CAPITAL-OUTPUT RATIO AND THE CAPITAL-TURNOVER RULE

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The aim of this paper is to highlight the role that capital output ratio has played in actual planning practices in developing countries. Furthermore, the paper evaluates this role in a static (or comparative static) rather than in an explicit dynamic context.

The capital-output ratio has only recently received a prominent place in economic analysis. This concept which emerged with the Harrod-Domar (1) theory of growth is now being used as o tool to determine the total capital requirements to achieve a certain rate of income growth. The capital-output ratio in the early writings of investment criteria was also used to a lesser extent as a device to assign priorities to investment projects. Its former use is now broadly accepted, but its latter use as an allocational device has been chalanged extensively.

It is a known fact that under imperfections which exist in the markets of underdeveloped countries, prices cease to be a satisfactory device for the distribution of investment resources and for the assessment of social costs and benefits of investment projects. It is also indicated that the dispersal of single investment decisions based on maximization of commercial profits as the only criterion may lead to a non-optimum investment combination. Therefore, when investment projects are evaluated from the society or from the general economy view point investment criteria take on a dif-

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(1) The Harrod-Domar theory of growth relates a country's rate of growth of income to its savings-income ratio and incremental capital-output ratio. Thus $g = \frac{s}{v}$ where g stands for growth of income, s for savings-income ratio and v for the incremental capital-output ratio. See, R. F. Harrod-An Essay in Dynamic Theory, EJ. March, 1939; Also E. Domar - Expansion and Employment. AER. March, 1947.

ferent form than private investment criteria (1). This is because Plannig Agencies in developing countries, contrary to private investors, attempt to value investments in terms of their effects on national income, employment, balance of payments and distribution of income. The success of an investment programme calls for the appraisal of projects on the basis of their contribution to these major economic objectives. For this reason, it becomes essential that investment decisions be based on social profitability criteria rather than commercial profitability rules.

In the earlier studies of investment criteria private profitability was substituted by partial project evaluation measures such as capital turnover rate, capital-labour ratios, balance of payments effect criterion and social marginal productivity rule (SMP) (2).

This paper will, however, be confined to the discussion of capital-output ratio and capital turnover criterion. It should be emphasised at the outset that the capital-output ratio when applied as a priority criterion is synonmous with the capital turnover rule suggested by J. J. Polak (3). It is suggested that to maximize income at present choice should be made of investment projects with a low capital-output ratio ie., a high rate of capital turnover. In other words this implies that capital which is a scarce factor in developing countries should be allocated in a way that provides a maximum addition to income.

The paper is divided into two parts. Part I, is concerned with the various concepts of capital-output ratio; theoretical basis of the capital-output ratio and with its practical usage in formulating development programmes. Part II, proceeds with a discussion on definition of output and capital and shows the theoretical drawbacks of capital-output ratio in so far as it is applied as an investment criterion.

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(1) In practice the commercial profitability rule is often applied in various forms. Most of the private enterprises operate on a rate of return criterion (annual accounting rate of return, internal rate of return), on a pay-back period and more efficient firms on the basis of the present value method.

(2) For a good summary of public investment criteria, See, H.B. Chenery, The Application of Investment Criteria, QJE. Feb. 1953 p. 80; Also, UN- Choice and Phasing of Public Sector Projects - Economic Bulletin For Asia and The Far East, Vol. XVII, No. 2, Sept. 1966. pp. 16-29.

(3) J.J. Polak, Balance of Payments Problems of Countries Reconstructing with the Help of Foreign Loans. QJE. Feb. 1943 pp. 208-240.

PART I

I. VARIOUS DEFINITIONS :

At the beginning it may be useful to distinguish between the average and the marginal capital-output ratio (or incremental capital-output ratio). The average ratio is the value of the total stock of capital divided by total annual income :

$$ACOR = \frac{K}{Y},$$

Output here can be in terms of gross or net and it can be defined in terms of value or volume of product. İf product is taken in terms of value the planner may face the problem of prices since there may be changes in the price level. İf the volume of production is the choice one then may be confronted with the lack of auniform unit of measurement and other problems of commodity classification. Capital, on the other hand, can be measured in a very abstract way or in a more physical way, in the former capital will stand for all assets involved in the process of production and in the latter for money value or some physical unit (1).

The incremental capital-output ratio (ICOR) for the whole economy is the value of the addition to capital (net investment) divided by the addition to income (net national income).

$$ICOR = \frac{I}{\Delta Y} = \frac{\Delta K}{\Delta Y} = \frac{(\Delta Y) - 1}{\Delta K} = \frac{1}{MP_k}$$

The incremental capital-output ratio need not, of course, equal the average ratio and even though any change in the average ratio may be expected to be slow, the incremental ratio can vary a great deal more. More explicitly, it can be argued that if marginal capital-output ratio is equal to average ratio there will then be no additional change in output. If, on the other hand, marginal capital-output ratio is smaller than average ratio output will decrease and while marginal ratio exceeds average ratio output will record an increasing tendency.

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(1) J. Tinbergen defines capital as «The sum total of market value of the equipment and machinery and stocks and the depreciation funds accumulated.» See. J. Tinbergen - The Design of Development. Baltimore, 1966, p. 70.

It can be asserted that the ICOR may be a powerful tool of analysis if it could reasonably be assumed that the ratio is independent of the behaviour of the other variables in the system.

Capital-output ratios can however lose their importance if factors completely unrelated to additions to capital stock cause great variations in output. There are several possibilities here. (i) First, there may be unutilized capacity which, prior to the addition to the capital stock for some reason or another unconnected with capital accumulation, is utilised after the investment takes place. (ii) Secondly, there may be an increase in the labour force that can occur simultaneously with the addition to capital. (iii) Thirdly, a factor which is often ignored is the change in the availability of "free-factors" that affect the production process and at the same time bear no economic cost ie., climatic conditions (rainfall, sunshine). (iv) Fourthly, technological change is an important factor affecting the value of the capital-output ratio. Technological change here implies any kind of shift in the production function. (v) Finally, the quality and energy of the labour force are other factors that will obviously have some bearing on the capital-output ratio. For instance, a highly skilled labour force and one that is highly flexible and mobile will naturally produce more output per unit of capital than an immobile and tradition-bound labour force (1).

