as to class. The countries from which data were used to compute the ratios were Australia, Canada, Hungary, Palestine, and Rumania. Capital was valued in different ways in each country; for example, some used total capital assets while others used only fixed capital assets. Bohr has derived the following frequency distribution showing the eleven industrial categories against the ratios which have been classed into ranks:[62]

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[60]Ibid.

[61]Ibid., p. 159.

[62]Ibid., p. 160.

TABLE IV

FREQUENCY DISTRIBUTION OF RANKING OF INDUSTRIES IN ORDER OF INCREASING AMOUNTS OF CAPITAL PER PERSON EMPLOYED

Category	Rank										
	1	2	3	4	5	6	7	8	9	10	11
Clothing	*****										
Furniture		*	*	*							
Leather, Fur Rubber		***			*						
Textiles			*	*	*	*	*				
Light metals			*	*	*			*			
Semi-mfg. metals			*	*			**				
Building Materials			*	*				**			
Paper & Printing						*	**	*	*		
Food, Drink, Tobacco							*			****	*
Chemicals										*	****

The industries at the top of the table would be the most suitable for an underdeveloped country if it was short of capital, since they require less capital than those at the bottom of the table.

For the study of the requirements of skilled labor, Bohr has used a ratio of the amount of skilled and supervisory

personnel to the total number of employees. Data for the
year 1930 in the United States was used to calculate the
ratios. The subsequent table shows some selected results
from Bohr's table.[63]

TABLE V

SELECTED INDUSTRIES IN ORDER OF SKILLED PERSONNEL
NEEDED

Percentage of Skilled and supervisory workers of total gainfully employed	Industry
Less than 10%	Gloves Tanning Tobacco Cigars Brick, tile, terra cotta
10% - 20%	Rubber Soap Paper and Pulp Lime, Cement Hemp, Jute, Linen
20% - 30%	Sugar and Sugar Refining Blast furnaces, Charcoal, Coke Steel Rolling Mills
30% - 40%	Flour and Grain Furniture Agricultural Implements Tinware
Over 40%	Printing and Engraving Marble Suits, Coats, Overalls

To measure the locational pattern, Bohr devised a
locational coefficient "which measures the concentration of

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[63]Ibid., p. 163.

a particular industry compared with the distribution of the industry as a whole."[64] The greater the coefficient is in value, the more concentrated (geographically) the industry is. Again the data used for the calculation of the coeffi- cient were data from the United States for the year 1939. Some of the results obtained are shown in the following table:[65]

TABLE VI

SELECTED INDUSTRIES IN ORDER OF INCREASING
LOCALIZATION COEFFICIENT

Class	Industry
Class I .14 - .33	Concrete products Beer Bricks and tile Bread Foundries
Class II .34 - .42	Furniture Rope and twine Iron and steel forging Leather goods Clothing
Class III .43 - .55	Petroleum Refining Edged tools Steel works
Class IV .57 - .83	Fertilizer Clocks and watches Textile machinery

The prevalent size measure was "based on the size of the median firm in cases where the distribution of employ- ment by firm size shows a regular distribution."[66] In this

[64]Ibid., p. 157.   [65]Ibid., p. 164.   [66]Ibid., p. 157.

case data from the United States for the year 1930 and data
from the United Kingdom for the year 1929 were used. In the
table that follows, the greater the number is, the greater
the prevalent size.[67]

TABLE VII

MEASURES OF PREVALENT SIZE IN INCREASING ORDER

Industry	Prevalent Size
Boots and Shoes	none
Soap and Candles	none
Butter	1
Flour milling	1
Tanning	2
Bricks and tile	2
Cement	3
Paper making	3
Chemicals	4
Petroleum refining	4
Rubber	5
Steel works	5

To apply the criterion, an underdeveloped country
will match its favorable factors in one characteristic against

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[67]Ibid.

its unfavorable factors in another characteristic. Bohr
commented that no signle characteristic was a criterion in
itself. The relative importance of the characteristics will
vary from country to country.

