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DEFINITIONS AND EXPLANATION OF SELECTED TERMS USED IN INDUSTRIAL PROJECT EVALUATION

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Alphabetical Index

Figures in parenthesis indicate page numbers

Accounting Prices
Shadow Prices

Due to the "fundamental disequilibria" that exist in underdeveloped countries, market prices would diverge widely from opportunity costs[1]. To correct this, the use of accounting prices which would be equal or closer to opportunity costs are suggested[2]. Accounting prices are defined as prices that would be established in the markets if the markets were in equilibrium. Also, when equilibrium is achieved the opportunity cost of each factor would equal its marginal productivity. The markets are not in equilibrium due to imperfections and lack of complimentary means of production. A. Qayum[3] defines accounting prices of factors "as the values of the marginal productivity of factors when a selection of technique has been made which provides the maximum possible volume of output given the availability of resources, the pattern of final

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1 see opportunity cost

2 Tinbergen, J. The Design of Development, (Baltimore 1958)

Chenery, H.B & Kretschmer, K.S., "Resource Allocation for Economic Development, Econometrica, Oct. 1956

3. Qayum, A., Theory & Policy of Accounting Prices (Amsterdam, 1960)

Accounting Prices (contd.)

demand and technological possibilities of production".

For the practical computation of accounting prices no generally accepted method has so far been prescribed or tried. In the literature concerning the subject various methods of iterations have been suggested whereby planners might start with one set of shadow prices, do all the excercises with respect to them and then in view of the actual results ask once again whether the shadow prices chosen were in fact right. If not some method of successive approximation can be followed until we reach a set of consistent optimal shadow prices. Also, one of the solutions of a linear programming problem - the dual solution is said to contain a set of data for shadow prices for every limited resource and every product figuring in the problem. However, the practical value of these suggestions for use in underdeveloped countries is limited.

Shadow Price of Labor

The market price of labor in underdeveloped countries can be considered t be above the equilibrium rate due to the existence of widespread unemployment and underemployment. Yet the estimation of the accounting price of this factor is difficult because of the great variety of skills and types of labor and the regional immobility of labor. There can also be a difference in the opportunity cost of labor in industry and agriculture. Existence of unemployment is not sufficient reason to consider the accounting price to be equal to zero unless the unemployed cover every type and skill.

Shadow Price of Foreign Exchange

By foreign exchange rate is meant the price paid in domestic currency for a unit of foreign currency. In underdeveloped countries this rate is likely to be kept down through government poli y. If resources are to be optimally allocated . better valuation is necessary. Although problems of heterogeneity does not arise in the case of a shadow price for foreign exchange, problems will arise due to the varied uses to which foreign exchange is put. The tariff structure will also contribute to this difficulty.

Shadow Rate of Interest

Fiscal and monetary policies in underdeveloped economies tend to keep the market rate of interest below the equilibrium rate. The problem of a shadow rate of interest is intertwined with the bigger

question of a socially desirable rate of discount.
(see also Time Horizon)

Accounting Prices for the Output

Ordinarily, the use of shadow prices is to help determine an optimal investment program, where pricing the scarce factors is of crucial importance. Logically, however, shadow prices are equally applicable to the pricing of output, although it should be noted that this could lead to abuses of the accounting price concept which danger is less in the case of factors.

Activity Analysis
Linear Programming

Activity Analysis is a procedure for analyzing any economic transformation in terms of elementary units called activities. An activity is defined here as a process of transforming fixed proportions of inputs of goods and services into fixed proportions of of outputs.

As its theoretical contribution, activity analysis has led to the restatement in a general form of the classical theory of production and of the relations between productive efficiency and prices. In practical uses, it provides the mathematical technique of linear programming which leads to optimal solutions to problems of resource allocation. Consistency between available resources, interactivity demands and outputs is satisfied in such a model. It should be noted that linear programming is only one particular form of activity analysis, a form which is well suited to numerical calculations.

Linear Programming problems concern themselves with the efficient use or allocation of limited resources resources to meet desired objectives. These limited are autonomous elements (taken as given) and they are called restrictions or constraints. Mathematically it would be represented by a set of simultaneous linear equations of the form

$a_1x_1 + a_2x_2 + \ldots\ldots + a_jx_j + \ldots\ldots\ldots + a_nx_n = a_0$

where a_j's are known coefficients and x_j's are unknown variables. These simultaneous linear equations represent the conditions of the problem (or specifies the linear constraints - in development programs, that the demand for commodities and factors should not exceed their supplies). The number of unknown variables would exceed the number of equations and therefore the system is underdetermined. Underdetermined systems of equations have a number of solutions. Linear programming deals with nonnegative solutions to underdetermined systems of linear equations. The solutions for the unknown variables (x_j's) which satisfy the basic conditions represented by the linear equations and the nonnegativity condition are called <u>feasible solutions</u>. In order to select one solution from the number of feasible solutions more conditions are introduced. This is done by specifying the overriding objective of the problem - again in the linear form. This is called the <u>Objective Function</u>

e.g. $c_1x_1 + c_2x_2 + \ldots\ldots\ldots + c_jx_j + \ldots\ldots + c_nx_n$

where c_j's are coefficients and x_j's are activity levels.

It may be required that the objective function is to be maximized (e.g. National Income, Employment) or minimized (e.g. use of a resource such as capital). A solution that satisfies the linear constraints, the nonnegativity criterion and the objective function is called an Optimum Solution or Program.

Linear programming problems come in pairs. We can solve it for the activity levels that give the desired objective. This is the solution to the Primal Problem. The primal problem has a counterpart which is implicit in the equation system and is called the Dual Problem. Solution to the Dual Problem gives us the prices necessary to achieve the desired objective. Resource allocation and pricing are two aspects of the same problem and since linear programming solves the allocation problem it should solve the pricing problem also.

An important objection to linear programming approach is that it is restricted to the solution of problems involving linear constraints and a linear objective function. A linear objective function implies a fixed set of relative weights and in cases where our values are sophisticated enough to require modification of these relative weights depending on the exact amounts of the different types of benefits or costs involved, the objective function can no longer be linear, and the excercise is no longer one of linear programming. We shall have to use non-linear programming methods to solve such problems.

Linear programming is still of limited application with respect to underdeveloped countries due to lack of data regarding production relations and computer capacity.

Alternative Cost
Opportunity Cost
Transfer Cost

Alternative cost of producing a good is defined as the cost of attracting factors of production from being used in the production of other goods to the production of the good in question. This definition stems from the principle that the cost of producing anything is the value of the alternative, or the opportunity, that is sacrificed. Opportunity costs are implicit in production costs[1].

Opportunity cost concept is applied to the three specially important resources, viz: labor force, capital and foreign exchange. The opportunity cost of labor in countries with large unemployment or underemployment, is very low or even zero, according to this principle, because it is possible to increase labor input in one activity without a corresponding decline in any other activity. There are other reasons too for the market price of labor to be higher than its opportunity cost -.statutory minimum wages, collective bargaining contracts etc. The market cost of capital, the rate of interest is manipulated by the monetary authority and affected by fiscal policy

1 see accounting prices

and therefore generally lower than the opportunity cost and hence does not reflect its relative sacarcity. Thus the labor cost is overvalued and capital cost is undervalued. In the case of foreign exchange both overvaluation and undervaluation can occur.