II — THEORETİCAL BASIS OF THE "ICOR" :

It may be useful to explain how the incremental capital-output ratio can be derived from the simple production function and then indicate the simple connection between the incremental capital-output ratio and the rate of national income growth.

If Y represents output and K capital input L labour input and

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(1) Discovery of natural resources such as oil-fields and copper-mines can have a marked impact on the value of ICOR especially if they can have the possibility of being exported over 4-5 years which in turn can cause a rise in national income and thus a decline in the value of ICOR. Extension of cultivable land can also lead to an increase in agricultural output which in turn increases national income without requiring a substantial addition to capital stock.

t technological change in a given period; then the aggregate production function can be written as : (1)

$$Y = f(K, L, t) \qquad (I)$$

The increment in output corresponding to a given increment in the factors of production in a given time period, can be shown as :

$$dY = \frac{\partial Y}{\partial K} dK + \frac{\partial Y}{\partial L} dL + \frac{\partial Y}{\partial t} dt \qquad (II)$$

Here $\frac{\partial Y}{\partial K}$ represents the marginal productivity of capital and dK, dL and dt represent changes in the factors of production. However, we are interested here in the changes in capital dK (net investment) and increment in income (dY) and the mutual relationship between these two factors.

If we divide both sides by dK we obtain :

$$\frac{dY}{dK} = \frac{\partial Y}{\partial K} + \frac{1}{dK}\left(\frac{\partial Y}{\partial L} dL + \frac{\partial Y}{\partial t} dt\right) \qquad (III)$$

On the other hand, if we assume that changes in L and t do not affect the changes in output (Y) then dL = 0, dt = 0 will hold. Given that these factors are constant, the relationship between changes in capital-stock and output becomes :

$$\frac{dY}{dK} = \frac{\partial Y}{\partial K} \qquad (IV)$$

From here, incremental capital-output ratio can be written as .

$$ICOR = \frac{dK}{dY} = \frac{1}{\frac{\partial Y}{\partial K}} \qquad (IV)$$

Since $\frac{\partial Y}{\partial K}$ represents marginal productivity of capital,

(1) Natural resources (ie., land) are usually taken as given parameters and do not appear as an element in the production function. Therefore land has been omitted from the above production function.

$$ICOR = \frac{1}{\text{marginal productivity of capital}} = \frac{1}{MP_k}$$

Thus the incremental-output ratio is defined as the quantity of capital required to produce one unit of output. As can be seen from equation (V), ICOR is a coefficient which represents the reciprocal value of capital productivity coefficient. Marginal productivity of capital, in turn, becomes equal to the reciprocal value of ICOR.

$$\frac{dY}{dK} = \frac{1}{ICOR} \qquad (VI)$$

Admittedly, the increase in total output associated with an addition to the stock of capital is determined not only by the amount of additional capital, but also by additions of some other units-labour land, technical skill, management. Only, if it is assumed that the supply of these other factors is infinitely elastic, is the increase in output determined solely by the amount of additional capital. The link between the marginal productivity of capital and the capital-output ratio is that the magnitude of both depends on the supply of all other factors of production; the greater the supply the higher the marginal productivity and the lower capital-output ratio. Therefore, if the supply of factors other than capital increases more rapidly than the stock of capital we can expect an improvement in the efficiency of the utilization of capital and a decrease in the capital-output ratio.

III — USE OF INCREMENTAL-CAPİTAL-OUTPUT RATİO :

For an aggregative income growth theory, the role of the capital-output ratio concept can be readily seen from the simple connection between the ICOR and growth rate of national income. In static terms, the rate of growth of national income is obtained by multiplying the current investment rate (proportion of net national income invested) by the reciprocal value of the ICOR (1)

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(1) It should be noted here that capital output ratio has been defined in "static terms" where it is assumed to be constant. In more complex growth models it has been used as a dynamic concept where all derivations are with respect to time.

Let Y be net national income, ΔY the absolute increase in net national income and let I be net investment,[1] that is the increment to capital stock. We can therefore write;

$\frac{I}{Y}$ representing the investment rate, and

$\frac{I}{\Delta Y}$ representing the incremental capital-output ratio ;

Then it follows that the rate of net national income growth becomes :

$$\frac{\Delta Y}{Y} = \frac{I}{Y} \cdot \frac{\Delta Y}{I} = \frac{\Delta K}{Y} \cdot \frac{\Delta Y}{\Delta K} \qquad \text{(VII)}$$

In other words, rate of growth of national income becomes equal to investment coefficient times the reciprocal value of ICOR. For instance, if net invesment is 20 per cent of national income and if we know that the rate at which investment is turned into net income per year is 4 to 1, we can then infer that the rate of national income growth will be 5 percent per annum. This relationship can be shown by a simple diagram (see, figure 1).

In Figure 1, the horizontal axis depicts amounts of net investment as a percentage of current national income that is the current increment to capital stock as a percentage of national income. The vertical axis shows current rates of increase in net national income.

The curve α 1 represents the incremental capital-output relationship for a given initial percapita output of Y_1. Each point on the α 1 curve tells us the percentage of national income invested and the

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(1) It should be clear that addition to capital stock between the time periods of t and t-I will correspond to net investment. Thus

$\Delta K = (K_t - k_{t-1} = I$(net) investment)

Following Harrod-Domar model, if K represents capital stock and α incremental capital-output ratio we can write:

$K = \alpha Y$ where $\Delta K = \alpha \Delta Y$. Divide both sides by Y;

$\frac{\Delta K}{Y} = \alpha \cdot \frac{\Delta Y}{Y}$. Rate of growth of national income becomes: $\frac{\Delta Y}{Y} = \frac{\Delta K.}{Y} \cdot \frac{\Delta Y}{\Delta K}$.