In the first section of this chapter, the industrial
requirements criterion has been presented. Bohr has taken
four industrial requirements and analyzed different types
of plants. Conclusions can be drawn from the analysis that
will aid an underdeveloped country to decide on what type of
plant it would be feasible to build, given the country's
particular position as far as the amount of capital, the
size of the plant needed, the necessity of skilled labor,
and the locational pattern of the plant.

The Capital Extensiveness Criterion

W. Arthur Lewis has a criterion for investment which
is termed the capital extensiveness criterion. The criter-
ion is not a single statement but is found through several
pages of his book.[68] Lewis has suggested that production
projects are not determined by any one factor, but a whole
host of factors, some of which may be more important for a
particular country than are others. Particular attention is
paid to the shortage of capital, the lack of skilled labor,

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[68] W. Arthur Lewis, The Theory of Economic Growth
(Homewood: R. D. Irwin, 1955).

and the shortage of foreign exchange.[69] From the former

three restraints on development, Lewis has derived his cri-

terion.

Given the restraints of capital, labor, and foreign

exchange, three general prescriptions are given. The whole

production plan must be kept within the limits of total re-

sources. Within the production program itself, projects

should economize on scarce resources. Lastly, projects that

increase the supply of the scarce items should be given

priority. The point seems obvious but Lewis says it is often

overlooked in development plans. His statement is:

> The last is fundamental, though often neglected; the
> true test of planning is not how effectively resources
> are licensed and rationed, but how quickly shortages
> are eliminated by increasing supplies.[70]

Lewis, assuming that capital is in short supply, has

a specific rule for the choice of projects. Projects where

the marginal ratio of output to capital is the highest are

the most favorable.[71] Coupled with the rule is the warning

that some projects will give benefits in excess of their

returns. The main examples are public utilities industries.

It is further stated that:

> Neither does the rule correspond to using capital in
> projects with low ratios of capital to labor, since
> some industries where capital yields the most output
> happen to be capital intensive.[72]

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[69]Ibid., p. 385.   [70]Ibid.

[71]Ibid., pp. 385-386.   [72]Ibid.

Again the example put forward is the public utility industry.

In examining the problem of skilled labor shortages, it is recommended that capital should be used in projects that increase employment opportunities by selecting those projects "where the work could not be done by hand or where the cost of doing it by hand would be prohibitive or where applied to work that is already done by hand."[73] What Lewis is suggesting is to have the capital substituted for skilled labor wherever possible.

In the foreign trade sector of the underdeveloped economy, Lewis proposed that government should encourage the country's exporters to gain new markets for goods produced in the country. Needed foreign exchange will be gained as well as a market for goods. Goods made of metal and textiles were suggested items of trade. At this juncture, Lewis believes an additional advantage can be gained, if temporary protection is given to the underdeveloped country's domestic industry, its labor force will be able to specialize and train itself. The reason given for the action is that "the gap between them and the industrial countries would continue to widen for no better reason than the momentum of specialization.[74]

In the last section of the present chapter, the capital extensiveness criterion of W. A. Lewis has been presented.

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[73]Ibid., p. 211.

[74]Ibid., p. 351.

Lewis has derived rules for the selection of projects assum-
ing shortages of capital, skilled labor, and foreign exchange.
It has also been suggested that the public utilities frame-
work of the country not be overlooked, since it has some
unusual characteristics.

PART TWO

ANALYSIS OF THE VARIOUS CRITERIA

INTRODUCTION

The criteria presented in Part One of this thesis will be analyzed in the following two sub-sections. The first sub-section will examine the development of the investment criteria or models. Included are the author's comments on the criteria with respect to the choice of the appropriate economic variables and the structural equations of the models which have been formulated. The second sub-section of Part Two will present an analysis of the criteria with respect to their operational utility. Attention will be given to any operational procedures suggested and the empirical difficulties which may arise in the application of the criteria.

It is hoped by the author that the method of analysis suggested above will not only give some insights on the development of investment criteria in the literature but, also, will suggest perhaps the future trend for the development of theoretical investment criteria as influencing the underdeveloped countries of the world.

