
Appropriate Technologies and Inappropriate Policy Instruments

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INTRODUCTION

The post-war period has seen rapid growth of the majority of developing countries together with growing unemployment and inequality in the distribution of incomes. Recognition of the failures of the growth process in these respects has led to a marked change in ideas about the development process and the objectives of economic policy. This is reflected in the increasingly frequent advocacy of alternative development strategies such as 'redistribution with growth' and 'basic needs'. It is in this general context that the concept of 'appropriate technology' has arisen. We shall argue, however, that existing approaches to it are either incorrect or incomplete. The basic problem lies in a failure to consider technology within a wider context of alternative policy instruments in a situation of sub-optimal levels of employment and equality in developing countries. At least part of this problem is ascribed here to the contextual misuse of Sen's model of choice of techniques in conjunction with a misconceived notion of dualism on the part of the original proponents of 'intermediate technology'. That the concept has a great deal of potential relevance for the current problems of developing countries is not in dispute, but until the potential is actualized in the form of analytical rigour and empirical verification, its operational relevance will remain questionable.

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WHY APPROPRIATE TECHNOLOGY?

Analytical scrutiny of the concept of 'appropriate technology' almost always begins with an attempt to define the meaning of 'appropriate'. The first step in this process is usually to specify the relativity of 'appropriate' to the objectives of development. Thus 'technology is only "appropriate" (or "inappropriate") by reference to criteria or objectives which themselves must be specified in empirical terms'.¹ The 'appropriateness' of the technology is then made to depend upon its 'consistency' with reaching the objectives specified. We believe, however, that this way of posing the problem is misleading and that the relevant starting point requires a logically prior question to be posed. In effect, this concerns the issue of whether technology *of any kind* is the relevant solution to the problem at hand. Unless this question is asked, the only requirement of 'appropriate technology' is that it contributes positively to the objectives chosen. The International Labour Office, for example, seems to require of 'appropriate technology' merely that it 'contribute to greater productive employment opportunities, elimination of poverty and the achievement of equitable income distribution'.² But even if technology is appropriate in this sense it does not follow that it is the appropriate policy *instrument*.³ Alternatives may exist which achieve the same objectives more efficiently (the notion of efficiency in this sense is discussed below). In the context of poverty eradication, for example, it may make more sense to devote resources to the formation of local institutions such as co-operatives which could be able to secure a wider distribution of the benefits from existing technologies. The point is that the *relevance* of technology and the *choice* of particular technologies have to be considered simultaneously as interdependent problems.

The need for this simultaneity in procedure is largely unrecognized in the literature. A good example here is Hans Singer's interpretation of the role of technology in meeting the basic needs of the poorest groups.⁴ His response to the prevailing inequality in income distribution is simply to argue for 'more appropriate' technology and in particular 'a special kind of appropriate technology: a technology which differs from that developed in the industrialized countries and for the industrialized countries even more than the difference in factor proportions would require.'⁵ The possibility that the technological solution may be infeasible is

not discussed nor that this objective may be more efficiently met by other instruments.

A first step in the direction of a more general framework requires definition of the 'efficiency' of policy instruments. For the sake of discussion we assume there is a single policy objective while acknowledging that in reality multiple objectives are combined into a complex objective function. The instruments available to meet the given objective will vary according to (at least) the following factors: (a) the resource cost of implementation; (b) the rapidity of implementation; (c) the political and social feasibility; and (d) the efficacy in terms of both the rapidity and durability of results.⁶

The inter-relations between these factors comprising the efficiency of instruments are many and complex. The time profile of resource costs, for example, may vary with the required rapidity of implementation. Thus an attempt to eradicate poverty within a relatively short space of time will require very large initial and, in all likelihood continuing, resource expenditures, while a more gradual attack on the problem will have a more even time profile of costs. The political feasibility of an instrument is likely to depend, at least in part, on the extent of administrative and other resources. Many instruments may be efficacious but infeasible and vice versa. Moreover, the very fact that at least *some* instruments are likely to be infeasible will in many cases affect the outcome of any single instrument or group of instruments. The relevant framework is thus likely to involve the theory of Second Best and the problem becomes one of discovering the instrument(s) most likely to bring about a Second Best solution.⁷