There is no practical procedure of determining the precise opportunity cost of labor, capital or foreign exchange. There are possibilities to correct existing prices upwards or downwards in a very rough and arbitrary way by the use of accounting or shadow prices.

Arrow Diagram Network

In Plan implementation diagram, if activities are represented by full lined arrows, and events by circles or rectangles, we can show the path of plan implementation. Circles at the tail and head of an arrow indicate the commencement event and the end event repectively for any particular activity. The implementation of an industrial project or program is thus represented by a network of arrows and circles appropriately laid out to show the concurrent or sequential interdependence between activities. Such a diagram is called Arrow Diagram Network. The diagram can be used to identify every single activity in the network uniquely by referring to a beginning event and an end event. This is a variation of Pert[1] used by the U.S Department of Defense.

Critical Path in Arrow Diagram Network

This is defined as the longest path which indentifies the critical activities and events that control successful completion of the project for normal activity durations. The network can be contracted to shortest overall project duration at lowest

1 see Pert

possible increase in direct cost, working from the critical to subcritical paths in turn by using the rapid durations and their corresponding direct costs. By including all indirect costs in above, the optimum overall project duration which gives the minimum total project cost can be determined. A reallocation of other resources in men, machines and materials in order to improve the allocation of resources already considered will give us the Master Plan Network for project implementation.

Activity, aggregate

Implementing an industrial project plan calls for the execution of several different types of jobs or activities. Activities can be classified into concurrent activities and sequential activities (coming after other activities have been partially or wholly completed). This activity interdependence is based on the nature of the activities and the extent and manner of their further breakdown into individual work packages. The work breakdown structure depends largely on the level of responsibility at which the implementation-planning process is being considered and conducted. At a given level of responsibility, related work packages may be aggregated and assigned to different individuals making them responsible for its execution. Thus an aggregate activity(or simply activity) is composed of several work packages at a given level of responsibility in plan implementation. An activity must have a beginning and an end. In the case of all intermediate activities, the commencement of any activity depends on the completion of one or more preceeding activities. The completion of a preceding activity is called an event or milestone. An event and its preceding activities can be said to constrain the activities that succeed that event.

Implementation Gap

While much work has been done on the formulation of optimal, feasible and consistent development plans, little has been done with regard to implementation of plans. No cohesive implementation theory is found for an analytical treatment of the various aspects of managerial problems involved in plan implementation. Dynamic plan execution is the indispensable link between plan targets and the realities of attaining them. This gap between the Plan and its execution, between planners and its executors, is termed the Implementation Gap.

Average Investment Efficiency Coefficient

is used in certain centralised economies (e.g. Hungary). This is a measure which indicates the average labor and capital requirement to increase production by one unit.

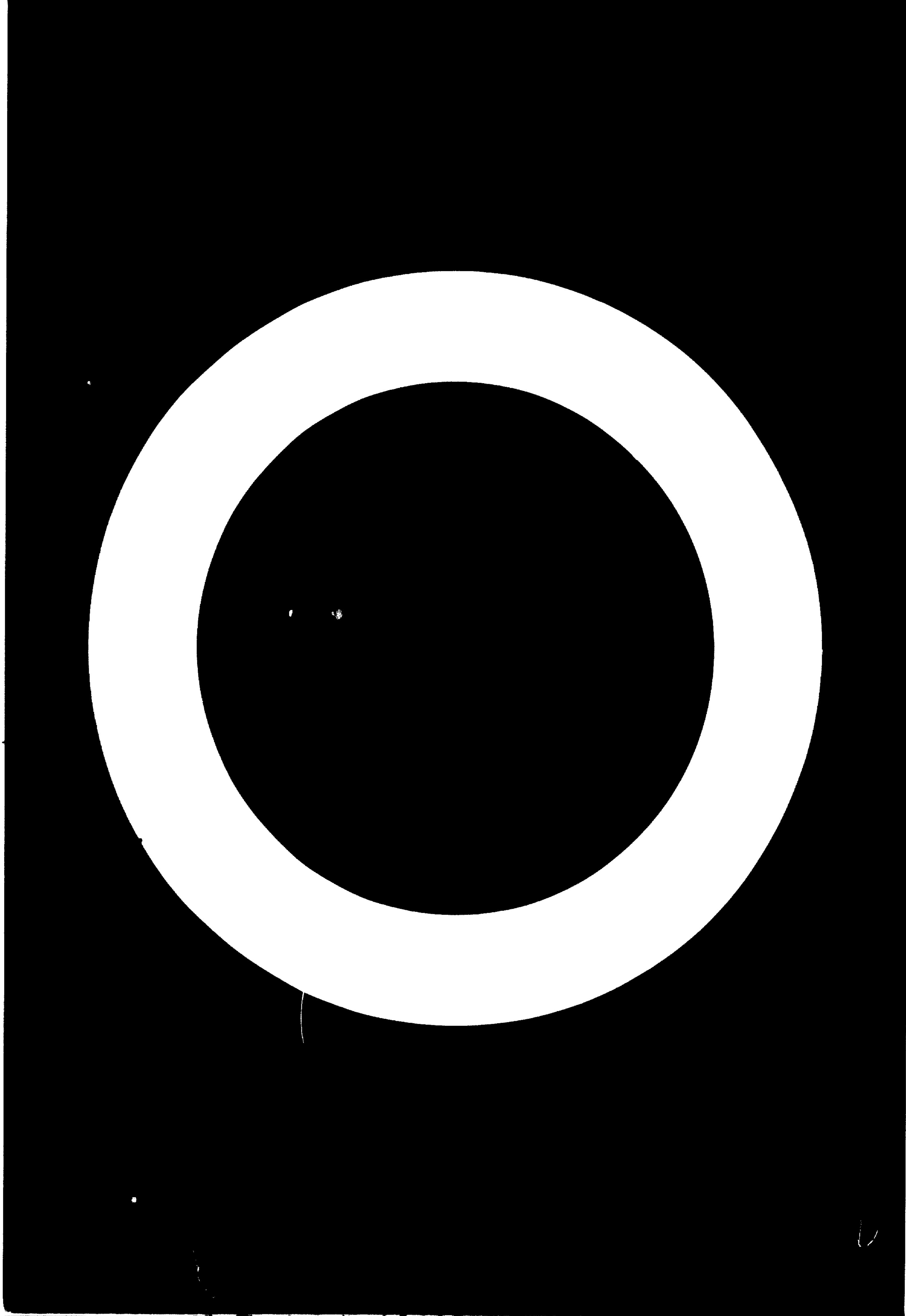
To compute the coefficient:

First, the average amount of investment required (over the economy) for release of one unit of labor is calculated. Let this be represented by b_g. Next the accessory investment requirement of a material input worth one monetary unit is calculated (represented by b_k). b_k is in effect the capital intensity of production. The total investment requirement for expanding production by one monetary unit is the labor input of b_g and the capital input of b_k.