SECTION ONE

THE DEVELOPMENT OF INVESTMENT CRITERIA

The first investment criteria developed were the fac-
tor intensity criteria. Two types of the factor intensity
criteria were the rate of turnover criterion proposed by
J. J. Polak and N. S. Buchanan and the labor intensive cri-
terion advocated by Kurt Mandelbaum and A. J. Brown. The
factor intensity criteria attempted to choose the techni-
ques of production and the project simultaneously.

The variable chosen by Polak and Buchanan in their
rate of turnover criterion was the rate of return on imme-
diate output of a particular project. In other words, the
ratio of output to invested capital was to be maximized.
The maximum was arrived at by assuming that capital was in
short supply.

The only economic variable chosen for inclusion in
the criterion was the output-capital ratio. The author
questions the use of the single variable on several grounds.
The use of the single variable can be justified on the
grounds that capital is the only scarce resource or all
other resources are so numerous that capital becomes the
deciding factor in the selection of projects.[75] Another

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[75]H. B. Chenery, "Comparative Advantage and Develop-
ment Policy," American Economic Review, LI (March, 1961) p.
27. Chenery gives support to this idea.

criticism is that production must take place under conditions
of constant costs.

To justify the use of the single variable the social
opportunity cost of labor must be zero. There has been a
great deal of debate about this assumption in the litera-
ture. On one hand, if there is disguised unemployment in
the backward sector of the economy, the social cost of using
the labor in a new project is thought to be zero. However,
the transfer of labor to the new project will involve costs
in transport, housing, and job training for the labor. Cost
is involved but there is a question in the author's mind
about the significance of the cost, is it large or small?
Another turn on the same line is that anytime labor is to
be employed from the advanced sector, the costs mentioned
above must be incurred so they will have to be accounted for
in every project.

There is also a question about the objective of the
criterion. Does mere maximization of the output-capital
ratio lead to economic development? The author believes
that a problem will be created. W. Galenson and H. Leiben-
stein give some support to the idea.[76] Their case is that
if the economy consumes 110% of current output, certainly
no development is taking place. In fact, capital is being
used up in the process. If the above is the case, there can

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[76]Galenson and Leibenstein, op. cit., p. 345.

be no economic development.

Turning now to the labor intensity criterion, many
of the same criticisms are applicable. The labor intensive
criterion advocates the substitution of labor for scarce
capital. At first glance the labor intensive criterion
seems to be ideal but there are several objections to the
criterion.

First, labor is not a perfect substitute for capital
in the operation of a project. Also, the same problem is
encountered with this criterion as was with the rate of
turnover criterion: namely, the social cost of labor. Sec-
ond, projects which may add to development and be of a cap-
ital intensive nature are not given consideration in the
criterion. The author tends to go along with Mandelbaum in
his reservations about the labor intensive criterion.[77]
Along the lines of the first objection, one would expect
any industry included in the program to use the most up-to-
date production methods. If methods of production are changed
frequently, the labor force will continually have to be
trained in each successive level of technology. Lastly, the
labor intensive criterion may bring about disguised unemploy-
ment since there may come a point where the use of inferior
equipment will hamper production.

Both the labor intensive criterion and the rate of

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[77]Mandelbaum, op. cit., pp. xvii, 7-9.

turnover criterion have dealt with the scarcity of capital
in their final formulations. Although capital shortages
may be very important considerations, the author believes
that they are not the only ones since capital is not the
only scarce resource. Other inputs such as skilled labor,
certain types of raw materials, human capital, and foreign
exchange also deserve consideration in a properly formulated
investment criterion for underdeveloped countries.

In summation of the factor intensity criteria, three
important things stand out. The number of appropriate
economic variables chosen is small in relation to the eco-
nomic development problem. Secondly, the structural equa-
tions of the formulations of the criteria are of a static
nature rather than of a dynamic nature, as is the process of
economic development. Finally, there are serious reserva-
tions about the assumptions behind the criteria. However,
the first attempts at the formulation of investment criteria
were not wasted, as the two concepts, the rate of return
and the substitution of labor for capital, were used in more
analytically rigorous and more inter-related criteria.