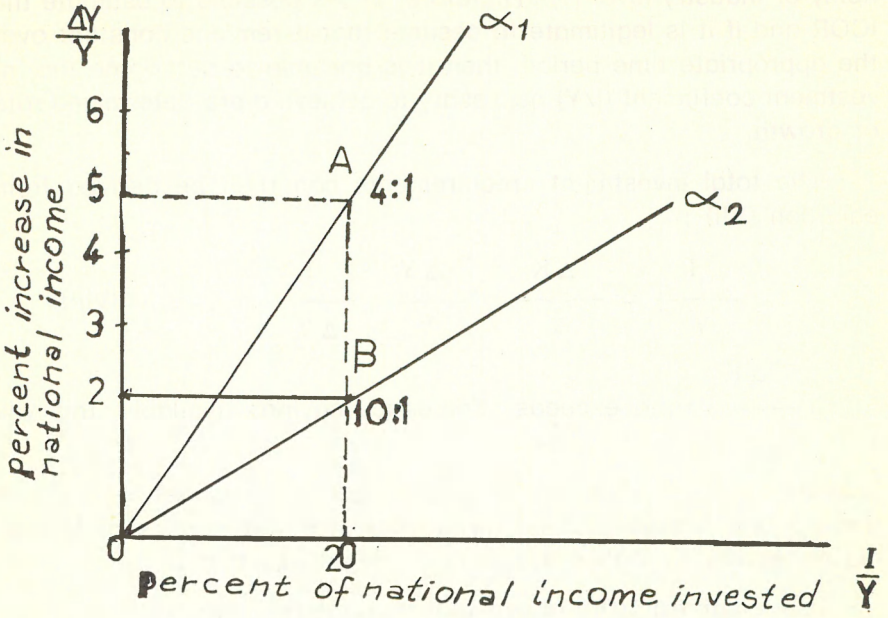

Figure 1

increase in national income resulting from that investment. It is clear that if the rate of investment is assumed 20 percent the corresponding increase in national income would be 5 percent; this reflecting an ICOR of 4: 1. The curve α_2 on the other hand, shows a higher ICOR than α 1 as a result of a smaller initial level of per capita income Y_2. Here, of course, the ICOR becomes 10 to 1. This implies that marginal productivity of capital here is lower than in the first case.

The capital-output ratio curves are drawn as linear functions, but this need not be the case. The ICOR curve may rise at an increasing rate at first in order to reflect possible advantages of complementarities in investment that may take place. Beyond some rate of investment the curve, however, may rise at a decreasing rate because at higher rate of investment, increased competition for scarce resources may make capital goods more expensive. In other words, this implies that beyond some point increased growth rates of income can be achieved only at higher ICOR's at the margin.

The incremental capital-output ratio received wide application in many developing countries for determining the total capital requirements necessary to achieve a target growth rate either at the eco-

nomy or industry level (1) Therefore, if it is possible to estimate the ICOR and if it is legitimate to assume that it remains constant over the appropriate time period, then it is possible to determine the investment coefficient (I/Y) necessary to achieve a pre-determined rate of growth.

The total investment requirements can then be derived from equation (VII) ;

$$\frac{I}{Y} = \frac{\Delta K}{Y} = \frac{\Delta Y}{Y} \cdot \frac{I}{\Delta Y} \qquad \text{(VIII)}$$

If $\frac{\Delta K}{Y}$ ratio exceeds domestic savings available, this will indicate to us the urgency of introducing new measures to augment the amount of saving or equally it indicates the amount of foreign aid necessary to realise the planned target of income.

It is clear from the above formula that the investment coefficient is positively related both to the rate of growth of income and the value of ICOR. On the other hand, ICOR is inversely related to the rate of growth of income with a given level of investment coefficient. In other words, the higher the ICOR, the smaller the rate of growth of output becomes and vice versa. This last point can be illustrated by a diagram as can be seen in Figure 2.

The horizontal axis indicates the rate of growth of income and and the vertical axis the ICOR. From the definition of ICOR, it can be deduced that high ICOR will imply low marginal productivity of capital reflecting a little increment to national income. It is also normal to assume that ICOR being high implies that investment allocation is directed toward social overhead capital rather than productive sectors where the former requires high capital-output ratio and a long gestation period. Thus in that case, it is natural to expect a reasonably lower rate of growth (i. e. $\frac{\Delta Y}{Y} = 2$) of income at least until the investment projects included in SOC sectors reach maturity and begin to contribute to national income.

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(1) ICOR, of course, can be used for the whole economy, for a sector or for an individual project. The principle of capital-output ratio, however, remains the same.

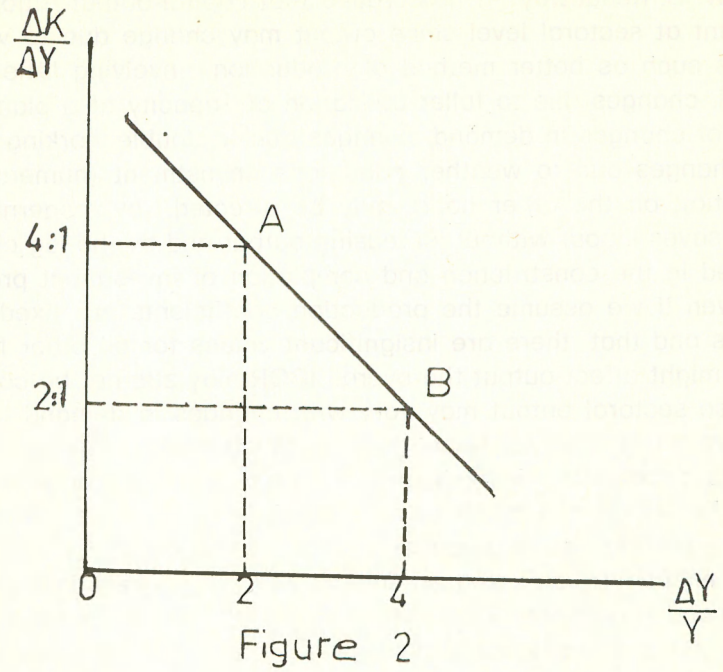

Figure 2

IV — CONSTANCY OF ICOR :

