

The Problem of Technological Choice

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DR RAJ, examining the much-debated question of small scale industries in the context of the second Five-Year Plan, arrives at the conclusion that even if increase in employment be not made an objective in itself and maximisation of the rate of growth of the economy be made the guiding consideration, a case can be made out for small scale industries: that the optimum technique in the sense of one which, when adopted, makes the maximum contribution towards increasing the tempo of development can very well differ from the most advanced technique.

Very few people will differ from the view that the optimum technique, as defined above, is not necessarily the most advanced technique. We, however, differ from Dr. Raj on three things. We differ from him on the method of analysis that leads him to his conclusions; we differ from him on the formula he proposes for the choosing of the optimum technique in any industry; and we differ from him on the point that there is any inevitable contradiction between the choice of advanced techniques and a desire to enlarge employment opportunities.

New Orientation

To start with, we shall give a new orientation to the problem by calling it the problem of technological choice rather than the problem of technological change. Dr. Raj treats the problem in a way that, permits him to discuss the introduction of such technical innovations as may further aggravate the employment situation by 'displacing' some workers. While the introduction of new techniques in existing units of production is by no means ruled out in planned development, the problem of 'change', when it may mean a further worsening of the employment situation, is not one which in our opinion is being debated in India in the context of the second Five-Year Plan. The problem relevant to the Plan, as we see it, is as follows. The Plan visualises increased production of different quantities in different industries. The existing units of production are by and large supposed to continue as before. As to the margin of additional production, the question that arises is: 'through what means to realise this?'. There are certain industries where the same production can be obtained through

different technological variants promising largely different volumes of employment. It is here that the 'problem of technological choice' arises and expresses itself in the question: which technological variant to choose?

Before we set out on an examination of the problem, we deem it important to clarify two points which Dr. Raj unfortunately leaves a bit vague: firstly, how to measure the 'advancedness' of or want of it in a technique; secondly, what the scope or the problem is like.

A Definition

As to the first, we lay down as a definition that technique A be considered more advanced than technique B with regard to the production of commodity C, if the production of an equal quantity of commodity C (measured in physical units) requires a smaller number of man hours of labour, direct and indirect, if technique A is used than if technique B is used. Thus, if the commodity C is textile, we have to compare the number of man hours of labour spent to produce a yard of textile through technique A and B, taking into consideration direct labour in weaving as well the indirect labour involved in such input items as yarn, coal or electricity, transport etc. as also in the depreciation of capital.

As to the scope of the problem, theoretically, the question of choice arises in all productive activities. There may be different degrees of automatization in the manufacturing of steel or in the construction of steam locomotives. This, however, does not come within the range of the present problem, which concerns industries wherein the differences in employment resulting from the adoption of alternative techniques are significantly large and what is more, the employment-giving techniques are such that they allow of small scale production, possibly in tiny units scattered in villages. This, in practice, severely restricts the scope of the problem; as a matter of fact, hardly any other indus-

*There can, however, be several other alternative definitions, all of them being more or less correlated. The capital-output ratio and the capital-labour ratio are two other measures often used as explieatum for the vague concept of the "advancedness" of a technique.

try except spinning, weaving, food processing, pottery and some leather crafts satisfies the specifications.

It is as well to point out here that the 'scale' of production of a unit and the 'technique' used are not the same thing. Both Dr. Raj's problem and the problem discussed in the present article concern 'technique' and not 'scale'. There seems, however, to be considerable confusion in the proposals made by the protagonists of small scale industries as to 'scale' and 'technique'. It is evidenced by the multiplicity of terms used, viz., "small scale industries", 'cottage industries', 'household Industries', 'village industries', 'hand industries' etc. Hand pounding of rice by peasant women in villages and engineering enterprises using power and machine tools, but employing less than ten people (and, therefore, not regarded as factories under the Factory Act) are both being considered as illustrations of what they desire.

Questions of Analysis all now come to our difference with Dr. Raj's analysis. According to him, if the objective be the maximisation of the rate of growth of the economy, variant A is to be regarded as superior to variant B if the proportion of the surplus per worker in A to that in B is larger than the proportion of capital per worker in A to that in B; and the optimum technology should be arrived at by subjecting all the competing variants to this comparison.

This criterion is not, however, applicable to our problem for the following reason. The criterion must obviously be applied to industries separately and individually, irrespective of the technological choices made and amounts of investible funds allocated to the other industries. It must therefore be supposed that there is a given amount of investible fund allotted to the particular industry in question before the choice is made. If it be so, the result of the application of Dr. Raj's criterion will be to maximise the surplus obtained from the particular industry in question. One is, of course, not interested in the surplus accruing from any one industry, but that obtaining in the entire economy. Presumably, Dr. Raj would say that *if* the same

Criterion be applied in every field where there is scope for choice, the overall surplus will automatically be maximised.