Hence $(b_g + b_k)$ input in money units = 1 money unit of output/ annum

The inverse $1/b_g + b_k$ is called the Average Investment Efficiency coefficient and is represented by β. This is a key figure which shows the average effect of investments on the expansion of production. Its value is affected by natural and technological conditions already existing, the international progress of technology and its achievements, the organization of production and factors affecting the utilization of established production capacity, objectives of the national economic plan, the quality of economic and technical planning of the individual investment project, the extent of general employment and the rate of the natural growth of population.

#see also Efficiency Indicator of Labor Releasing
Investments and
Efficiency Indicator of Production
Expanding Investments



There are two variants for the discounted cash flow method

(i) The Internal Rate of Return

(ii) Net Present Value

The Internal Rate of Return

This is also referred to as the Interest Rate of Return, the Y ld, the Investors Method, Rate of Return, and the Marginal Efficiency of Capital

The internal rate of return (ρ) on a project is obtained by the solution to the following equation:

$$\sum_{t=0}^{N} \frac{B_t - C_t}{(1 + \rho)^t} = 0$$

where B_t = the benefits anticipated to accrue in year t of a project's life

C_t = costs anticipated to be incurred in year t

N = length of life of the project

Costs are defined to include capital outlays, labor, materials, energy and transport costs, and maintenance and repair expenditures. Costs do not include depreciation charges or actual or imputed interest charges, as the internal rate of return itself reflects the implicit "net interest yield" of the project, and in this sense allows for the depreciation of the project's cost.

The calculation of this rate involves a series of trial and error iterations whereby the analyst seeks to determine the rate of discount (ρ) that reduces a particular stream of cash inflows and outflows to zero. The rate of discount that exactly balances cash inflows and outflows is the internal rate of return of an investment project. This rate represents the highest rate of interest an investor could afford to pay without losing money, if all funds to finance the investment were borrowed and the loan, principal, and accrued interest were repaid by application of the cash proceeds

<u>Drawbacks of the Internal Rate of Return</u>

(i) Organization's cost of capital - the highest interest rate an investor could afford, had he borrowed all capital, is very hard to determine. Therefore, in practice there remains no minimum cut off rate against which proposed investments can be tested.

(ii) the trial and error iterations necessary for determining the internal rate of return are time-consuming and tiresome in the cases of projects with complex cash flow patterns and for organizations having to process more than a few projects at a time.

The Net Present Value of a project is found by discounting at a predetermined interest rate or discount rate all future net cash flows arising from the project. This predetermined rate normally should reflect the enterprise's own expected investment opportunity rate. In cases of nationalised firms, the opportunity rate selected is usually that of the economy as a whole. The decision rule in this variant is that if the net present value resulting from this calculation is greater then zero, then a project should be accepted as it implies a rate of return above the firm's or country's normal investment opportunity rate.

Among the advantages of this procedure are (i) there is no need for a notion of organization's cost of capital. The idea of opportunity rate is familiar to most business men, and (ii) it avoids the trial and error iterations required to find the Internal Rate of Return.

Capital Output Ratio
Rate of Capital Turnover
Capital Coefficient

The Capital Output Ratio (C/O) represents the amount of additional investment required to produce an additional unit of output. It is a ratio between the number of units of Capital required (C) to produce one unit of Output (O). Sometimes its reciprocal is considered - the Product to Capital Ratio.

An overal Capital Output Ratio can be used for estimating capital requirements for the whole economy. It is usually estimated as based on past performance of the economy but should also make allowances for expected changes. Capital Output ratio is also computed for different sectors as well as different projects.

see also Factor Intensity Criteria

Commercial Profitability

For the firm in the private sector, financed by risk or equity capital, the prime objective theoretically is "to maximise" the long run earnings to the present ordinary or equity shareholders. Actually the behavior of companies today seem to approximate to what has been referred to as "satisficing" behavior - meaning "a quiet life, the enjoyment of public esteem and power, a reluctance to experiment, a reluctance to change and organization"[1]. However, the divergence from profit maximising behavior is smaller, the greater the pressure on profits (through competition etc.) and the greater the importance in the company of a specialist function for creating and evaluating technical and market possibilities.

Criteria of Commercial Profitability include: The Pay-back Period, Rate of Return on Capital and the Discounted Cash Flow Method.

1 Carter & Williams, "Investment in Innovation"(London 1958)

Consumers Surplus

There is a gap between the total utility derived by the consumer from the purchase of a quantity of a good and the total market value that he pays in exchange for it. This gap is called the Consumers Surplus, which the consumer gets because he obtains more utility than the value he foregoes for it. The law of diminishing marginal utility can be used to show how this surplus arises. The law states that the earlier units of a good give more utility to the consumer than the later units. Yet he pays the same price for each unit of the good. Therefore he obtains the extra utility on the earlier units.

Demand and Supply Functions or Schedules

One variable is a function of another variable if one magnitude is related to another magnitude in such a way that for each value of the latter there corresponds a unique value of the former. When we say that quantity demanded or supplied is a function of price we mean that for every price there is a corresponding quantity that will be demanded and supplied.

Meyer & Cole[1] expresses the Supply and Demand Functions more specifically for each time interval of the total planning period as follows:

$$D = f\,(P,\ T,\ K,\ Y, \Delta N, \ldots\ldots\ldots)$$
$$S = f\,(P,\ T,\ K,\ Y, \Delta N, \ldots\ldots\ldots)$$

where

D & S are quantities demanded and supplied
P = Price of Transport Services
T = Time interval
K = cost of system capacity
Y = consumer income
Δ N = growth in population

Here time interval is specified as one year and the length of the planning period about the same as the economic life of the system. A different demand curve for each time interval is considered, each being a monotonically decreasing function of capacity in each time interval. Supply functions are positive linear functions of capacity.

1 Meyer & Cole - "Capital Budgeting & Pricing Techniques"

Economic Models

An economic model is an organized set of relationships that describes the functioning of an economic entity, whether it be a household, a single industry or a national economy, under a set of simplyfying assumptions. All economic reasoning is based on models (including hypothetical models) but in industrial planning, models which can be given quantitative form are more important. The data and relationships required for constructing a model are usually either based on the past experience of the economy concerned or borrowed from economies considered to be sufficiently similar. Before using such models for planning purposes it is necessary either to adopt certain specific assumptions with respect to the country's future or to adjust the historical relationships to allow for prospective changes.

Economic models can be applied to the determination of economic policies in two ways: In the first case, it may be used to determine the effects of a particular set of economic measures, for example, of investment in certain sectors. The measures and other data are taken as given, and the model is used to trace their effects throughout the economy.

This type of models are called projection models. In the second case, a certain set of objectives is specified, such as a given rise in income or employment or a given reduction of a balance of payments deficit, and the model is used to determine the most appropriate policy measures to achieve these objectives. Such a model is called a decision model or policy model.

Three types of models are used in development programming:

(i) Aggregate models which apply to the entire economy and deal with production, consumption, investment and the like as single aggregates. Such models are used to determine possible growth rates in national income; the division of the national product among consumption (public and private), investment and exports, the required volume of domestic savings, imports and foreign financial assistance needed to carry out a given program.

(ii) Sector models which apply to individual sectors. Sector models are used to determine levels of production and consumption by economic sectors and to explore alternative production possibilities within individual productive branches.