Inter-temporal elements further complicate the problem as when the rapidity with which instruments take effect varies inversely with the durability of their results. The nature of these interactions depends thus not only upon the objective chosen but also on its inter-temporal dimension. This conclusion assumes particular relevance with respect to technology in the context of attempts to create employment, reduce poverty or redistribute income in favour of the poor. In particular, the relevance of appropriate technology as an instrument in this regard will turn importantly on the length of the time-horizon assumed for its operation. Specifically, technology is likely to be much less suitable where the objective is a rapid increase in employment or reduction in poverty and inequality. There are basically two aspects of this. On the one hand, at least part of the 'appropriate technology' solution involves

the development of new techniques in order to offset the overwhelming historical bias in favour of designs in and for developed countries.⁸ If, as Findlay argues, design costs are an increasing function of labour intensity, the resource cost and the time lags involved in implementation are likely to be considerable.⁹ On the other hand, offsetting these disadvantages is the major advantage of technology as a policy instrument. Unlike measures such as fiscal transfers, the development and diffusion of new technologies alter the process by which incomes are generated. To this extent the development of 'appropriate technologies' involves a sustainable improvement in the positions of those affected. Whether or not this particular attribute of technology as a policy variable entirely offsets the factors mentioned above depends thus on the time horizon within which objectives are framed.

As far as our other criteria are concerned, namely, political and social feasibility, two related points are germane at the present level of generality. The first is that the precise specification of the objective (including its inter-temporal component) may again be crucial. In particular it may, from the point of view of political feasibility, be much easier to implement technologies which raise the incomes of some of the poorest groups without improving the overall distribution of income than to effect an actual redistribution. The point is that the former may require only the development and *promotion* of new techniques for the poorest groups as opposed to the additional requirement of *opposing* (banning outright or discriminating against) those desired by the upper income deciles of the population.¹⁰ The second and related question is whether in the redistributive case, technology is likely to constitute a more or less feasible solution politically and socially than other instruments. Nothing useful in general can be said here. Much depends, of course, on the *scale* of the proposed redistribution. On a large scale, technology reform may be no more feasible politically than a land reform, whereas on a much smaller scale it may be possible to achieve results via new techniques which were impossible to achieve with other instruments. The example of the development and diffusion of bamboo tubewells in Saharsa District of Bihar is illustrative here.¹¹ This tubewell was invented a decade ago and, on account of its very low price in conjunction with some block loans, was widely adopted by the smallest farmers. The result was a narrowing of the gap between rich and poor farmers. It also seemed to the author that the invention was possibly bringing about a fundamental

change in the pattern of land ownership — something which had until then proved impossible. The social acceptability of measures will also vary according to their scale. Fiscal transfers, for example, may be socially acceptable on a small but not a large scale.

The above discussion illustrates some of the considerations which, in our view, constitute the relevant general framework of analysis within which the concept of appropriate technology ought initially to be located. The very difficulty of formulating reasonably precise notions at the level of generality with which we have been concerned suggests, however, that if the concept is to be useful there is a need to invest it with greater specificity. That is, if a concept is to be operationally useful there must exist *reasonably clear criteria for its application*. It is to this, our second major question, that we now turn.

CRITERIA FOR APPLICABILITY

There are basically two reasons for the current lack of reasonably clear criteria for the applicability of appropriate technology in the sense defined above. The first involves a misconception of Sen's work on the choice of techniques and the second concerns E. F. Schumacher's original formulation of the intermediate technology concept.¹² The former is essentially concerned with the public sector while the latter has the private sector as its major frame of reference. We begin with Sen's analysis and the public sector.

(a) The Public Sector

Sen's starting point is the relationship between the overall savings rate and hence growth, and the optimal choice of technique in the economy. The analysis takes place in the context of a state-owned enterprise in an economy deemed to have a suboptimal rate of savings. It is assumed that the state is unable to secure the desired savings rate by fiscal or other means. The relationship posited by Sen is defined by the connection between factor intensity and the functional distribution of income on the one hand, and between the latter and differential savings rates on the other. In particular, relatively capital-intensive techniques are assumed to raise the profit share out of which, in turn, savings are taken to exceed those made out of wages.