Incremental capital-output ratio assumes a stable relationship between capital and output which is more likely to be the case in the overall economy. This may however be assumed to be true for a developed economy where an adequate supply of co-operant factors is likely to exist. Political, social and institutional factors which constitute pre-requisities for economic development also already exist. Therefore, when ICOR is calculated under these conditions it is perhaps reasonable to assume the supply of other factors is forthcoming. However, in a developing country where the co-operant factors (1) appear to be in short supply it is not legitimate to consider an increase in capital alone as a sufficient condition for an expansion in output.

Since the overall ratio will be affected by the changing composition of output and investment among the several sectors, it is essential to examine the capital-output relationship at the sectoral

(1) Ignoring other variables such as trained manpower, entrepreneurship and institutional arrangements and attributing all of the output increment to capital will imply taking a very narrow view which assumes an automatic re-relationship between output and capital.

level. W. B. Reddaway (1) has argued that capital-output ratio is not constant at sectoral level since output may change due to various factors such as better method of production involving little or no capital, changes due to fuller utilization of capacity of a plant as a result of changes in demand, changes due to double working shifts, and changes due to weather conditions. Investment (numerator of the ratio), on the other hand, may be affected by modernization which saves labour without increasing output and by the lag element involved in the construction and completion of investment projects.

Even if we assume the production coefficients are fixed in all sectors and that there are insignificant values for all other factors which might affect output the overall ICOR may still not be constant because sectoral output may vary with changes in demand.

There are two significant factors which might cause the capital-output ratios to diminish as a country develops economically. First, the quality of the labour force is likely to increase as income grows. This may be so because the increased consumption expenditure ensued from increased income will very likely improve the vitality and knowledge of the labour force. (2) Further as capital increases this will facilitate the division of labour and hence cause higher labour productivity. Second, indivisibilities of certain capital-goods can be overcome as output increases and also the likelihood that external economies make themselves felt as output increases may resuit in a gradual decline in the capital output ratios. (3)

PART II

V — CAPİTAL-OUTPUT RATİO AS AN INVESTMENT CRITERION

(i) **İntroduction :** As we have mentioned earlier the capital-output ratio is defined as the quantity of capital required to produce one unit of output. This is a coefficient which indicates the reciprocal value of capital productivity coefficient.

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(1) For more detailed discussion See, W.B. Reddaway - The Development of Indian Economy, Homewood, 1962, p. 207.

(2) H. Leibenstein states that: "This is not an exogenous change in the quality of the labour force, but one that is directly attributable to the growth in per capita income itself." Economic Backwardness and Economic Growth 1957.

(3) It is, however, sometimes argued that the contrary might occur when exhaustible and non-replaceable resources per man will decline as both income and population grow. As the supply of exhaustible resources decline its prices rise. To the extent that this resource enters into the production of capital-goods, the capital-output ratio will rise accordingly.

According to this kind of measurement capital-output ratio will be the total capital required by the project per unit of value added or gross annual value produced. The ratio of total capital and gross annual production value is the reciprocal value from which the capital-turnover rate is measured. It should be noted that the rate of capital turnover is the ratio between the enterprisès gross annual production and capital and is a device to measure capital productivity not in terms of profits but in terms of gross production value.

Therefore, when capital-output ratio is applied to assign priorities to investment projects those with low capital-output ratios (or a high rate of capital turnover) will be selected. This implies that capital which is a scarce factor in developing countries should be allocated to projects where the rate of capital turnover is maximized so as to provide a maximum contribution to national income.

(ii) **Definition of Output and Capital :** Because numerator and denominator of capital-output ratio may be defined in various ways the implications of resorting to one or another concept need to be borne in mind.

Let us take first, output. Output which is taken here to mean value added (VA) can be calculated in two different ways. It can be taken in terms of **gross** or **net;** and it may be defined in terms of value or physical quantity.

Value added can be first found by taking the difference between the sales value of output (goods and services) created by the investment and the expenditure on purchases of raw materials from third parties. Or it can be taken as the sum of factor incomes such as salaries, wages, rents, interests and profits. (1)

For gross value added, to the above sum indirect taxes and depreciation need to be added. Whereas for net value added (NVA) the last two items ought to be excluded from the above sum. Net value added can simply be shown as in the following equation :

$$NVA = C_t + P_r - (X_p + D_p + T_i)$$

Where C_t denotes total cost, P_r profits, X_p input purchased from third parties, D_p depreciation and T_i indirect taxes.

Capital investment on the other hand, includes imported machinery (excluding customs duties), wages paid to skilled and unskilled labour, payments to various national materials and equipment, customs duties, indirect taxes on raw materials, land etc. This is of course, investment from private firms point of view. But in social

(1) See. UN-Manual on Economic Development Projects. UN-New York 1958. p. 222. Profits are taken here to mean "pre-tax" profits.

evaluation of investment customs duties and indirect taxes on raw materials are excluded and do not enter the concept of social investment. The only difference between pricing at market values and at social cost will derive from indirect taxes paid on "purchases from the third parties", as these taxes are omitted from the social cost estimates.