(iii)Inter-industry models, which are concerned with the relationships of productive sectors of an economy with each other, and each of these sectors with other entities of the economy. These models serve to determine the demand for intermediate products and capital goods (including imports), and their solution provides for a mutually consistent set of production levels by economic sectors, and imports for the whole economy. The pattern of transactions between industries and other major sectors of the economy - the internal structure of the economy is displayed in the input-output table. From the input-output table an input-coefficient matrix is derived by obtaining the ratio between each input to an industry and the total output of the industry.

Efficiency Indicator of Labor Releasing Investments

In the calculation of efficiency of investments in Hungary, investments are divided into two groups:

(i) Labor releasing investment - investment carried out in existing production processes in order to reduce the input of live and stored-up labor while keeping volume of production unchanged. Investment here is not aimed at raising productivity.

(ii) Production expanding investment - investment aimed at expansion of production and through this, the increase of national income. It is possible this type of investment may also release labor.

In both these types of investments, the efficiency coefficient is a refinement cover the synthetic formula for measuring the effectiveness of investment in centralised economies (mentioned elsewhere).

The Efficiency Indicator of Labor Releasing Investments at the plant level is given by

$$g = \frac{\text{result}}{\text{input}} = \frac{M_1 - M_2}{B}$$

where B = amount invested

M_1 = the annual wages before investment

M_2 = the annual wages after investment

$M_1 - M_2$ = the annual saving in wages

On the National Economic level this indicator is given by:

$$\varepsilon = \frac{O_1 - O_2}{B \pm (A_1 - A_2)\, b_k}$$

where $O_1 - O_2$ = the annual value of reduction achieved in production costs (money terms)

$A_1 - A_2$ = the reduction of the material requirement of production

b_k = the average accessory investment requirement of the materials (the average capital requirement of the product)

B = amount invested

Efficiency Indicator of Production Expanding Investments

As against labor releasing type of investments there are investments aimed at productivity expansion and increase in National Income. Efficiency of investment here is measured by the ratio of net expansion in production to the cost incurred by it measured in terms of basic investment and labor releasing investment. The indicator for plant level is given by

$$g = \frac{\text{result}}{\text{input}} = \frac{T - A}{B + B_g} \quad \ldots\ldots\ldots\ldots\ldots(1)$$

where T = increase in gross output

A = cost of material character: materials, power and transportation cost

T - A = value of annual net production

B = amount of basic investment

B_g = amount of labor releasing investments

Representing the average efficiency of the labor releasing investments in the National Economy in a certain period by r

$$r = \frac{M_s}{B_s}$$

where M_s = the labor force to be secured in the period under examination through labor releasing investments

B_s = the amount to be invested in order to release labor in the period under examination

And b_g the reciprocal of r, i.e. the investment amount needed for saving one monetary unit of annual wages is given by

$$b_g = \frac{1}{r} = \frac{B_s}{M_s}$$

If M/year of money wages is to be saved it can be achieved by $M.b_g$ of investment

So $B_g = M.\ b_g$

where M = annual amount of wages necessary for the operation

Therefore formula (1) can be rewritten

$$g = \frac{T - A}{B + M.b_g}$$

On the national level the indicator is

$$g = \frac{T}{B + M.b_g + A.b_k + A.b_g}$$

where T = the production value showing the result

B = the amount of basic investment

$M.b_g$ = the amount of investment necessary to assure the labor supply of basic investment

A = annual value of all materials used

b_k = the average accessory investment requirement of the materials (the average capital requirement of the product)

$A.b_k$ = the investment requirement of the plants producing the material needed for the operation of basic investment

$A.b_g$ = the amount of labor releasing investments assuring the labor supply for the accessory investments securing the material requirements

Elasticity of Demand

is a measure of the responsiveness of quantity demanded to a change in unit price of the commodity. Alfred Marshall who introduced this concept into economic theory states that "the elasticity or responsiveness of demand in a market is great or small according as the amount demanded increases much or little for a given fall in price, and diminishes much or little for a given rise in price"[1]. The usual formula for the elasticity coefficient

$$E = \frac{\Delta Q}{Q} / \frac{\Delta P}{P}$$

where ΔQ = change in quantity demanded
ΔP = change in price
Q = orginal quantity
P = original price

Sometimes this coefficient is referred to as the price elasticity of demand and it takes into account effects of changes in real income (as a result of price changes) and effects of substitution between commodities.

If the coefficient of elasticity is greater than one, demand is elastic and it implies that the consumers total outlay on the product increases after a fall in price and the total outlay on the product would decrease after a price rise. If the coefficient is

1 Alfred Marshall, Principles of Economics, 8th Edn.

less than one, demand is inelastic and the consequence of a price fall would be a fall in the total amount expended on the product. A unitary elasticity, when the coefficient is equal to one, is a case for which total expenditure on a product remains unchanged in the face of a price change.

Export Efficiency Indicator

is used in certain centralised economies with a view to reducing the domestic input of the "yield" of a unit of foreign exchange.

The selection of the export articles to be produced with the existing productive capacities, with due regard to marketing possibilities, relies upon the "Export Efficiency Indicator" - G.

$$G = \frac{\text{input}}{\text{result}} = \frac{O - A_{i1} \text{ in domestic currency}}{T - A_{i2} \text{ in foreign currency}}$$

where O = the production cost in domestic currency
A_{i1} = the price of import materials used for production in domestic currency
T = the export price of the product in foreign currency
A_{i2} = the price of import materials used for production in foreign currency

Thus 'G' shows the cost in domestic currency for the "yield" of one unit of foreign exchange. The smaller the value of the indicator, the higher the economic efficiency of producing the product with existing capacities.

Factor Intensity Criteria

This principle of investment evaluation is derived from the classical principle of comparative advantage in international specialisation and trade. Since underdeveloped countries are marked by relative capital scarcity (relative to other factors: labor and raw materials) they are advised to specialise in items that require less capital per unit of output and to depend on other countries for goods requiring more capital input[1].

The "minimum capital-output ratio" criterion can be justified only under severe restrictive assumptions: (i) Capital is the only scarce resource in the economy or the relative abundance of other factors make capital the crucial factor in determining cost differences, (ii) Each investment alternative produces same output or market prices used to measure and compare different outputs correctly indicate social values, and (iii) assumption of constant costs in production.

A related criterion which has attracted attention in modern times is the capital intensity criterion. Here we measure the ratio of Capital to Labor. This criterion is derived from the Heckscher-Ohlin version

1 N.S.Buchanan, International Investment & Domestic Welfare (N.Y. 1945)

of comparative advantage principle in international specialisation. Assuming identical production functions in all countries and if underdeveloped countries have low capital-labor ratios, then such countries have a comparative advantage in production of goods with low capital-labor ratios. The main difference between capital-output ratio and capital-labor ratio is that the former assumes labor has zero opportunity cost while the latter relaxes the assumption to saying that underdeveloped countries have a lower capital-labor ratio than developed countries.

Both these criteria fail to take into account the existence of other factors of production (such as natural resources) which will be considerably untapped in underdeveloped countries.