The implications of Sen's analysis for our earlier discussion are as follows. In the first place it assumes in effect that there is no problem of political feasibility or difficulty in implementation. The state encounters 'no social or political obstacles when it implements its choice of technique decisions'.¹³ Secondly, the effects of these decisions, or what we have called efficacy, are unambiguous. The functional relationship posited above between profits and investment, for example, is certain in the context of state planning. The problem, as Cooper points out, is that this model of state planning is all too often carried over to the very different problems of the private sector. Thus,

whilst most people agree that it is wrong and confusing to use the neat and tidy Sen model of choice of techniques to predict behaviour in the very untidy reality of capitalist underdevelopment; very few of us can claim that we have consistently and systematically avoided this kind of aberration. In fact there is a rather general tendency to be unsystematic.¹⁴

Apart from the questions of implementation, feasibility and efficacy mentioned above, there are two additional factors which make the Sen framework irrelevant for our purposes. The first is that Sen does not deal with the problem of technical change; his concern is solely with the existing (neoclassical) range of techniques. Secondly, since the 1960s when growth was the primary if not sole objective of developing countries, the emphasis has shifted increasingly to the goals of reducing widespread unemployment, poverty and inequality in the distribution of income.¹⁵ This shift could crucially alter not only the efficacy but also the other components of the efficiency of different policy instruments as our framework above was concerned to stress.

Given all these difficulties one might have thought that a coherent set of criteria would have evolved within which to analyze the applicability of 'appropriate technology' in the private as opposed to the public sector. Unfortunately, however, this has not happened. In order to locate the reason for this we start with the original pioneering conception of 'intermediate technology' by E. F. Schumacher.

(b) The Private Sector

As far as the private sector is concerned it is necessary to

distinguish at the outset between two distinct concepts of 'appropriate technology'. The first has as its frame of reference the developing countries prior to their attempts at industrialization. Historically, this concept may be located in the immediate post-war period, when in 1953 Nurkse wrote of the developing countries that, 'Much simpler tools and equipment may be appropriate to the relative factor endowments of countries of this type, *in the early stages of industrial development*' (emphasis added).¹⁶ In other words, this concept refers to the technology which ought to have been developed by the then pre-industrial countries of the Third World but was not. The second concept by contrast (though rarely distinguished from the first) takes as its frame of reference the situation which itself *results (in part at least) from the fact that the 'appropriate technology' of the first concept was not developed*. That is to say, the frame of reference is the present-day developing countries, many of which have progressed a considerable part of the way towards industrialization and whose growth for the most part has been based on 'inappropriate technologies'. In short, the two concepts refer, respectively, to developing countries prior and subsequent to the introduction of 'inappropriate technologies' on a large scale. How important is this distinction and where can Schumacher's concept of 'intermediate technology' be located in terms of it?

In Schumacher's approach the fact that the society *as a whole* has changed since the application of inappropriate technology is irrelevant to *that part of the economy* which is taken to represent the frame of reference for intermediate technology. Moreover, this part of the economy is said to have remained substantially unaltered — indeed, this is the very problem intermediate technology was invoked to solve.

The typical developing country with which Schumacher is concerned is a 'dual economy' which he defines in a somewhat special way thus:

In the dual economy of a typical developing country, we may find fifteen per cent of the population in the modern sector, mainly confined to one or two big cities. The other eighty-five per cent of the population are largely by-passed.¹⁷

Moreover, in the introduction to this chapter on intermediate technology he makes it clear that his concern is solely that of 'helping the people in the non-modern sector'.¹⁸ This can only be achiev-