The next link in the chain of formulation of invest-
ment criteria comes with the formulation of the social mar-
ginal productivity criterion. The principle was suggested
by A. E. Kahn and then the criterion was formally stated by
H. B. Chenery. The objective of the criterion was to pro-
vide a method of measuring the contribution of a project to

the whole economy. Project inputs are to be measured at
their social costs and the balance of payments effect of a
project was formally included in a criterion for the first
time.

One of the first things to be said about the SMP
criterion is that there is a case where the criterion is
nothing more than the Polak-Buchanan rate of turnover cri-
terion plus a balance of payments premium. If the social
cost of inputs is equal to their private cost, the criter-
ion approaches the rate of turnover criterion. Only when
there is a difference between social cost and private cost
is the SMP formulation any different from capital turnover
considerations plus a balance of payments effect. If there
is no difference between social costs and private costs,
the SMP is subject to the same criticisms of the factor in-
tensity criteria as presented above.

In the author's opinion, the SMP criterion is subject
to some of the same criticism that the factor intensity cri-
teria were. The number of economic variables is still too
small although the balance of payments premium is an im-
provement over the factor intensity criteria. Again non-
marketable outputs are excluded from the criterion. In
addition, the physical inter-dependence of projects is given
no consideration. Finally, the author will also support the
correction of the criterion suggested by Otto Eckstein. His
correction is based on external economies. His statement

is:[78]

> If a project purchases factors from productive units
> operating under decreasing cost, the social cost is
> not equal to prices based on average cost, but to
> marginal cost.

As the reader will have noticed, the use of social cost in

the investment criteria discussed has given rise to problems.

With the formulation of the social marginal productiv-

ity criterion, theoretical investment criteria started to

become more complex and there was an improvement over the

factor intensity criteria. The criterion advocated the exam-

ination of alternative projects from the viewpoint of the

size of their contribution to the whole economy and the num-

ber of variables was enlarged by one with the inclusion of

the balance of payments effect.

The reader will have noticed, also, that all of the

criteria discussed up to this point have emphasized output

in the present time periods and that no consideration is

given to the time preference of the population of an under-

developed country. In the author's opinion time preference

must be given consideration in a criterion. It is necessary

to consider time preference of the population to set the

pace of growth of consumption output.

The next link in the development of theoretical in-

vestment criteria comes with the proposal of the marginal

reinvestment quotient criterion suggested by Galenson and

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[78]Eckstein, op. cit., p. 61.

Leibenstein. The objective of the criterion is to maximize the surplus over the wage bill and reinvest the surplus. Their criterion turns the emphasis from projects which are capital-light to projects which are capital intensive. Emphasis has now been switched from the present to the future time periods.

The author's primary objection to the criterion is the assumption that the propensity to save out of wages is zero while the propensity to save out of profits is one. Eckstein for one states there is no reason for this assumption.[79] If the assumption is to hold in an underdeveloped country, the government will probably have to control all profits. This also raises a question in the author's mind about entrepreneural initiative being dampened. The assumption can also be criticised for its use of a social welfare function where half of the population would starve in the near future.[80] Although this may be one way of solving population problems, ethical considerations are against it as is the fact that labor will have to be in a condition to produce.

The criterion is also open to criticism since it is

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[79]Eckstein, op. cit., p. 65.

[80]H. Neisser, "Investment Criteria, Productivity, and Economic Development," Quarterly Journal of Economics, LXX (November, 1956), p. 645; F. M. Bator, "On Capital Productivity, Input Allocation, and Growth," Quarterly Journal of Economics, LXXI (February, 1957), pp. 96-110.

biased toward capital-intensive projects. Some capital-light
projects will add to the development of a nation, yet the
criterion gives no consideration to this fact. Also, no
consideration is given to time preference, balance of pay-
ments effects, and important non-marketable outputs such as
human capital. The criterion then is subject to the same
limitation of all the others discussed so far, the number
of economic variables included in it is too few.

The criterion although utilizing the factor intensity
principle, has presented a contribution. The reinvestment
potential of a project is important and the criterion has
given the economist an important "tool."

The culmination of the development of theoretical
investment criteria in the author's opinion is with the mar-
ginal growth contribution criterion proposed by Otto Eckstein.
His analysis is the most sophisticated of any of the invest-
ment criteria presented in the literature and it also takes
into account more inter-relationships than any of the others.