Incommensurables & Intangibles

Project evaluation criteria used are seldom neat and precise. There will be considerations which have an important bearing on the desirability of a project but which cannot be readily included in the evaluation criteria for various reasons. When such considerations can be given a quantitative form, but involve a dimension other than money and cannot be converted into money terms (flow) in a meaningful way, they are called "incommensurables". If they cannot be put into any meaningful quantitative form, such considerations are "intangibles". The test of a planner is whether he can turn an intangible into an incommensurable or a money flow, and an incommensurable into a money flow.

The two important aspects of handling incommensurables and intangibles are (i) to be able to estimate the effect of a proposed project with respect to such considerations and (ii) to somehow or other give the proper weight to each consideration.

When it is difficult to convert a factor to money cost, a high estimate and a low estimate may be used in making decisions.

Inferior Good

is defined as a good whose consumption declines when income rises as it is substituted by goods of higher prices or conversely whose consumption rises when income declines as it is substituted for higher priced goods. The name does not indicate that the good is of inferior quality. A stock example of inferior good is margarine.

Infra-Structure, Social and Economic
Social Overhead Capital

There are certain types of basic investment projects which must precede other normal investment activity in order to provide the necessary climate for the latter to come about. Power, transport, education, communications and others can be included in this category. Their services are indirectly productive and become available after long gestation periods. Investments in these basic needs constitute the social and economic infra-structure of the economy. Quick-yielding, directly productive investments always follow them.

The major problem faced in project evaluation in this type of investment is that their value cannot be assessed by the monetary returns directly accruing to them.

Interdependency

(i) Demand Interdependency

The demand for the output of one project depends upon which other projects are carried out.

(ii) Cost Interdependency

The cost of one or more inputs of one project depends upon which other projects are carried out. This type of interdependency is closely related to the first type, since what is a demand for one project is a cost for another.

(iii) Interdependence due to external economies and diseconomies

Interdependency due to external economies referred to here is technological interdependency. These cover interdependencies arising from a direct relationship between the output of one project and the output of another.

Interdependency due to external diseconomies indicate increasing social costs.

(iv) Conditional Interdependency

In this category, one project must be undertaken as a condition for undertaking another.

(v) Blocking Interdependency

In this case, undertaking one project precludes undertaking another.

Linkage Effects

A given change in the production originating in one industry is likely to be felt by direct and indirect likks through a number of other industries. There will be a difference in the direction and intensity of the inter-connections and many indirect effects are likely to be negligible for practical purposes; but some are important enough to be taken into account. The indirect effects created by the change of the amount and/or structure of inputs are called backward linkage effects. The changes of outputs create the so called forward linkage effects, resulting in new or increased production based on the supply of some new product.

Marginal Growth Contribution

The conflict between the Social Marginal Productivity criterion objective of maximising income at the present time and the Marginal Per Capita Reinvestment Quotient criterion objective of maximisation of per capita output or average income at some future point in time, has been reconciled by O.Eckstein[1] in his Marginal Growth Contribution criterion. Eckstein specifies the social objective to be the maximisation of the present value of the future consumption stream. If a discount rate close to zero or equal to zero is used, this objective would approximate the future income objective, whereas with a high discount rate of future consumption we obtain maximisation of current income. Eckstein also assumes a different savings ratio for each project. From these premises he derives the Marginal Growth Contribution formula. The formula has two terms - the first, an efficiency term, which measures the project's direct contribution to consumption (present value of the consumption stream) and the second, a growth term, which

1 O.Eckstein, "Investment Criteria for Economic Development and the theory of Intertemporal Welfare Economics", Quarterly Journal of Economics, Feb. 1957

measures the present value of the future consumption stream made possible by the increased growth of capital.

The results obtained by the use of Marginal Growth Contribution criterion depends on the rate of discount applicable to future consumption.

Eckstein suggests the use of fiscal measures to obtain an income distribution capable of yielding sufficient savings rather than the selection of projects based on the reinvestment quotient criterion.

Marginal Per Capita Reinvestment Quotient

The proponents of this criterion W.Galenson and H.Leibenstein[1] are not in agreement with the Kahn-Chenery Social Marginal Productivity[2] approach. They feel that the social marginal productivity criterion becomes inadequate with the assumption of a social welfare function in which the objective is to maximise per capita output or average income at a predetermined future time rather than to maximise a discounted stream of income over time. If so, then "the correct criterion for allocating investment must be to choose for each unit of investment that alternative that will give each worker greater productive power than any other alternative. To achieve this it is necessary to maximise (a) the amount of capital per worker and (b) the quality of the labor force"[3]. Maximisation of Capital Labor ratio has to be done at the expense of consumption in underdeveloped countries since voluntary savings and fiscal policy to obtain forced savings are not so readily available

1,3 W.Galenson & H.Leibenstein, "Investment Criteria, Productivity and Economic Development", Quarterly Journal of Economics, August 1955

2 see Social Marginal Productivity

here. Of the two components of income from a project, profits and wages, profits are likely to provide more savings. Therefore the most productive project which maximises per capita income at some appointed future time will be the one with the highest profit per unit of capital invested. Following this line of argument the authors go on to prove that even though in the short run labor intensive techniques may be preferable, there can be considerable doubt about its validity as a general proposition. Therefore they advocate the adoption of projects with the highest capital labor ratio.

This is a reversal of the factor intensity criteria. This implies an assumption about the production functions namely that increasing capital intensity will raise the average returns to capital. This is not a justifiable conclusion. Also, the authors have taken the consumption of the unemployed workers as equal to zero which is not warranted. A distinction has to be made between the amount of reinvestment per worker and reinvestment of capital previously employed.

Marginal Productivity of Factors of Production

Marginal productivity of a factor of production is the additional product or output added by the use of an extra unit of that factor with the other factors held constant. Under equilibrium the marginal productivity of a factor would equal its opportunity cost.

Marginal Productivity of labor is the value added to output by the use of an additional unit of labor while land, capital and technology remain constant.

Marginal Productivity of Capital

Conceptually the above definition for factors of production holds good here too. However, a distinction has to be made between the private marginal productivity of capital and the Social Marginal Productivity of Capital[1]. Private marginal productivity is taken to be approximately equal to the market rate of return on investment. Social marginal productivity is harder to estimate as it should reflect the social rate of discount which is determined by the social time preference between current values and future values.

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1 see Social Marginal Productivity

Marginal Utility

is defined as the additional utility derived by a consumer from the use of one extra unit of a good. It can be shown that the marginal utility derived from each additional unit of a good is smaller than the marginal utility of each former unit. This principle is embodied in the law of "diminishing marginal utility".

The above principle is used to show how a consumer arrives at the equilibrium position between his consumption needs. A rational consumer might be expected to rank all the possible ways he could spend his money income according to the satisfaction they yielded and would do this by proceeding down this heirarchical ordering until all his funds were exhausted. Assuming that every product can be consumed in precisely the desired amounts, the rational consumer would spend on every product until the marginal utility from the last unit of money spent on each product is equal to the marginal utility derived from the last unit of money income spent on every other product - otherwise he could make himself better off by transferring funds from a product yielding low satisfaction to one supplying greater satisfaction.

National Economic Profitability

Since market evaluation grossly violates notions of social welfare, there has to be some other criteria for determining a project's desirability.