This is correct provided one starts by making an allocation of investible funds to different industries before the technological choices are made. This, however, is not possible. The impossibility can be demonstrated through Dr Raj's own illustrative example. He compares the surpluses to be obtained by investing an equal amount, viz. Rs. 160,000 through three different techniques in the cotton, textile industry. He shows that in the case of variant II, there will be employment for 800 workers and a surplus of Rs. 480,000, while the more advanced variant III will give employment only to a single worker and produce a surplus of only Rs. 94,500. What Dr. Raj, however, overlooks is that his calculations imply that the production of cotton textile per day through variant II is 16,000 yds, while that through variant III, is only 1280 yds. Now surely these very different quantities of the same commodity cannot be absorbed by the same market at the same price.

Market not Altered

To be accurate, the market does get altered by a change-over from technique III to technique II. Thus, the production of 36,000 yds. through variant II instead of 1,280 yds through variant III means an additional income of Rs. 11,04,000 in the community. But this additional income of Rs. 11,04,000 will not surely be spent all on textile only; for the additional supply of textile in the market is worth precisely this amount, namely, Rs. 11,04,000. Only a part of it would be spent on textile and the rest would make a demand on sundry other consumer goods, including food. *The supply* of these other consumer goods cannot, however, be made to match this changed demand, as we have assumed that the allocation of investment fund to, and choice of technology for, the other industries are made independently of the textile industry. We have carried out the argument in terms of a closed economy; but generalisation for an open economy is not difficult, as we can similarly argue that the amount of a commodity that the foreign market will absorb cannot change with a change-over from one technology to another any more than the home market can,

The root of the trouble lies, in our

opinion, in Dr. Raj's unexplained assumption that the rate of growth of the economy is maximised if one obtains the maximum amount of surplus from a given industry to which a given investment fund has already been allocated. Before we pass on to what we think is the correct approach to the problem, we give an example of another faulty criterion which also is meant to be applied to industries individually, and is, therefore, very convenient. We have seen that the difficulty in using Dr Raj's criterion is that it ignores the fact that a market can absorb only a given quantity of a commodity at a given price.

Supposing one keeps the production targets fixed and tries to choose technologies in such a way that the pooled surplus from all industries taken together is the maximum, then the criterion of optimality for any given industry will be to choose that technology which yields the maximum amount of surplus per unit of output. This criterion will very often lead to the adoption of the most 'advanced technique' in the sense of our definition. Thus, in Dr. Raj's example, if indirect labour per unit of output be assumed to be the same between variants II and III, the latter is more 'advanced' than the former. If we assume that the fixed production target of 1280 yds, per day has to be realised, it can be seen that variant II will yield a surplus of Rs. 38,400 whereas variant III will yield the same amount as before, namely, Rs. 94,500.

But if this criterion does not treat production targets as a function of the choice of technology, it treats the investible fund in the particular industry in question (and therefore the total investible fund) as being determined by the choice of technology. It has, therefore, to be rejected likewise; for the total investible fund is not really variable. It is usually given before the problem of choice of technology is faced.

The problem has, in our opinion, to be posed in the following manner. Given a volume of investible fund for the current year, it must be so distributed in the different industries and a collective choice of technologies so made in the different industries that

- (i) the industries can grow in a balanced way and
- (ii) the aggregate surplus of all the industries, taken together, can grow at the fastest rate.

If industrial surplus be considered

the main source of investment, then the rapidest growth of the economy means the rapidest growth of surplus year after year. The investment fund for the current year, therefore, has to be so utilised as to conform to the rapidest possible growth of the surplus. But it cannot be used in any way whatsoever. It must be so distributed as to allow the different industries to produce in a balanced fashion.

Thus, the production of fuel, power and raw materials must equal their input requirements; producer goods must be so produced that they fit in with the allocation of investment funds to different industries as also the replacement requirements of different industries. Then, a given allocation of the investment fund and a given collective choice of technologies in the different industries determine the income *generated* amongst different classes of consumers; and that determines the amounts purchasers will wish to spend on different consumer commodities. The supply of different consumer goods in physical quantity must maintain certain proportions amongst themselves so as to be in harmony with the proportions between different consumer demands.

Optimum collective choice

It is therefore not possible to give any formula for individual choice of the optimum technique for individual industries. There will be an optimum collective choice, which will depend on such ratios as the surplus per worker, capital-labour ratio, capital output ratio, rate of amortisation etc. for all the industries and all the different techniques taken together.

