A CRITIQUE OF "APPROPRIATE" TECHNOLOGY FOR UNDERDEVELOPED COUNTRIES
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M.R. Bhagavan

Stockholm 1978
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CHAPTER I

A CRITIQUE OF THE OECD, WORLD BANK AND USAID APPROACHES

PREFACE

Recently, three authoritative studies have been published, one each by the OECD, the World Bank and USAID, which between them give a comprehensive coverage to the arguments in support of so-called "appropriate" technology. In addition to overall analyses, they contain many case studies relating to countries, sectors and topics. The World Bank report also carries several technical appendices giving details of the Bank's ongoing "appropriate" technology projects. ¹, ², ³

In this Chapter we will first give a summary of the main points and arguments as they appear in these three publications in their own terminology, and then follow it up with our critique of appropriate technology.

SUMMARY OF THE OECD, WORLD BANK AND USAID APPROACHES

Drawbacks of modern technology: The developing countries do not have, and are highly unlikely to be able to generate, the financial resources and the educational and economic infrastructures for building up their modern industrial sectors to sizes that would solve the development problems of their whole populations within the foreseeable future.

The introduction of capital intensive technology has socially disruptive consequences. The modern industrial sector in developing countries has been built on artificial prices and protection. It produces for the high-income portions of the domestic market and for export. It is usually not adapted to the supply and real costs of capital, labour, foreign exchange, and generally suffers from underutilized capacity, excessive down-time. It is maladjusted to local customs. Its export products may not be competitive enough internationally to be exportable. It destroys traditional skills and with them the
livelhood of numerous craftworkers and artisans. It stifles the growth of indigenous technological capacity and technological capacity and technological innovation.

Definitions of other technologies. The technologies which overcome the numerous drawbacks which these considerations point to are variously called "appropriate", "intermediate" and "low cost". "Intermediate" means somewhere between traditional and modern. "Low cost" is not defined with respect to any concrete economic index such as the annual per capita income or GDP, but the assumption is that it is much less expensive than modern technology.

However, each concept has one or more dominant trait which helps to distinguish it a little bit from the rest. Thus, while "low cost" concentrates on economic factors, "intermediate" lays stress on the engineering aspects, and "appropriate" on socio-cultural impact. Of the three, "appropriate" is the most fluctuating in time and space, and heavily influenced by value judgements and ideological considerations.

Over the last decade, a number of groups in North America and North-Western Europe have been campaigning for "alternative" and "soft" technologies which do not have the same anti-environmental and anti-ecological impact that the advanced technologies have. Although these "alternative" and "soft" technologies are innovated for use in the advanced industrial countries, many of them would be "appropriate" to developing countries.

Therefore one has five concepts to deal with: appropriate, intermediate, low-cost, alternative and soft. In the literature, these partly overlapping concepts are used interchangeably for one another. We do the same in this paper, and elect "appropriate" to stand in for all the rest. For the sake of convenience, we will throughout abbreviate "appropriate technology" by aptech" and "modern technology" by "modtech".
General aspects of the definitions. The appropriateness of technology should be considered in relation to development goals, products, processes, culture and environment. The questions to be asked are: Does the technology support the goals of development policy? Are the products and services affordable by, and useful and acceptable to, the intended users? Do the production processes make economic use of inputs? Are the products, processes and related institutional arrangements compatible with the local environment and culture?

"Appropriate technology can be used in developing countries in all economic sectors, at all levels of capital intensity, for the benefit of people of all income levels". "Appropriateness of a particular technology to a particular country situation depends on so many factors that formal general definitions are of limited use".

Specific aspects of the definitions. In most developing countries, capital and sophisticated skills are scarce and expensive, unskilled labour is plentiful and cheap. Unemployment is a serious problem.

The goods and services required for consumption should be low-cost, available to low-income people without extensive external support (subsidies) and compatible with local cultural patterns.

From these, aptech gets the following operational characteristics: Intensive use of semi-skilled and unskilled labour, sparing use of capital and highly trained personnel. Foundation on locally and domestically produced inputs, and on national personnel, and not expatriates. Economic efficiency of small and medium scale production enterprises. Replication by local entrepreneurs. Production and services mainly for local and regional markets.

Hardware and software. A distinction is made between the material and non-material aptech. They are called respectively "hardware" and "software". Hardware comprises machines, tools, products, workshops, etc. Software consists of organizational
knowhow, information network, policies, institutions, management structures, tax structures, marketing infrastructure, etc.

Software cannot be transferred. Hardware that is developed and manufactured in one place can be transferred to another without losing appropriateness. But not so with software. To be appropriate, software has to be developed on location in the communities where it is intended for use. An example: A French team installed a solar water pump in a village in a North African country, to provide clean drinking water free of charge to everyone in the village. This pump is longlasting and requires very little maintenance. So it was appropriate from the hardware point of view. But as soon as the French team left, the two richest villagers occupied the pump and began to sell water to the rest of the inhabitants. From the software point of view the project was therefore a failure.

Numerous instances can be recorded of the inappropriateness to developing countries of agricultural extension services and education systems developed in North America and Europe. Such transferred software is not only highly expensive but also quite ineffective.

Aptech has more software than hardware. Software is much more difficult to develop and diffuse than hardware. Not enough attention has been paid to this matter by the protagonists of aptech.

Aptech complements modtech. The activities and utterances of the protagonists have led to two serious misconceptions, causing critics to attack the whole concept itself: It is a substitute for the modtech of the advanced industrial systems. It is second best and inferior.