What is usually suggested to find national economic profitability is to start with market evaluation of costs and benefits, and compute the "present value" of each project at the market rate of interest.

We can then systematically "correct" the set of market prices by bringing in those factors that the market does not reflect, e.g. "external effects", considerations of inequality of income distribution, the weights to be attached to the welfare of future generations. The correction will also include the market interest rate and therefore the basis of the present value calculation. Thus modified the commercial profitability figures will give some indication of our notions of social desirability.

The use of "shadow prices" is suggested to achieve the above goals.

Most of the criteria suggested such as the National Product criterion (Tinbergen), Social Marginal Productivity (Kahn & Chenery), Marginal Per Capita Reinvestment Quotient (Galenson & Leibenstein), Marginal Growth Contribution (Eckstein) incorporate one or more of the above considerations.

National Gross Rate of Return

is the annual rate at which the project generates value added for each unit of output. Even if there is no marketable product or service, the product or service would still have a value

$$\text{National Gross Rate} = \frac{\text{Value Added}}{\text{Investment}}$$

This rate of return considers that a severely limiting factor in newly developing countries is the capital available per capita. If this scarcity exists it can be argued that a society that invests so as to maximise value added per unit of investment will maximise income over time. The national gross rate of return counts value added without regard to who in the economy receives the income or what is done with the income generated.

National Product or Consumption criterion

in project evaluation is calculated based on the project's direct, indirect and secondary contributions to total output, all values to be computed in "accounting prices"[1]. Tinbergen[2] also describes this as the National Welfare Test. Direct contributions are significant in complementary activities. Examples are transportation and power plants. Indirect consequences are contributions to welfare (national product or consumption) to be anticipated in the absence of additional changes in total national income. E.g. Land reclamation and more jute growing as a consequence. Secondary consequences consist of changes in production which are the consequence of changes in national income, both in the short and long run, connected with the new production.

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1 see accounting prices

2 Tinbergen, J., Design of Development (Baltimore, 1958)

Open Economy

An economy is said to have an open character when the actual and potential scarcity of natural resources and conditions make it impossible to utilise the existing and expected capacities in the long run on the basis of domestic resources alone to the fullest extent.

Thus the basic characteristic of the open economy is that a large part of national income arises in foreign trade both on the export and import side. During those stages of development when the need for capital intensive goods are high this is especially applicable. The import needs of the economy are suddenly rising to a qualitatively new level. Therefore in such an open economy where a certain high level of industrial development has been achieved the implementation of any long term program is a function of the increasing export ability of the economy. Sound development strategy has to take into account the cumulative effects that one unit increase or decrease in export produces much more than one unit fluctuation in national income, in employment and in the standard of living.

Since the increase of national income and employment and consumption are functions of the economy's export ability, the most important criterion for project evaluation is the expected net foreign exchange earnings of a project or of the national economy as a whole in the long run.

Optimality

The most widely used notion of optimality in economics is the so called "Paretan Optimality". A Paretan improvement indicates a situational change such that some people (at least one person) gain and nobody loses. This definition leads to the conclusion that an economic situation is optimal if no Paretan improvements are possible starting from such a position. This is a very weak sense of an optimum because such an optimum can be achieved even when some people are very poor while others are very rich, provided the unhapiness of the poor cannot be reduced except by reducing the happiness of the rich. Thus Paretan optimality says nothing about distribution and is consistent with any degree of inequality of income distribution.
The Paretan conept of optimality is something that is necessary for welfare maximisation but not sufficient. This accessory condition should not be confused with the sufficiency condition.

The optimality of the perfectly competitive market mechanism has been proved, within the range of certain specific assumptions, by using the notion of Paretan optimality. The specific assumptions are - perfectly competitive markets, no external effects, no saturation of wants. So that if projects are evaluated at free market prices and people act like competitive decision units, it will be assured that we arrive at a situation such that no person can be made better off without making someone else worse off. This has led to identifying market profitability with economic soundness.

The assumptions of perfect market - especially that of the capital market is erroneous. In labor surplus economies where the marginal product of labor is zero is never reflected in the market. No external effects is also a far-fetched assumption. Paretan optimality assumptions also do not consider the effect of a program on future generations. Finally, stopping with Paretan optimality implies ignoring distributional questions in which economic planners are clearly interested.

Parameters, technical and economic

Statistically a parameter is defined as any characteristic of a population. In economic models in particular those attributes of variables which are given, rather than those determined inside the model, may be called parameters.

Technical and economic parameters of factors and product will influence the production costs, technical quality, technology as well as investment expenses, expected prices, marketing ability etc. of the product.

Pay-back Period
Pay-off Period
Capital Recovery Period

In project evaluation at the firm level this criteria can be used. The pay-back period is defined as the length of time required for the stream of cash flows of an investment (gross earnings) to equal the original cash outlay.

Its principal advantage is its simplicity in both concept and calculation. Also, it concentrates on the earnings in the near future, which are more valuable and certain than earnings in the distant future. The disadvantages of this method are (i) it does not take into account the time pattern of earnings within the payback period, and (ii) it does not measure the profitability of the project.

P E R T

Program Evaluation Review Technique

is a technique for planning and program control, using a pictorial representation of all actions that must be taken, and an analytical procedure for predicting performance time and evaluating uncertainity for the program. The essential elements of a Pert plan are

(i) Activities

The effort required to proceed from one event to another. It is measured in terms of elapsed time.

(ii) Event

A definable point in time where some action has been completed or started; the boundary between two or more activities.

(iii) Network

A graphic presentation of the individual events and activities and their interrelationships, of which a project is composed (see Arrow Diagram Network).

(iv) Time Estimates

This is the estimated time required for accomplishment of an activity. Three estimates are used to determine both probable time and degree of uncertainity.

Pert (contd.)

(a) Optimistic Time

The optimistic time is the time which will be required to complete an activity if everything that can go smoothly does go smoothly. The optimistic time is expected to occur one per cent of the time.

(b) Pessimistic Time

The pessimistic time is the time which will be required to complete an activity if everything that can go wrong does go wrong. The pessimistic time is expected to occur one per cent of the time.

(c) Most likely Time

The most likely time, is the time which is (based on previous experience) actually anticipated to be required for completion of an activity.

#see also Critical Path in Arrow Diagram Network.

Price Discrimination

In general price discrimination means that a firm charges two or more prices for the same product. Price discrimination is possible by firms in all market situations, other than pure competition. Price discrimination is designed to appropriate all or part of the consumers surplus to the producer. In industrial planning, price discrimination is advocated for capital budgeting, when the best single price fails to generate enough revenue over the planning period to provide a total greater than the present cost. Three general types of pricing schemes are suggested in an attempt to retrieve more revenue, all involving forms of price discrimination:

(a) Cyclical Price Discrimination

applicable to situations in which very sharp seasonal, daily or other variations occur in the rate at which the service or product is consumed, such discrimination often being a means of ameliorating the high costs and other problems associated with very intensive peak use or demands

(b) Interconsumer Price Discrimination

wherein different price levels for different categories of customers are established within any single time interval, but the various levels remain constant for these different consumer groups over and between time intervals throughout the planning period; and

(c) Intertemporal Price Discrimination

in which there is only one price charged in any time interval, but that price may change over time within the total planning period.