It is not, however, our position that nothing can be said as to the particular problem of choice which is being debated in the context of the second Five-Year Plan. We have already seen that the range of industries covered by the problem (e.g. textiles, leather craft, pottery, food processing etc) is very small indeed; further, they are mostly consumer goods industries. As far as these industries are concerned, it can be safely suggested that the choice in these cases must be in favour of 'advanced' technologies. The reasoning is as follows.

In a closed economy where savings amongst wage earners are negligible, the surplus in the consumer goods industries must roughly equal the wages and salaries "paid out to the

workers in the producer goods industries. While the share of the national surplus going into the producer goods industries can be and should be increased by reducing wastages of the surplus through unproductive activities of all types, capital export etc.. it is fundamentally through the increase of surplus in the consumer goods industries that the number of workers employed in the producer goods industries has to be increased.

The techniques should therefore be so chosen for those consumer goods industries where in scope for choice exists that the net surplus of the consumer goods industries increases. This will most probably mean choice of such techniques in those industries as will increase the net surplus per unit of output.* This is so because we have to assume that for these selected industries investment have to be so made that the fixed production targets are realised. We have already seen that the industries, where our problem of choice at all exists, are few in number and not very important, compared to the basic industries of the economy, which are agriculture and the heavy industries.

Investment in these two sectors has to be made year by year from considerations of long-term planning; the growth of these two sectors almost completely determines the rate as well as the pattern of growth of the entire economy. The growth of the other industries has to conform to this overall pattern. The investment maturity period in these basic industries being very much larger

'We have been cautious to use the qualification 'most probably' and not make the flat recommendation that the optimum technique for any one of these industries will be the most advanced available; for, such a definite opinion will contradict our own earlier standpoint that one can only have an optimum collective choice and no optimum individual choices. While, by investing in advanced techniques in the consumer goods industries, we ensure a larger surplus from the consumer goods industries in future years when investments have matured, it may (though not necessarily) mean allocating a larger share of the current investible fund to the consumer goods industries at the cost of the producer goods industries, and that may mean (though not necessarily) retarding the pace of growth of the economy.

than in the subsidiary industries, it follows that investment in the latter industries has to keep in view more or less fixed levels of production in the industries in the next few years.

We shall now come to the question of employment. It is curious that only small scale consumer goods industries are discussed in the context of expanding employment opportunities. Yet, if there are economic activities where labour and capital can really substitute each other, they are more to be found in the producer goods industries than the consumer goods industries. Thus, earthenware pottery is not really a substitute for chinaware, and khadi cannot be deemed to satisfy the same consumer needs as mill cloth. "But a well dug or a piece of land levelled by human labour is indistinguishable from one dug by a driller or one levelled by a bulldozer.

There is actually plenty of scope for employment in the building industries. Mass application of paid human labour to such activities as building of roads, houses, dams, etc.

-mimic-

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digging of wells and canals, clearance of forests, tilling up of swamps etc. has not been considered seriously as an economic proposition until now.

Let us suppose that we have found out the optimum collective choice of technologies and that they are being applied. The economy is growing in a balanced way, and the overall surplus is growing at the maximum speed subject to conditions of balance. Now year by year the surplus can be utilised for capital formation in two ways: it can be converted into capital goods through the international market or it can be converted into capital goods through local production.

There is, however, a limit to the production of capital goods via the international market because of the objective situations obtaining there; there is also a limit to the local production of capital goods of the type of tools and machinery imposed by the amount of capital stock available in the producer goods sector. If the entire amount of surplus is not at all absorbed in these two ways, the rest can be utilised to give employment through labour intensive activities in the producer goods sector, i.e., constructional activities, and through the expansion of social services. The first will give employment to under-employed peasantry and other unskilled workers; the second to the unemployed middle class. As the fruits of their labour do not enter the market as competing commodities, difficulties of balance will not arise as in the case of consumer goods.

Thus, while the second Five-Year Plan protagonists of small scale industries want to solve the unemployment problem through the introduction of less advanced technologies in a certain number of consumer goods industries, our method of attacking unemployment consists in expanding the surplus in the consumer goods industries rapidly, which, as we have seen, means the very opposite, i.e., the introduction of advanced technologies in the same industries.

If an objection be raised that building activities offer scope to a very specialised type of labour or only to unskilled labour, and therefore cannot be considered seriously as an employment giver, the answer can be that industries like weaving and spinning, which are being currently considered as employment givers, do not offer any wider scope either!