ed, in his view, through the development of an intermediate technology and its application to the non-modern sector. The two basic features of this type of technology are that it be based on the creation of workplaces cheap enough to be created in large numbers and that it be unskilled labour-intensive. Schumacher thus attempts to maintain a perfectly neat dichotomy between a homogeneous group of relatively rich individuals in big cities and an equally homogeneous group with low incomes living in rural areas and small cities. It is as if all that had happened was the grafting-on of an independent modern sector, using inappropriate technology, to an essentially unchanged traditional economy. In this way he argues in effect not only that technology is the most efficient instrument available for the reduction of unemployment and poverty, but also that it is *uniformly applicable throughout the supposedly homogeneous non-modern private sector* of the economy. Much of the unrealism of this view stems from a spurious conception of dualism in developing countries, or of an enclave economy. Rural areas, for example, though typically more equal than the urban sectors of developing countries nonetheless display considerable inequality in the distribution of income.¹⁹ Equally, there are large numbers of the worst-off members of society living in large cities. Secondly, the increased inequality in the distribution of income within the typical developing country in the post-war period cannot *entirely* be ascribed to the growth of the modern sector. At least part of the increase — which can be decomposed into the sum of inter- and intra-sectoral inequalities — is due to the growth of inequality *within* the sectors which Schumacher regards as non-modern.²⁰ Indeed, to some extent the increase may itself have been caused by the interdependent but unequal relations between sectors.

In contradistinction to Schumacher, Charles Cooper places considerable emphasis on the political-economic significance of the two differing frames of reference for 'appropriate technology' mentioned above. In particular, his view is that 'a hall-mark of the intermediate technology argument is that there we start from a traditional economic system which has to be preserved', whilst instead there is in fact an

economic system where 'modernization' (for want of a better word) has already disrupted pre-existent systems and created new classes and interest groups — an urban capitalist class, a labour aristocracy and so on — which usually control the

political and economic process . . . As far as traditional social systems are concerned there is very little left to preserve.²¹

Once this distinction is recognized, moreover, we have to 'face the problem of just how to implement an intermediate technology programme which is in many ways in direct conflict with the interests of the political and economic élites.'²²

Cooper's view serves to impart a much needed degree of realism to Schumacher's notions but neither approach gets us very far. The reason is that the situation — social, political and economic — differs a good deal both between and within developing countries. The heterogeneity of poverty, both occupationally and spatially, for example, is only now beginning to receive attention from those concerned with the eradication of poverty. The 'implementability', feasibility and efficacy of alternative instruments are thus also likely to vary both between and within countries. A study by Gotsch amply illustrates this important point with regard to the efficacy of technology as a redistributive instrument.²³

Gotsch's study is concerned to analyze the effects of introducing the *same* innovation into two areas of south Asia having significantly different relationships between land, institutions, and people. The innovation concerned is the tubewell and the two areas are Comilla District in Bangladesh and the Sahiwal District of Pakistan. The former has a small-farm structure and a relatively egalitarian distribution of land. In the latter, by contrast, a much larger farm-size structure is associated with a more unequal distribution of land. The farmers in Comilla were organized in a cooperative to purchase the tubewells whose irrigation potential (50 to 80 acres) greatly exceeded the small farms of 1 to 2.5 acres. In Pakistan, which lacks small-farmer organizations, the tubewells were installed individually with the distribution of services biased primarily in the direction of the larger cultivators. The (expected) distributional impact in the two areas is quite different — in Comilla the labour-using technology led to a reinforcement of the relatively egalitarian distribution, while in Pakistan the same technology had quite the opposite effect of becoming a 'source of increasing inequity'. Gotsch also stresses the importance of the second-round effects of the technology on the institutional and social structures. In this case the outcome was a reinforcement of the initial effects. That is, in Pakistan the technology weakened the likelihood of any institutional organization of small farmers and

merely strengthened the power of large farmers via an enhancement of the credibility of threats of dismissal or eviction. In Bangladesh, on the other hand, with a pre-existent small-farmer movement, the effect of the tubewells was to reinforce and strengthen small-farmer organizations.

Another study by Disney underlines the difficulty of predicting the income distributive effects of relatively cheap and labour-using technology in an inegalitarian setting.²⁴ This study concerns 'gobar-gas' plants used to produce methane gas and manure in India. Though these plants are considerably more labour-intensive than the competing method which produces nitrogen by the use of chemical fertilizer, the result of their introduction, again based on fragmentary evidence, was to exacerbate existing rural inequalities. This result was due, firstly, to a capital cost (albeit a very low one) beyond the reach of the poorest farmers; second, to the differential access to credit by small and large farmers, and lastly, to a poorly functioning system of co-operatives. Many more studies of a similar kind are required.