Programming Criteria for Project Evaluation

This is essentially a general equilibrium solution to the problem of project selection. In its most elaborate and sophisticated form the costs and returns of all feasible projects, the available factor supplies, and "correct" prices for at least final outputs are all fed into an electronic computer. The computer then tries various combinations of projects calculating whether or not each combination uses all the resources and what its total final value is. Finally, the computer chooses that combination which has the maximum value of the final outputs. Conceptually, this is the ideal project evaluation criteria. Starting with available resources and the valuations on final outputs, it proceeds directly to the goal of maximising the total value of final output. Project interrelations are considered and assuming the "correct" prices are used for the final product, it would select those projects which actually do maximise the final value and gain in social utility.

However, the practical use of this criteria is limited due to the number of possible combinations to be evaluated, the lack of allegedly "correct"prices and other data in underdeveloped countries.

Linear Programming attempts to simplify the approach almost to the point of taking away its conceptual validity and no practical use has yet been made of this either.

Rate of Return on Capital
Book Rate of Return

variants: Average Return on Investment
Book Method
Engineers Method

The rate of return on capital is defined as the ratio of profit to capital. There are minor variations between the different concepts whose titles are mentioned above.

Average Return on Investment is the average income from a project expressed as a percentage of capital outlay.

In the Book Method, the expected or 'normal' profit as a percentage of the average capital employed over the life of the project is considered.

In the Engineers Method, the expected or 'normal' profit as a percentage of the initial capital employed is the criterion.

The main disadvantages of the rate of return on capital method are (i) difficulties with regard to definition of profit, especially the difficulty of defining normal profit where profit may not be constant over the years, and (ii) the difficulty of defining capital outlay where investment allowances are given and where working capital forms a large proportion of the capital invested, and (iii) the time pattern of income from investment is not considered - allowance is not made for the fact that the same sum of money tomorrow is worth less than it is today.

see also Benefits - Cost Ratio

Rate of Return to the Entrepreneuer

If in private enterprise, the main risk is taken by the entrepreneuer who borrows money from a bank or obtains a loan elsewhere, this rate of return becomes meaningful. If a project goes well, one would expect an entrepreneuer to get an attractive return on his investment. If the project goes poorly the entrepreneuer does badly. In a sense, this rate is the margin for error for for those who lend to the entreprise. The greater this margin the greater the entrepreneuer's risk. The inputs of the financial flow are investment funds which are supplied by himself. The outputs are depreciation and profit of the entire enterprise, less required amortization payments.

Sensitivity Computations

(i) On the sectoral level

In a sectoral linear programming model, when the optimum program has already been computed, computation of cumulative effects induced by any of the changes in various factors of the model is easy. The object of sensitivity computations is to measure the effects caused by changes of one or another factor for the sectoral program as a whole. For example by changing construction expenses we are able to see the effect of this change on the whole investment activity of the sector, moreover changes in output, exports, imports etc. can also be considered.

(ii) on the national economy level

The object of national level sensitivity computations is to measure the cumulative effects of a change in any factor on other factors. We would like to know for example the effect of a decrease of investment funds on consumption, export or on secotral allocation of investments, labor etc.,

and sensitivity computations can provide it easily if the model and the optimum size of various activities are already determined.

Social Marginal Productivity Criterion (SMP)

A.E.Kahn[1] in an article he wrote in 1951 proposed the rule of social marginal productivity as a guide to selection of investment activities. H.B.Chenery[2] has attempted to give quantitative from to the SMP principle by applying it to a number of empirical situations in Greece, Turkey, Portugal and Southern Italy. Imperfections in the market mechanism in underdeveloped countries cause private value and private cost to diverge from social value and social cost. Therefore in allocating investment resources, the criterion to be followed is "the total net contribution of the marginal unit to national product and not merely that portion of the contribution (or its costs) which may accrue to the private investor"[3]. Following this statement Chenery has formulated a measure of SMP by using simple rules of thumb such as balance of payments effect, capital intensity etc. He has made use of data likely to be available in a developing economy.

1 Kahn, A.E., "Investment Criteria in Development programs" Quarterly Journal of Economics, Feb.51

2,3 Chenery H.B., "The Application of Investment Criteria" Quarterly Journal of Economics, Feb.53

Chenery's SMP formula is:

$$SMP = \frac{X + E - M_i}{K} - \frac{L + M_d + O}{K} + \frac{r}{K}(aB_1 + B_2)$$

where SMP = average annual increment in National Income (plus balance of payment equivalent) from the marginal unit of investment in a given use

K = increment to capital (investment)

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

E = added value of output due to external economies

M_i = cost of imported materials

L = Labor cost

M_d = cost of domestic materials

O = Overhead cost

r = marginal rate of substitution between National income and balance of payments effect

B_1 = effect of installation of investment on balance of payments

a = combined amortization and interest rate on current borrowing

B_2 = effect of operation on balance of payments

Dividing the social marginal product into

(a) value added in domestic economy per unit of investment

$$\frac{V}{K} \quad \text{where } V = X + E - M_i$$

(b) total operating cost per unit of investment

$$\frac{C}{K} \quad \text{where } C = L + M_d + O$$

and (c) balance of payments premium per unit of investment

$$\frac{Br}{K} \quad \text{where } B = (aB_1 + B_2)$$

the formula for SMP can be shortened to

$$SMP = \frac{V}{K} - \frac{C}{K} + \frac{Br}{K}$$

$$= \left(\frac{V}{K}\right) \left(\frac{V - C}{V}\right) + \frac{Br}{K}$$

SMP is thus found to be the product of the percentage of social value over cost $\left(\frac{V - C}{V}\right)$ and rate of capital turn over $\left(\frac{V}{K}\right)$ plus the balance of payments premium.

Even if this approach can be criticized on the grounds that ranking of investment projects in this manner is a rigid and mechanical approach, the conceptual and analytical usefulness of the concept has to be recognised. The SMP criterion provides us with a measure of project selection in terms of a consistent and defendable set of values.

Main criticisms of the SMP approach include (i) that the criterion does not consider the specific multiplier effect of investment on future income levels, (2) it ignores changes in the quality of the factors of production such as labor force which is a consequence of current investment patterns, and (3) that this criterion is less general than the over-all programming approach, because it is based on a partial equilibrium analysis that is only valid for relatively small changes in the economic structure.

Surplus Rate of Return

The savings from the income generated from a project cannot be controlled adequately for investment purposes in any economy (except centralised economies). Since savings are a limiting factor on economic growth, the surplus rate of return will have to be considered. The investment inputs of a project are in effect surplus (to consumption) resources that are made available to the project during the investment period. To the extent that the project generates large surpluses soon, it makes it possible to engage in additional projects. Therefore we have to consider the question "at what rate are reinvestible funds generated by the project for each unit of surplus made available to the project?" The answer to this question is the surplus rate of return. This rate is computed as the difference between total sales value of the project and the cost of purchased inputs (raw materials, power etc and labor costs). The surplus is taken to be equivalent to profits, depreciation, interest payments and taxes. It is viewed from the point of national economy rather than the enterprise. The assumption is that all such surpluses will be used for further investment while wage and salary payments will be spent entirely on consumption. (see also Marginal Per Capita Reinvestment Quotient).