The marginal growth contribution combines considera-
tions of productivity with those of reinvestment so it is a
synthesis of these two important concepts. Furthermore,
the criterion takes into account another significant variable:
time preference. The stated objective of the criterion is
to maximize the present value of the future consumption
stream.

As was mentioned above, the criterion is a synthesis

of the SMP criterion and the reinvestment quotient criterion. If the interest rate (which expresses the planning authority's judgment about time preference) is zero, the criterion approaches the reinvestment quotient criterion. If the interest rate is not zero, the criterion combines both the reinvestment criterion and the SMP criterion. In the author's opinion Eckstein has utilized the two most important features of investment criteria presented in the literature, since a project is examined simultaneously with respect to productivity and reinvestment.

Eckstein's analysis has then added the two economic variables of the two other criteria together. He has incorporated a productivity term from the SMP criterion with a reinvestment term from the marginal reinvestment quotient criterion. However, one important variable has been left out of the analysis: the balance of payments premium included in the SMP criterion. The criterion needs to be "corrected" for this important variable. Other economic variables, also, have been left out of the analysis. Variables such as external economies and diseconomies and human capital have not been included.

The author does not think the assumption of all projects having equal lives is justifiable. If the number of alternatives is large, it would be unlikely that all projects would have equal lives. Second, the author thinks the assumption that all markets function perfectly (except

the capital market) is questionable. Labor markets in under-
developed countries are examples of markets not functioning
properly.

The reader will probably wonder why the industrial
requirements criterion and the capital extensiveness criter-
ion are omitted from the discussion of the development of
theoretical investment criteria. The author feels the two
criteria have contributed nothing to the development of in-
vestment criteria with respect to the economic variables
that are considered or to the 'structural equations' in the
criteria.

Neither Bohr nor Lewis have added anything to the
analysis contained in the literature previous to their en-
deavors. They suggest no method of weighting the factors
which they consider and their analysis of generally poor
analytical quality. Lewis' statements are quite obvious
except to the most casual reader. He has simply set down
some general guides for investment planning. In fact, Lewis
seems to disregard the problem posed by the definition of
an investment criterion. Most of the author's criticism of
Lewis applies equally to Bohr. Moreover, Bohr has commit-
ted a more serious methodological error than Lewis. First,
he has used data for the calculation of the industrial
characteristics from the United States and the United King-
dom dated in the late twenties and early thirties. He
fails to recognize that the technology described by the

data is probably obsolete, especially in the case of capital intensive operations. The author also thinks that the whole criterion is suspect since factor endowments vary so widely all over the world.

This section has presented the development of investment criteria for the underdeveloped nations along with the author's comments about the criterion with respect to the choice of the economic variables and the structural equations of the models formulated from them. The criteria have developed from the fairly rudimentary principles of factor intensity to the social marginal productivity criterion. The emphasis was then turned from productivity considerations to those of reinvestment potential. Finally the process culminated in the formulation of the marginal growth contribution which utilized the SMP criterion and the reinvestment criterion. As the process of development of the criteria went from the simple to the complex, the analysis became more rigorous and more inter-relationships were taken into account. Also, the number of economic variables were increased from one to many.

In the author's opinion more economic variables need to be included in the criteria, especially those considering non-marketable products such as human capital, sociological development, and political development. Along the same line, structural equations which are dynamic rather than static are badly needed.

SECTION TWO

THE OPERATIONAL UTILITY OF THE VARIOUS CRITERIA

Since the final test of a theory of resource allocation must rest in its empirical application, an attempt to describe some of the difficulties of the application of the criteria discussed in this thesis will be made. Empirical applications of the criteria will also be pointed out. Finally, some comments on the present allocation of resources in the underdeveloped nations will be noted.

There are two procedures necessary for the application of investment criteria. First, an operational procedure is necessary to obtain data for the calculation of the economic variables in the particular criterion. Second, if expectations of future economic variables are to be used in a model for investment allocation, sample observations are necessary. Regression analysis or come other forecasting technique may be used. With the above in mind, the various criteria will be examined on the basis of their operational utility.