Because net investment is derived from gross investment minus depreciation which is based on the accounting concept it may be doubtful if this figure can give the true value of the increments to the stock of productive capital. The doubt here stems from the fact that depreciation is calculated on the basis of an accounting concept rather than actual depletion of the stock of capital.

The question which may arise is whether to take ICOR gross or net of depreciation. No doubt the selection of either will produce different results and choices. This might be illustrated clearly if we take the following example.

Let us take two projects A and B each costing $ 100, but A with a life of 20 years and B with 4 years. Also suppose that straight-line cost is the agreed depreciation charge on both of them.

	Project A	Project B
Capital Cost ($)	100	100
Gross yield ($)	40	55
Annual Depreciation ($)	5	25
Net yield ($)	35	30
Life of projects	20	4
Gross ICOR	2.50	1.81
Net ICOR	2.85	3.33

It is clear that the gross incremental capital-output ratio favours project B, while net incremental capital-output ratio favours project A.

Now one may ask : Which concept of output one ought to take into account when computing the coefficient. This depends on whether the structure of capital is to remain stable or whether changes in the economy are to occur. Net output will be the choice if there is stability in the economy. This is because in this case depreciation is not needed to shift capital to other sectors. If capital

is to be shifted to other sectors-in the course of change-it may be desirable to deal with the gross concept of production. (1)

There is also a lag problem confronting the calculation of ICOR since this year's investment does not coincide with this year's output. This, of course, makes the comparison between input and output very difficult. For instance inputs in period t may lead to output in period t + 1, and again investment in period t + 1 brings output in period t + 2 and so on. (i. e. some investments need many years to yield their product - Hydro Dam, irrigation).

The relation between inputs and outputs in reality may show an even larger variety of lags than is expected. The rate of output may be constant or may vary; it may begin immediately or start after a lag. Then the imputation of a given output to a given input becomes necessary. In such a case, it is common practice to apply present value formula for the measurement of income streams in the future and compare it with the capital cost of a given investment project (2)

The Capital-output ratio as an allocational device was first suggested by Polak (3) and Buchanan (4). J. J. Polak was the first to consider the balance of payments problems arising from large-scale post war reconstruction programmes and their implications for the composition of the investment programme. Polak has stated that "..... given the magnitude of capital investment ..... it is desirable from the point of view of foreign exchange to maximize output and thus the rate of turnover (5) and also to minimize the capital required in order to keep the service of the foreign debt down."

What is suggested here is that the criterion of efficiency will be : "maximisation of foreign exchange earnings per unit of investment." Then the recommended types of investment projects would

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(1) See. C. Kindleberger, Economic Development McGraw-Hill Book Company. London. New York 1965. p. 88.

(2) If there is a lag and variability in the stream of outputs the present value formula becomes :

$$PV = \frac{V_1}{(1+r)} + \frac{V_2}{(1+r)^2} + \ldots\ldots\ldots\ldots + \frac{V^n}{(1+r)^n}$$

The PV of the nearer output is higher than that of those outputs occurring in the distant future because they are heavily discounted.

(3) J.J. Polak, Balance of Payments Problems of Countries Reconstructing with the aid of Foreign Loan OJE. Feb. 1943, pp. 208-240.

(4) N. S. Buchanan International Investment and Domestic Welfare. New York, 1955.

(5) The rate of turnover of capital is the value of annual output divided by the value of capital used to produce this output.

include those requiring **the least** amount of capital. Because he is mainly concerned about the balance of payments effects of different investment projects he argues that investment projects which fall within commodities for exports should receive higher priority. First, projects are classified according to their final product then the ultimate choice will depend upon the contribution of each project to the balance of payments compared with their initial investment.

N. S. Buchanan as well has been in agreement with Polak where he states : "..... if investment funds are limited, the wise policy in the absence of special considerations would be to undertake just those investments having a high value of annual product relative to the investment necessary to bring them into existence." (1) This implies that projects which are maximizing output at the least cost will be selected.

If we follow the capital-output ratio as an allocational device, projects are to be ranked according to **minimum** requirement of capital per unit of **discounted net output**. Then it is clear that those projects with the lowest cost of capital per unit of discounted net output are to be selected until the capital available has been exhausted.

(iii) **Theoretical Appraisal of Capital-Output Ratio :**

There is no strong theoretical justification for the capital-output ratio being used as an instrument to determine priorities among investment projects.

1. First of all capital-output ratio cannot be considered as a rule for maximizing **future** output. The main goal in Development Policy is not maximizing output at a point of time but rather a maximum rate of growth **over time.** Even if we assume that capital-output ratio would maximize the present value of output, this does not mean that the rule is correct for attaining this maximum over time. Let us take an example to illustrate this point.

Suppose that there are two projects, A and B each costing $ 100, and A with an investment life of 4 years and B 20 years.

As can be seen from the Table below the total output for project A is $ 160 and for B $ 400. On the other hand, the capital-output ratios are 2.5 and 5.0 respectively. Since annual output **net**

(1) N. S. Buchanan, op. cit. p. 24.

	Project A ($)	Project B ($)
Initial Investment	100	100
Annual Output	40	20
Life	4	20
Annual Straight-line Depreciation	25	5
Total output over Investment life	160	400
Capital-output ratio	2.5	5.0

of depreciation is $ 15 in each project this may raise the question of which project is contributing more to the national output.

In order to compare these projects it is necessary to calculate the present value (PV) of each project's income streams through their investment life. If the market rate of interest is 5 percent the PV of projects A and B will be $ 142 and $ 249 respectively. (1).

Now in the light of this result the choice will naturally be in favour of B rather than A, even though the capital-output ratio in the former is higher than in the latter. Therefore, one may conclude that capital-output ratio, as illustrated by the above example cannot be an appropriate guide for assigning priorities to investment projects. Clearly, when capital-output ratio is used the contributions of projects to national income **over a period** are neglected. In other words capital-output ratio does not take into account the lifespan of projects whereas long-life projects can be more advantageous. For instance, in long-life projects the depreciation - gross capital ratio is particularly low which means that the project will continue to create output for a long period without requiring large replacements.