Synthetic Index of Economic Effectiveness of Investment

In order to check alternative forms of investment from the point of view of "comparative efficiency" in centralised economies synthetic formulae have been developed.

On the sectoral level and for single plants, the task of investment evaluation is practically reduced to the choice of one out of various investment variants bringing about equivalent productive effects. If the problem is thus simplified, the issue which must be regarded as an essential in the evaluation of economic effectiveness of investment is a choice of the proper level of technique of a given investment project. Attempts to quantify the differences among alternative variants from that point of view have enabled laying down the basic and simple form of synthetic index of economic effectiveness of investmnt.

Many economists starting from a statement of scarcity of capital, base the "coefficient of efficiency" on the rate of substitution between the additional investment outlays and eventual decrease of operating costs. As the latter can be reduced to labor, this rate of substitution might be treated as the individual marginal rate of substitution between labor and investment. This simple assumption of a two factor production function cannot be justified except in rare cases (viz. post-war reconstruction period when labor was the most serious bottleneck) as there are other bottlenecks which cannot be ignored (e.g. raw materials and intermediate goods) when techniques are selected. Therefore standard methodologies recommend the use of other yardsticks also in the choicemaking process besides the use of a synthetic index. Reference here is mainly to the use of indices in physical terms - techno-economic indices, such as input of fuel, power and other material per unit of output, output per unit of equipment etc.

Given below is a synthetic formula derived from capital-labor substitution. Assuming two different variants of an investment project where production of each variant is the same:

(i) $I_1 < I_2$ where I_1 and I_2 are investment outlays of the respective variants being compared

(ii) $C_1 > C_2$ where C_1 and C_2 are the annual operating costs of these variants (mainly representing labor costs)

and denoting T = <u>Period of Recoupment</u> of additional investment outlay (marginal rate of substitution between capital and labor), E = reciprocal of T (coefficient of comparative effectiveness of capital investment),

both T and E are determined by comparing the candidate variants as follows:

$$T = \frac{I_2 - I_1}{C_1 - C_2}$$

$$E = \frac{1}{T} = \frac{C_1 - C_2}{I_2 - I_1}$$

For the obligatory evaluation formula, the necessity of using the social marginal recoupment period is acknowledged. Thus for additional investment costs the following inequality is accepted as a condition of effectiveness

$$\frac{I_2 - I_1}{C_1 - C_2} < T^+ \quad \dots\dots\dots\dots\dots\dots(2)$$

where T^+ is the social marginal rate of substitution

The economic meaning of formula (2) is that additional investment cannot be accepted unless recoupment takes place by sufficient economies in operating costs, because in other sectors or branches of the economy the same investment outlay may bring about better economic results. Formula (2) can be expanded to

$$\frac{I_2}{T^+} + C_2 < \frac{I_1}{T^+} + C_1$$

or $I_2 + T^+C_2 < I_1 + T^+C_1$

In general the most effective use of capital is achieved by selecting a project I_1 such that $\frac{I_1}{T^+} + C_1$ is the lowest among a given set of alternatives. More generally, for the purpose of comparison among alternatives resulting in different levels of annual output, the evaluation formula can be expressed as

$$\frac{I.\frac{1}{T^+} + C}{P} = \text{a minimum},$$

where P indicates annual production. In countries where a uniform standard value for T^+ exists, it has been established in limits of five to six years (for Hungary five, Poland six).

The basic synthetic formula has been gradually developed further in the various centralised economies by taking into account differences among investment variants with regard to different patterns of gestation and fruition: (i) extent of immobilization - tie up or freeze, of investment during construction, (ii) length of period of exploitation, and (iii) the shape of production costs during the period of exploitation. In countries with important foreign trade sectors (such as Czechoslovakia. East Germany, Hungary and Poland) export promotion and import substitution aspects are now included in the synthetic formula.

Time Horizon

The problem of Time Horizon in economic planning is the problem of determining the socially desirable rate of discount. It is a problem of estimating at the beginning of plan period the value of the benefits that has to be achieved at the end of the end of the planning period.

In the private sector, the prevailing market rate of interest is accepted as the desirable rate of discount because of its correspondence to two magnitudes. First, it is supposed to represent the time preference of the members of society, expressing the relative weights to be attached to present consumption compared to future consumption. Secondly, it is supposed to express the productivity of private capital investment and this represents the opportunity cost of public sector projects. Planners on the national level, however, cannot accept the market rate for purposes of project evaluation due to the existence of imperfections and also because the preferences of future generations are expected to be reflected in their choice of discount rate.

Despite the fact that a lot of discussion is being conducted on this subject, no convenient rules of thumb are prescribed.

Total Outlay Curves
Net Outlay curves
Composite Net Outlay Curves

The demand curves can also be considered total outlay curves since we can obtain total outlay (expenditure) on the product by consumers at any point on the curve by multiplying the quantity by price.
Defining Demand and Supply as functions of price of transport services, time interval, cost of system capacity, consumer income, growth in population and other similar variables, the "net outlay curve"[1] for every time interval is obtained by subtracting the supply from the demand functions for each time interval. These represent derived demand curves for each facility itself after supply and operating costs and costs other than system use have been subtracted and are thus net effective demands for the facility's capacity. The linear aggregation of the net outlay curves gives the composite net outlay curve.

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1 Meyer, J.R & Cole, L.M., "Capital Budgeting and Pricing Techniques"

Transformation Curve
Production Possibility Curve

are curves that show the rate of substitution between two goods or two types of goods produced in a society given the availabilities of the factors of production and the levels of technique.
It illustrates the basic problem of economics, viz. the need for optimum allocation of limited resources between various needs of society.

Vectors

In elementary algebra we are concerned with expressions which take real numerical values. The expressions may be constants or variable taking values from the system of real numbers. Advanced algebra is not so confined. It is able to handle systems other than real numbers, e.g. complex numbers. It can deal with not only'magnitudes' such as length or width, but also "vectors" such as force or velocity which have "magnitude" and"direction". Higher algebra concerns itself with <u>sets</u> or groups of elements rather than single values as is the case with elementary algebra.

Vectors (contd.)

In a two dimensional plane we represent a point by a pair of numbers which we call coordinates, (a_1, a_2). This could be called a two dimensional vector. If we have an n-dimensional space, a point P in such a space would have n coordinates and it would be called an n-dimensional vector. An n-dimensional vector "a" is simply an ordered list of n numbers (or an n-tuple of components) and it is written

$$a = (a_1, a_2, \ldots\ldots\ldots a_i \ldots\ldots\ldots a_n)$$

What is important in vectors is the ordering of numbers. Vectors can be written as column vectors

$$\begin{pmatrix} a_1 \\ a_2 \\ a_3 \\ \vdots \\ \vdots \\ \vdots \\ a_n \end{pmatrix}$$

or row vectors $(a_1, a_2 \ldots\ldots a_n)$

In linear programming vectors are used to represent activities - called activity vectors which would include both output and inputs of the activity. The operations that can be performed on vectors lend facility to the solution of linear programming problems.

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