● NOTES

1. OECD: *Choice and Adaptation of Technology in Developing Countries* (1974), 22. See also Richard Eckaus: *Appropriate Technologies for Developing Countries* (National Academy of Sciences, 1977).
2. ILO: *Meeting Basic Needs* (1977), 36.
3. Nor does it follow from the widespread view that technology in the past has been *inappropriate* in this sense.
4. Hans Singer: *Technologies for Basic Needs* (ILO), 1977.
5. *Ibidem*, 3.
6. See also the criteria adopted by Keith Griffin & Jeffrey James, 'Supply Management Problems in the Context of a Basic Needs Strategy' (IBRD, 1978).
7. See Frances Stewart & Paul Streeten: 'New Strategies for Development: Poverty, Income Distribution and Growth', *Oxford Economic Papers* (November 1976).
8. See Frances Stewart: *Technology and Underdevelopment* (London, Macmillan, 1977).
9. R. Findlay: 'Some Aspects of Technology Transfer and Direct Foreign Investment', *American Economic Review, Papers and Proceedings* (1978).

10. See Carl Gotsch: 'Economics, Institutions and Employment Generation in Rural Areas', in Edgar Edwards (ed): *Employment in Developing Nations* (Columbia University Press, 1974).
11. A. J. Dommen: 'The Bamboo Tube-Well: A Note on an Example of Indigenous Technology', *Economic Development and Cultural Change*, Vol. 23 (1976).
12. A. K. Sen: *The Choice of Techniques* (London, Blackwell, 1968); E. F. Schumacher: *Small is Beautiful* (London, Blond and Briggs, 1973).
13. See Charles Cooper: 'Choice of Techniques and Technological Change as Problems in Political Economy', *International Social Science Journal* (1973). One would not wish, however, to push the point too far. That the state cannot *always* implement its choice of technique decision with ease is attested by the furore over the Roskill Commission Report in the United Kingdom.
14. *Ibidem*, 294.
15. See Keith Griffin: 'Increasing Poverty and Changing Ideas about Development Strategies', *Development and Change*, Vol. 8, No. 4 (1977).
16. R. Nurkse: *Problems of Capital Formation in Underdeveloped Countries* (London, Blackwell, 1953), 45.
17. Schumacher: *Small is Beautiful*, 137.
18. *Ibidem*, 143.
19. See H. Chenery et al.: *Redistribution with Growth* (OUP, 1974).
20. On the decomposition of increased inequality in this manner see Charles Frank Jr. & Richard Webb: 'Causes of Income Distribution and Growth in Less Developed Countries: Some Reflections on the Relations Between Theory and Policy', in Charles Frank Jr. & Richard Webb (eds): *Income Distribution and Growth in the Less-Developed Countries* (The Brookings Institution, 1977).
21. Cooper: 'Choice of Techniques', 300.
22. *Ibidem*, 300. According to a recent critique of the appropriate technology concept by Michael Howes, Schumacher circumvents this difficulty with a curiously asymmetrical pair of assumptions. Thus, while alteration of the choice of industry in a labour-intensive direction is assumed by Schumacher to be subject to powerful forces of opposition, no such problems are posited in opposition to 'intermediate' technological choices. In this way according to Howes he is led into the 'contradictory position of arguing that radical social change in the form of the alleviation of mass poverty can, by implication, be brought about without prior alteration of other elements in the political, economic and social contexts within which it arises.' See Michael Howes: 'Appropriate Technology: A Critical Evaluation of the Concept and Movement', *Development and Change*, Vol. 10, No. 1 (1979), 117.
23. C. Gotsch: 'Technical Change and the Distribution of Income in Rural Areas', *American Journal of Agricultural Economics* (May 1972). This study is also summarized by W. R. Cline: 'Policy Instruments for Rural Income Redistribution', in Frank & Webb (eds): *Income Distribution and Growth*.
24. R. Disney: 'Economics of "Gobar-Gas" versus Fertilizer: a Critique of Intermediate Technology', *Development and Change*, Vol. 8, No. 1 (1977).

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