2. Another weakness of this criterion is the fact that this rule may not maximize the value of **total output.** This is because maximizing the productivity of capital by itself is not a sufficient requirement for maximum total output. If the economic policy objective is maximizing total output not only productivity of the scarcest factor (capital) but productivity of the abundant factors as well must be maximized. To see this point let us consider an example:

(1) The market rate of interest is likely to understate the social cost of delayed increases in output. Hence it may be appropriate to apply an imputed rate of interest instead of the market rate interest.

Divide total output into **two** parts and let the first part be 0_1, assuming this part of 0 is to be produced by workers L_1 (in optimal combination of capital). The other part of output, say 0_2, is to be produced by the rest of the labour force, L_2, with little or no capital.

It is quite obvious that $\frac{0_1}{L_1} + \frac{0_2}{L_2}$ will always exceed $\frac{0_1}{L_1}$,

as long as capital is assumed to be a scarce factor relative to labour (1). Total output means output of any factor multiplied by the number of units of that factor, but this does not necessarily mean that maximizing the productivity of that factor alone would lead to maximum total output.

3. This criterion assumes that capital is the only scarce factor in the economy and other factors like labour and natural resources have no opportunity costs. In other words capital-output ratio is valid if capital is the only scarce factor in the system or other inputs are so plentiful relative to capital that the latter is the dominant element in determining cost differences (2).

This implies that, if prices were truly reflecting scarcities capital would have some positive price while other factors would have zero prices. However, if either labour or natural resources has a significant opportunity cost the capital-output measure will cease to be a meaningful device for resource allocation. It is also doubtful if any planning authority would deem one factor scarce, other factors so abundant as to consider all but the first as "free goods".

Further, this system would not characterise all less-developed countries because capital there is not always the scarcest factor. In fact capital in some less-developed countries may be less of a bottleneck than unskilled labour, immobile labour or social barriers(3)

4. Capital-output ratio does not take into account the indirect benefits an investment project might give rise to. Yet some large projects which require large capital-outlay may result in a considerable degree of external economies. For instance projects such as

(1) See. B. Higgins, Economic Development: Problems, Principles and Policies. New York. 1959. p. 634.

(2) See. H. B. Chenery, Comparative Advantage and Development Policy, AER. 1961, Vol. 51, No. 1., p. 27.

(3) See. D. M. Dosser - General Investment Criteria For Less-Developed Countries: A Post-Mortem. Scottish Journal of Political Economy, June 1962, p. 87.

transport or hydro-dams may be rejected on the basis of their high capital-output ratios, whereas the same projects' indirect benefits provided to other sectors or industries can be extremely high. Then selection of investments on the basis of capital-output ratios wil be against social overhead projects. In view of project complementarity in fact a project with a higher capital-output ratio should not necessarily be accorded a lower priority. It is then essential to take into account the concomitant expansion in other sectors and include them in the denominator of the coefficient so as to compare it with the value of capital invested.

5. Capital-output ratio rule is based on the explicit assumption that the market prices of goods and services will reflect the social cost of these goods. But, as is often admitted the market prices of inputs and outputs may not coincide with the social prices. The main reasons for such a strong divergence of social from market prices and costs include general wage rate overvaluation despite a large pocket of unemployment, very imperfect capital markets, monopolistic tendencies and external effects which are not reflected in the price of outputs sold and inputs purchased by any industry or project (1) For instance, if investment will make possible the utilization of resources which would not otherwise be used only the social cost of utilizing these resources should be charged rather than the total rent or wages which a producer may pay. The social cost of employing one more worker in any undertaking is the value of what he would have produced in other use of his labour. Therefore, the social cost will be nil if the worker is wholly unemployed and very low if he is largely unemployed.

VI — CONCLUDING REMARKS :

In aggregate terms capital-output ratio is widely used as a useful tool for estimating capital requirements needed to achieve a certain rate of growth (2). But even for this purpose it may only be a rough indicator since noncapital factors which may affect output are not taken into consideration.

For the following reasons some degree of caution should be exercised in the use of the capital-output ratio and in the interpre-

(1) For instance, because of immobile labour there will be irregularities in the returns to labour in different uses. Then market wage rate may not represent the opportunity cost of labour.

(2) Also capital-output ratios for individual sectors, industries or processes may be used to estimate capital requirement-sector by sector or project by project.

tation of the results it gives. First, despite the fact that available data show that for a number of advanced countries the capital-output ratio for a national economy as a whole remains stable over somewhat longer periods, its variability in underdeveloped countries during an intermediate plan period should not be neglected. In the developing countries where agriculture is dominant weather changes tend to affect the total national output considerably, but exercise very little influence on capital formation. Secondly, the capital-output ratio includes on the capital side (numerator) only physical capital. But in the investment outlays of almost all the plans "investment expenditure" on "human capital" is also included and it is hardly possible to quantify the effects of such expenditures on output. Investment in education, health and other social welfare mainly affects the capital-output ratio and should not be included in capital as traditionally defined. Thirdly, in developing countries capital formation and national income statistics from which capital-output ratio is derived are generally of a crude nature and the time lag between investment and output is usually arbitrarily assumed. The capital-output ratio thus arrived at tends to be rather unreliable for planning purposes, especially when the time series of such statistics is short.

Therefore, the danger implicit in imprudent use of the concept of ICOR must be borne in mind since it might result in underestimated or overestimated investment coefficient to attain a given income target. This tendency is not unlikely where the calculation of ICOR is dificult even in advanced countries and it may only be guesswork in many underdeveloped countries.

Capital-output ratio may change over time and its rate of change will depend on the operation of the whole system. To assume a given value of capital-output ratio is to assume away most of the problem. Since capital-output ratios differ so much from one industry to another and in cases from one technique to another it is conceivable that capital-output ratios will change in the future depending upon the industrial structure of the economy and on the techniques to be chosen.