Analysis with respect to the operational utility of the rate of turnover criterion centers around the use of the capital-output ratio. One of the first things to note is that information for the calculation of the ratio is lacking

in the underdeveloped countries. Higgins has stated that
work done at the Center for International Studies resulted
in finding only five countries where statistical information
was adequate to calculate the ratio.[81] If such is the case,
research must be done to compile data necessary for the
calculation of the ratio. Cautious use must be made of ra-
tios found in the literature since a ratio net of deprecia-
tion will give a different allocation than one which is not.[82]
The author favors the use of a ratio net of depreciation
since it will probably give the most accurate results. In
either case ratios used must be consistent with each other
regarding depreciation. The above comments lead the author
to believe the use of any criterion which embodies the capi-
tal-output ratio will be of little immediate value. Work
must be done in computing the ratios before the criterion
can be applied.

With regard to the labor intensity criterion, several
empirical studies are needed in order to apply the criterion.
First, a list of projects where the substitution of labor
for capital is possible should be drawn up. Second, the
cost of labor employed from the backward sector must be de-
termined to see whether it is significant to consider. The

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[81]Higgins, op. cit.

[82]A. K. Sen, "Some Notes on the Choice of Capital
Intensity," Quarterly Journal of Economics, LXXII, p. 561.

author is of the opinion that this cost may be found to be
significant since transportation charges may be involved as
well as construction of housing. If the labor must be
trained to perform some type of operation, the cost of
training must also be included in any decisions about pro-
jects.

Turning now to the SMP criterion, both the Chenery
formulation and the Tinbergen-King formulation require a
great deal of information. The author questions the avail-
ability of the information in the underdeveloped countries,
especially those without any organized statistical informa-
tion system. Again, statistical estimates will have to be
made with reference to the balance of payments effect and
the value of output resulting from external economies for
any particular project. The last mentioned estimate will
present problems, since the influences of external economies
are so elusive and there also is great analytical trouble
in even defining them.

Looking at the Tinbergen-King formulation, one sees
several price indicies used. The author sees the whole host
of problems associated with the use of index numbers to be
applicable to the formulation. The empirical problems with
the Chenery formulation will also apply.

Although the SMP criterion may have many operational
difficulties, it has been used in an underdeveloped country.
The criterion was used by the Philippine Government in the

form:[83]

$$IP = R_1 + R_2 + R_3 + R_4$$

IP = industrial priority

R_1 = the contribution to national income of the factors used in the project. The factors considered were land, capital, entrepreneurship, and an essentiality factor to account for the impact of the project on external economies, social benefit conditions, and the complete use of capital resources.

R_2 = the effect of the project on the balance of payments.

R_3 = additional economic values derived from the use of domestic materials and supplies.

R_4 = the social value derived from using domestic labor.

The criterion then has been applied by the government of an underdeveloped country, but the form has been modified for the application from the Chenery statement.

The author believes that any application of the marginal reinvestment quotient criterion will require a great amount of statistical information. The problem involved is to calculate the surplus for each alternative project. No empirical procedure was presented by Galenson and Leibenstein, since their development of the criterion was for expository purposes only; however the author does find that the operational use of the criterion will present other problems aside from the calculation of the surplus. Some kind of government commission will have to be set up to control the surplus in the sense that there must be no leakages from ie, i.e., if

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[83]Higgins, op. cit., p. 654.

there are leakages from the surplus, the criterion will not work.

Again, as with the criteria discussed previously, estimation of parameters is going to be a central part of the application of the marginal reinvestment quotient criterior, and problems will no doubt be encountered in acquiring statistical information for the calculation of priorities.

Since the marginal growth contribution criterion was proposed for expository reasons only, an evaluation with respect to its operational utility will not be too meaningful. But the author feels that a few comments on the topic may be of some value in the light of further development of investment criteria.

The application of the criterion, like those discussed previously, will involve estimation of several parameters. Probably one of the hardest to estimate will be the marginal productivity of reinvested capital. A great deal of work will also be required in finding the production functions for each of the alternatives. Since the planning authority will have to determine the interest rate, an opinion poll or some similar device will have to be used to determine the social time preference of the country.

