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THE CHOICE OF TECHNIQUES OF PRODUCTION IN EAST-AFRICA

One of the fundamental problems in developing economies is the selection of industrial projects. A range of investment criteria has been suggested on which to base this choice. Certainly one cannot say that these criteria have found wide application in practical planning. The reason is obvious, the lack of data is one of the essential limitations and one cannot help feeling irritated while studying the theoretically more and more 'ideal' investment criteria. It is not the intention to suggest that these elegant propositions are without use, but it should be realised that if one wishes to replace 'intuition' with 'science' in development plans, the applicability-aspect of criteria should not be neglected. The gap could be bridged from two sides, (a) the improvement of statistical information and (b) the modification of existing criteria to more useful tools in practical planning. It is believed that it is particularly the task of researchers in developing countries to emphasize the first aspect, and it is hoped that this proposed research programme reflects this belief. On the other hand, intellectual vanity will inevitably inspire an attempt to deal with the second aspect.

The empirical research will focus primarily on the cost function in specific industries using alternative techniques of production. The analytical framework will be the break-even analysis as applied by Sen, Boon and others. This analysis is micro-economic in nature, it deals with well-defined single production processes. The optimum technique of production is defined as the one with the highest benefit-cost ratio, where benefits and costs can be valued at market prices or, if these do not reflect scarcity values, at adjusted prices or accounting prices. It will be demonstrated later that rough orders of magnitude of accounting prices are sufficient to make the analysis useful.

The technique of break-even analysis can be shown in two ways, arithmetically and graphically. The demonstration of the technique of break-even analysis and its possibilities will draw heavily on G.K. Boon's, Economic Choice of Human and Physical Factors of Production, 1964.

The arithmetical method.

A break-even point is an intersection point of two total cost lines, in other words, the point where two production techniques have the same costs. Let the techniques be represented by the following simple cost functions:

$$T_1 = F_1 + V_1 \cdot U$$

$$T_2 = F_2 + V_2 \cdot U$$

where T stands for total costs, F for fixed costs, V for variable costs and U for output, and $F_1 < F_2$, $V_1 > V_2$

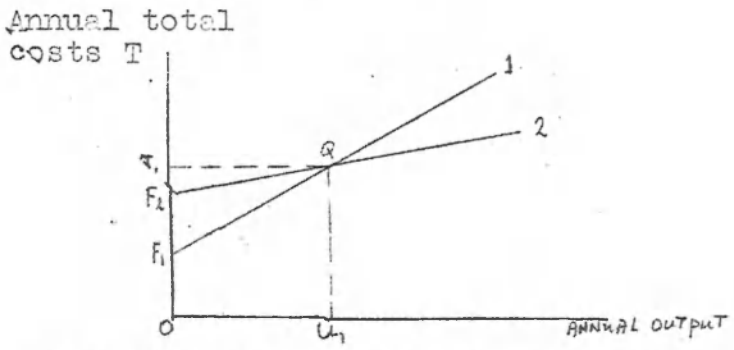
The only output level where total costs of both techniques are equal is obviously:

$$U = \frac{F_2 - F_1}{V_1 - V_2}$$

If more technical possibilities exist other break-even points can be computed in a similar way.

The graphical method.

The two cost functions can be graphically represented by two straight lines.



Q is the relevant break-even point, while it is easily seen that for an annual output $< U_1$, technique 1 is the optimum technique, for an output $> U_1$, technique 2 is to be preferred.

Critical wage rates

The determination of the optimum technique for different levels of output is made for given wage rates and interest rates. It is easy to see that also a break-even wage rate can be determined, keeping the output and interest rate constant. This will provide useful insight into how the optimal level of mechanization for a given output and interest rate depends on the wage rates.

1) In this simple demonstration of the break-even analysis rather complicated problems such as normal capacity, working capital costs, multi-purpose capital equipment etc. are neglected.

The cost functions have been altered in such a way that the variable costs per unit of output can be broken down in variable non-wage costs (V_c) and variable wage costs, which are the product of labour hours per unit of product (L) and the wage rate per hour (w). Now, w is the unknown.
The cost-functions are:

$$T_1 = F_1 + V_{c1} \cdot U_1 + (L_1 \cdot w)\, U_1$$

$$T_2 = F_2 + V_{c2} \cdot U_2 + (L_2 \cdot w)\, U_2$$

Hence:

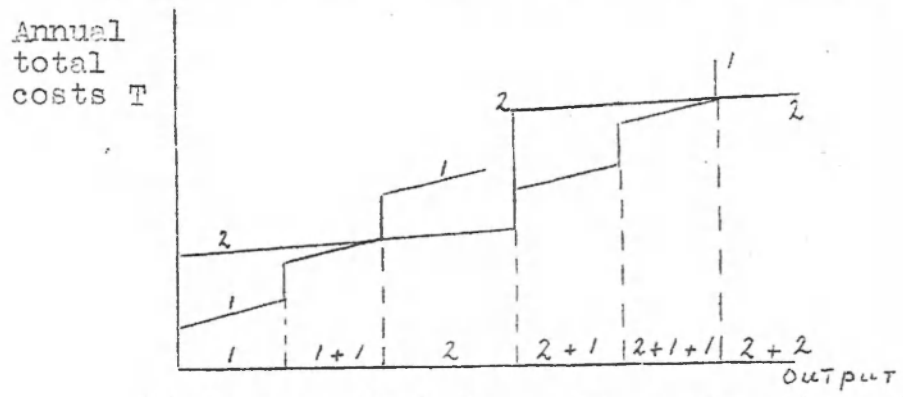
$$w = \frac{(F_2 + V_{c2}U_1) - (F_1 + V_{c1}U_1)}{(L_1 - L_2)\, U_1}$$

For a number of outputs the critical wage rates can be computed, indicating the ranges for which a given technique is optimal, given the output and interest rate, but changing the wage rate. This procedure is particularly useful if accounting prices have to be used, which can only be estimated roughly.

Similarly critical interest rates can be computed.

Indivisible means of production.

Until now the cost functions were continuous. This rather unrealistic assumption can easily be removed, as shown in next graph. Here the different techniques of production have a fixed cost-element with a given capacity. Consequently the cost function becomes discontinuous.



It is seen that the pattern of optimum techniques repeats itself for certain outputs. When technique 2 has reached its annual capacity, a combination of 1 and 2 leads to lower total costs of production than two units of technique 2.[1)]

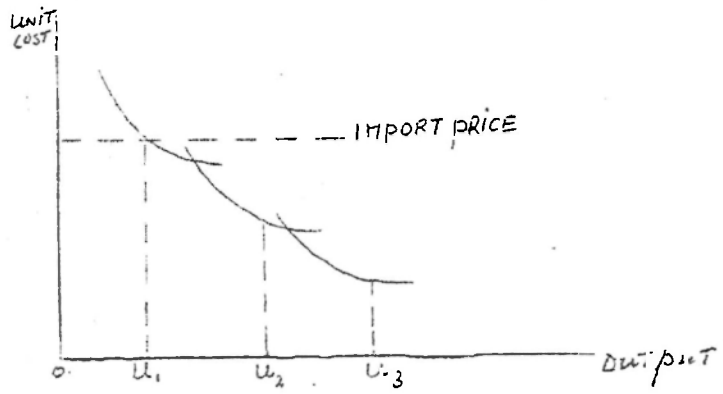
1) From a management point of view a homogeneously equipped plant might however be preferred.

Minimal versus optimal plant size.

What has been discussed above is the optimum plant size, which is the size which leads, within a specific period to minimal total costs. This implies problems such as the estimation of future demand, normal capacity etc. This concept is of extreme importance, when one wants to profit from economies of scale.

The minimum size of plant, another 'hot' subject in industrial planning, could be defined as that plant size at which establishment is economically justified, in other words, when the import price or the market price of local competitors is equal or higher than the unit cost price of production.

Both plant sizes can in principle be deduced from the analysis.



Minimal size: o - U1
Optimal size: (today): o - U2
Optimal size: (today + ½N): o - U5

(N = lifetime of capital equipment)

Accounting prices.

As stated above, the prices used in the analysis have to reflect scarcity values. According to prof. Clark (EDRP No. 15: Toward more Comprehensive Planning in East Africa) shadow prices of foreign exchange, investment funds, and trained manpower did not diverge substantially from their market prices until recently. A project analysis using market prices could therefore be quite useful to evaluate the techniques of production in existing industries.

He immediately adds, however, that in the years ahead, if more comprehensive planning does succeed in accelerating the rate of growth until the economies run up against these basic constraints, the scarcity values of foreign exchange, investment funds and trained manpower will rise above their market prices.

The factor excluded here, and most important when very labour-intensive methods of production are considered is unskilled labour. There is evidence that market wages for this type of labour - on fully justified social grounds - are considerably higher than relative scarcity would suggest.

Application of the criterium

Little systematic research on optimal techniques has been done. Yet, a start has been made in several research institutes (M.I.T., Netherlands Economic Institute and others) and the United Nations, especially by its Centre for Industrial Research. Moreover, a wealth of material is probably available in business firms in developed countries, though at best only out-of-date material will be made public. For specific industries, Indian textile for instance, industry studies have been made.
Though the above mentioned studies certainly do not form an exhaustive list of material potentially available, it intends to indicate that data have been collected, but as yet not presented in the appropriate form. It is the intention to focus in the first stage on the collection of this material. During the inevitable waiting time, case-studies will be made of some important industries in East-Africa.