It is not a satisfactory device to maximize the value of future output and to attain this maximum over time. When capital-output ratio is used the contribution of projects to national income over a period is ignored.

In conclusion, capital-output ratio is a misleading device by which to assign priorities for investment projects because it may usually discriminate against social overhead capital projects. Some disadvantages of this criterion, however, can be corrected by taking value added on a gross basis, including indirect benefits accruing from the investment and by applying shadow prices instead of market prices. However if, in addition, the lifespans of projects are different and if value added is not constant over time, ICOR must then be replaced by a somewhat more superior investment criterion (ie. SMP) which makes use of shadow prices of inputs and applies a discounting technique to calculate present value of the stream of outputs (1).

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(1) Some authors have argued that investment priorities should be assigned on the basis of social marginal productivity (SMP) which takes into account the contribution of projects to the national income when projects are evaluated from the society point of view. For this criterion See., H. B. Chenery - The Application of Investment Criteria, QJE. Feb., 1953., pp. 80-82, A.E. Kahn - Investment Criteria in Development Programs, QJE. Feb., 1951, p. 39.

REFERENCES :

1 — R. F. Harrod - An Essay in Dynamic Theory, E. J. March 1939.

2 — E. Domar - Expansion and Employment, AER, March, 1947.

3 — H. Leibenstein - Economic Backwardness and Economic Growth, 1957.

4 — B. Higgins - Economic Development, New York, 1959.

5 — J. Tinbergen - The Design of Development Baltimore 1966.

6 — J. J. Polak - Balance-of-Payment Problems of Countries Re-Constructing with the aid of Foreign Loan, QJE., Feb., 1943.

7 — N. S. Buchanan -International Investment and Domestic Welfare, New York, 1955.

8 — A. E. Kahn -Investment Criteria in Development Programs. QJE. Feb., 1951.

9 — H. B. Chenery -The Application of Investment Criteria. QJE. Feb., 1953. Vol. 67.

10 — H. B. Chenery -Comparative Advantage and Development Policy, AER. 1961, Vol. 51, No. 1.

11 — D. M. Dosser -General Investment Criteria for Less-Developed Countries: A post-mortem. Scottish Journal of Political Economy June 1962.

12 — UN - Manual on Economic Development Projects New York 1958.

13 — UN - Choice and Phasing of Public Sector Projects. Econ. Bull for Asia and The Far East, Vol. XVII, Sept., 1966.

14 — C. P. Kindleberger -Economic Development, McGraw-Hill Book. New York 1965.

15 — G. M. Meier -Leading Issues in Development Economics Oxf., Univ., press. New York, 1964.

ÖZET

Sermaye-Hasıla Oranı ve Sermaye Devir Oranı Kriteri

Makalenin ana amacı sermaye-hasıla oranı veya eş anlamda olan sermaye devir oranı (capital turnover) kriterinin, az gelişmiş ülkelerin kalkınma planlarında kullanılmasının doğurduğu sakıncaları incelemektir. Bu yazıda sermaye-hasıla oranı dinamik bir açıdan ziyade, «statik» bir açıdan ele alınmıştır. Harrod-Domar büyüme modeli ile ortaya çıkan bu terim, bu gün az gelişmiş ülkelerde planlarda öngörülen belirli bir kalkınma hızını gerçekleştirmek için gerekli toplam sermaye hacmini saptamakta kullanılmaktadır. Sermaye-hasıla oranı, ötetaraftan yatırım projelerinin seçiminde kullanılan ilk **denektaşı** (kriter) olarak göze çarpmaktadır.

Sermaye-hasıla oranı ortalama (average) veya marjinal sermaye-hasıla oranı (ICOR) olarak anlaşılmalıdır. Marjinal sermaye-hasıla oranı tüm ekonomi için, sermaye stokunda meydana gelen artışın (net investment) değeri ile safi milli gelirde meydana gelen artışın (net additional income) değeri arasındaki oran olarak tanımlanabilir.

Sermaye devir oranı sermaye-hasıla oranının tersinden başka bir şey değildir. Her iki oranın büyüklüğü, sermaye dışındaki öteki faktörlerin arzına bağlıdır; şöyleki öteki faktörlerin arzı arttıkça sermaye devir oranı artar ve sermaye-hasıla oranı küçülür. Milli gelirin kalkınma hızı, yatırım katsayısının (coefficient) marjinal sermaye-hasıla oranının tersiyle çarpımına eşittir. Ayni şekilde eğer, sermaye-hasıla oranı (ICOR) ölçülebilir ve uzun bir dönem sabit olduğu varsayılırsa, belirli bir kalkınma hızını gerçekleştirmek için gerekli yatırım hacmini saptamak kolay olur. Sermaye - hasıla oranı bütün ekonomi için kullanılabileceği gibi, bir sektör veya bir proje için de kullanılabilir. Ancak hepsinde ana prensip aynıdır.

Marjinal sermaye-hasıla oranı, özellikle genel ekonomi açısından sermaye ile üretim arasındaki ilişkinin devamlılığına işaret eder. Ancak bu basit ilişki, sermayeye eşlik eden (co-operant) faktörlerin yeteri ölçüde mevcut olduğu gelişmiş ülkeler bakımından doğrudur. Fakat, gelişmekte olan ülkelerde sermayeye eşlik eden faktörlerin yetersizliği nedeniyle, sermayenin tek başına üretimdeki artışın nedeni olduğunu kabul etmek zordur.