The benefit-cost criterion, although somewhat different from the marginal growth contribution criterion, may be the most nearly practical empirical form of the marginal growth contribution criterion. The criterion requires data

which are simpler to calculate and may also be more easily obtainable in an underdeveloped country. The criterion also has another point favoring its use. It has been used in Pakistan on the Thal Development Project.[84] The success of an application of the criterion will depend in part upon how accurately the forecasts of prices and other variables are in the future.

Nothing has yet been said about the empirical diffi-culties involved with the inclusion of non-marketable prod-ucts into investment criteria. None of the criteria dis-cussed in this thesis provide a operational procedure. Research must be done to devise some sort of measuring technique for their inclusion into investment criteria. If no technique can be found, the criteria must be sufficiently flexible to include some kind of rudimentary estimate.

In summation of this section, the author would like to review some of the more outstanding features of the operational utility of theoretical investment criteria. An application of any of the criteria presented involves col-lection of a large amount of data. Almost all of the cri-teria require estimation of certain key variables and the success of their application will depend in part upon how accurate the estimates and forecasts are. Finally, some

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[84]Thal is a location in Pakistan.

method must be found to include the values of non-marketable outputs into the criteria. The author is of the opinion that none of the criteria presented in this work are operationally useful in their form. Modification will be necessary, a fact which is supported by the empirical applications of the SMP and the MGC criteria presented above.

CONCLUSION

Since none of the investment criteria presented in this thesis have been without criticism, it is worthwhile in the author's estimation to review the criteria from an overall standpoint to see what the mean weaknesses are. The criteria discussed in this work are all of a static nature, while the problem of economic development has a dynamic nature. An investment criterion which attempts to cope with the dynamics of development is needed. The criteria also fail to take account of any product which does not have a marketable value. Factors such as human capital, sociological development, and political development are overlooked or are given scant attention. There is also little attention paid to the statistical information requirements of investment criteria in contrast to the inadequate quality and insufficient quantity of statistical information available in the underdeveloped countries. Also, there is scant attention given to income distribution effects resulting from a project. Finally, all of the investment criteria discussed have an implicit assumption that the output of alternative projects will be demanded by the population of the country. Nothing is said about the possibility of the demand for the output of different types of projects differing. It is hoped by the author that the above remarks may provide a sense of

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direction for the further formulation of investment criteria.

In the light of the previous paragraph, some value
may be derived from a general overview of the development
of the investment criteria discussed. The first criteria
suggested in the literature, such as the rate of turnover
criterion and the labor intensive criterion, utilized the
principle of factor intensity as their central building
block. The factor intensity criteria attempted to deal with
capital scarcity either by economizing on capital or substi-
tuting a more plentiful factor, such as labor, for capital.
A turning point in this train of thought was reached when
the social marginal productivity criterion was proposed.
Emphasis was switched to productivity and balance of pay-
ments effects of projects were taken into consideration.
The next link in the chain of thought comes with the mar-
ginal reinvestment quotient criterion which turned the em-
phasis from productivity of capital to consideration of
reinvestment. The process culminates with the marginal
growth contribution criterion proposed by Otto Eckstein,
where the social marginal productivity criterion and the
marginal reinvestment quotient criterion were synthesized.
Also, as each stage of the development of investment criteria
was reached, the analysis took into account more inter-rela-
tionships and became more rigorous.

The value of the criteria proposed and discussed in
this work lies in their being 'stepping stones' in the

development of a more perfect theory of investment allooa-

tion for the underdeveloped nations.   As Anatol Rapoport

has so aptly stated:

> Before ideas fruition, they must germinate. The
> most important direct consequence of an idea is that
> it gives rise to more ideas. I suspect that the most
> important direct result of a systematic and many
> sided study of a conflict would be the changes which
> such a study could effect in ourselves, the conscious
> and unconscious, the willing and unwilling partici-
> pants in conflicts. Thus, the rewards to be realis-
> tically hoped for are the indirect ones, as was the
> case of the sons who were told to dig for buried
> treasure in the vineyard. They found no treasure,
> but they improved the soil.[85]

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[85]Anatol Rapoport, Fights, Games, and Debates.

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