Herşeyden önce, marjinal sermaye-hasıla oranı, **sektörler** düzeyinde sabit değildir; çünkü üretim az veya hiç sermaye gerektirmeyen gelişmiş üretim tekniğine, talep artışına paralel olarak tam kapasitenin kullanımına, birden fazla vardiya işçi kullanımına ve hava şartlarındaki değişmelere bağlı olarak değişiklik gösterir. Öte taraftan, sermaye miktarı (oranın payı) işçi tasarrufuna yol açan modernleşme faktörüne, yatırım girişimindeki (lag) faktörüne ve yatırımın tamamlanma sürecine bağlıdır.

Makale ayrıca, sermaye-hasıla oranının (veya onun tersi olan sermaye devir oranı) yatırım kriteri olarak kullanılması olanaklarını tartışmaktadır. Sermaye-hasıla oranı bir kriter olarak düşük sermaye-hasıla oranına (veya yüksek sermaye devir oranı) sahip olan projelerin, öncelikle seçilmesini önerir. Az gelişmiş ülkelerde kıt kaynak olan sermaye, sermaye verimliliğini azami (maximum) seviyeye çıkaran projelerin seçimiyle ancak milli gelire en büyük katkıyı sağlamış olur. Bu kriterde göz önünde tutulması gereken önemli bir nokta şudur: sermaye devir oranı (capital turnover) teşebbüsün gayri safi yıllık üretimi ile bu üretim için kullanılan sermaye arasındaki orandır. Verimlilik burada kâr ile değil gayri safi üretimin değeri ile ölçülür.

Sermaye-hasıla oranı, yatırım kriteri olarak ilk defa J.J. Polak ve N.S. Buchanan tarafından ileri sürülmüştür. Her iki yazar da, sermaye kıtlığı karşısında gelişen ülkelerde en rasyonel politikanın (diğer bazı amaçların dışında), yapılan yatırım miktarına göre, en yüksek **yıllık üretimi** sağlayan projelerin öncelikle seçilmesi olarak görür. Ancak, bu kritere göre, projeler arasında sıralama, bugünkü değere indirgenmiş (discounted net output) safi üretimin **bir ünitesini** elde etmek için, en asgari (minimum) sermayeye ihtiyaç gösteren projelerden başlamak üzere yapılır ve elde mevcut sermaye miktarı tamamen tükeninceye kadar proje seçimine devam edilir.

Bununla beraber, sermaye-hasıla oranına karşı ileri sürülen eleştiriler oldukça geçerlidir: 1) Kalkınma planlarının başlıca hedefi üretimi zaman boyutu içinde bir noktada azamiye çıkarmak değil, fakat üretimi uzun bir zaman süreci içinde **maximum** seviyede tutmaktır. Bu itibarla, sermaye - hasıla oranı küçük olan proje, yıllık üretime en büyük katkıyı sağlayan proje olmayabilir; hatta sermaye-hasıla oranı büyük olan fakat yıllık üretime daha büyük katkı sağlayan proje (hayat süresi uzun) sermaye-hasıla oranı küçük projelere tercih edilmelidir. 2) Sadece sermayenin verimliliğini azami seviyeye çıkarmak (maximization) toplam üretimin azami seviyeye itilmesi

anlamını taşımaz. Denilebilir ki, toplam üretimin azami seviyeye erişmesi için sadece kıt kaynak olan sermayenin yanısıra, bol olan diğer kaynakların (meselâ, emek, arazi) verimliliğinin de, maximum olması gerekir. 3) Sermaye-hasıla oranı, sermayenin salt kıt kaynak olduğunu ve emek ve tabii kaynakların fırsat maliyetinin var olmadığı varsayımını içerir. Ancak, diğer üretim faktörlerinin fırsat maliyetinin sıfırın üstünde olması halinde, sermaye-hasıla oranı bir kriter olarak anlamsızlaşır. 4) Anılan kriter yatırım projelerinin yarattığı endirekt faydaları göz önünde tutmaz. Oysa, büyük sermaye-hasıla oranı gerektiren büyük alt-yapı yatırımlarının, önemli dış ekonomiler (external economies) yarattığı bir gerçektir. Bu faydalar, bu kriterin kapsamına sokulmalıdır. 5) Sermaye devir oranı kriterinin bir diğer varsayımı da, mal ve hizmetlerin piyasa fiatlarının sosyal fiatları yansıttığıdır. Oysa, bilindiği gibi faktör girdi ve çıktıların piyasa fiatlarının sosyal fiatlara eşitliği, rekabetçi piyasa koşullarının var olmaması nedeniyle ileri sürülemez.

Bu makaleden şu sonuçları çıkarmak mümkündür:

Sermaye-hasıla oranı, belirli bir kalkınma hızına erişmek için gerekli toplam yatırım hacminin saptanmasında kullanılmaktadır. Ancak, bu kaba bir tahminden öteye gidemez. Bu nedenle, sermayeye eşlik eden faktörlerin üretime katkısı dikkate alınmalıdır.

Sermaye-hasıla oranının, özellikle az gelişmiş ülkelerde sabit varsayılması geçerli bir görüş değildir. Sermaye hasıla oranı endüstri dalından dalına değiştiği gibi, üretim tekniklerinin seçimine göre de farklılık gösterir. Şu halde sözkonusu oran, genel ekonominin endüstriel yapısına ve seçilen üretim tekniklerinin niteliğine göre değişik değerler taşır.

Sermaye-hasıla oranı bir yatırım kriteri olarak kullanıldığı zaman, projelerin hayat sürelerini (life-spans) nazara almadığı için, gelecekteki üretimi **maximize** etmesi sözkonusu olamaz. Yatırım projelerinin evalüasyonu ve öncelik sıralamasında, sermaye-hasıla oranı yanlış seçimlere yol açan ve geçerliliği çok az olan bir kriterdir. Bu nedenle proje değerlendirilmesinde projelerin hayat sürelerini gözönünde tutan, girdi ve çıktıları sosyal fiatlara göre değerlendiren ve bugüne indirgeme tekniğini kullanan üstün bir kritere (örneğin, SMP), gerek vardır.