Both these doubts should be dispelled. The modern industrial sector is the cheapest and most efficient way of producing large quantity of good quality products demanded by the market. It must and will continue. It cannot be dismantled on grounds of more employment, smallness of scale, etc. This
means that aptech is not meant to replace existing or future growth of modtech, but as a complement to it. The two would coexist in the same society.\textsuperscript{5}

Aptech may appear as second best to the urban elites who have benefitted by the modern industrial sector, but it is certainly a big step forward to the vast majority in the rural areas in meeting basic needs in food, health, energy and shelter. It seeks to provide goods at competitive rates, thus setting free local innovative capabilities from the paralysing grip of modern technology, making development an autonomous process of "growth from below" and not "growth from above" as is usually the case.

The innovators. There are two types of innovators in aptech: organised groups and unorganised groups. Among the former are large industrial corporations, public and private consultancy institutions and charitable organisations. They have innovated hundreds of pieces of hardware, from bicycle-operated electricity generators to small rotary tillers. But the appropriateness of these innovations is undecided as they have not been tested on location. No overall inventory exists of such innovations. In all, the organised groups spend about $5 million per year on R & D in aptech, compared to $60 000 million that is spent globally on R & D in modern technology. Given this enormous difference in available resources (ratio of 1 to 12 000), it is obvious that aptech as developed by the organised groups will not make any noticeable impact in competition with modtech.

The unorganised groups fall into the so-called "informal" sector. They comprise small industrialists, individual innovators, artisans, craftworkers, farmers, traders and teachers. The pool of aptech that exists in the informal sector is vast, both in hardware and software. Its vitality and appropriateness is manifest in the vigour with which it has grown, often against competition from modtech, as for example the starch separation plant developed by a Phillipine small entrepreneur, first class razor blades manufacture from outdated equipment in Algeria, pump manufacture in Pakistan
and windmills for pumping out seawater from salt-making beds in Thailand, etc. There are thousands of such examples, but no overall inventory exists. They testify to the inventiveness and adaptiveness of local artisans, small entrepreneurs, etc. This source lies dormant, not being drawn into the national development efforts. The largescale import of modtech saps the self-confidence of the informal sector innovators.

The technologies already in use in the informal sector are much more viable than the untested and experimental technologies developed by organised aptech groups, especially by groups in advanced industrial countries.

Weaknesses of the innovation system. From the growth of modtech we learn that for innovations to succeed, R & D efforts must be tied closely to the production system and to market demand, through organisational, management and motivational links. This totality constitutes the innovation system.\(^6\)

In developing countries, the innovation system is weak, not only in modtech but also in aptech. The weaknesses as they affect aptech are: Lack of the equivalent of the industrial R & D; non-organisation of the enormous stock of traditional technology and inventiveness to withstand, or adapt quickly to, the competition from the modern industrial sector; absence of equivalent of industrial firm, with the drive to grow from smallscale to largescale production; absence of distribution and marketing system beyond the local market; lack of credits from banks and cooperatives; delays, obstacles and lack of incentives due to government bureaucracies and national planners, who prefer to encourage modern industry.

Non-egalitarian nature of innovation. The innovation process by its very nature is non-egalitarian. The minority who can afford to pay for the new innovation and required new inputs are the ones who benefit. The vast majority who cannot afford to pay lose out.\(^7\) An example: A peasant who lives in a tropical rain forest buys an improved version of a handcart.
If this new handcart breaks down because of the excessive loads piled on to it or cannot function in the rainsoaked mud tracks of the forest, the peasant loses the little savings with which he bought the cart. This is a risk he can seldom afford to take.

To overcome this inherent non-egalitarianism and the weaknesses of the innovations system, the risk taking must be socialised or the hardware must be made highly reliable and economically attractive. The criteria of low risk and high reliability, which makes aptech very complex from the engineering point of view, is not met by a wide range of existing innovations.

Community needs. The production of consumer goods for private individual consumption for which there is a substantial demand is taken care of by largescale modern industry and small enterprises in the informal sector. The provision of public services through largescale, national infrastructure is undertaken by the government. As apart from these "private" and "public" technologies, there is "community" technology which provides basic social and economic infrastructure to small communities, in particular in rural areas. Aptech groups and movements are concerned primarily with community technology, most of which consists of software in providing services like clean water, drainage, transport, primary education, health care, etc.

The innovations of aptech groups arise from the desire to meet community needs. However, the needs that the community itself identifies are not often the same as those pinpointed by aptech groups. The latter succeed temporarily in imposing their views on the former because of their relatively strong financial, technical and status resources but once they depart the community rejects or neutralizes the innovation. An example: Piped clean water was made available to the inhabitants in an African village to prevent the spread of waterborne diseases. But the villagers continued to drink water straight from the river, because it tasted so much better than piped water. The community has to be actively involved
in reaching compatibility in the identification of needs. In this, know-why is more important than know-how and know-what.

Having identified the needs, aptech groups innovate and develop the technology, but leave the manufacturing of the so-developed hardware to private and public firms.

Information. Organised aptech groups have a more important role to play in documenting and spreading information than in developing new technologies. They have to cater to three types of audiences: National policy makers, aid agencies, large industrial firms; extension officers, rural development agents, educators; small entrepreneurs, craftsmen, rural dwellers.

The information provided now through handbooks, documentation services, etc., is too general, too voluminous and too unspecific with respect to country, regions and problems to be really useful. What is required is detailed technical information about where products can be bought and at what price. Existing documentation and information services in advanced industrial countries are too expensive from the point of view of the user in developing countries. One piece of technical information costs about $150, i.e. equal to the average per capita annual income in many developing countries. But it is going to be even more expensive to supply information through information centres established in developing countries themselves, with their poor industrial base and communication infrastructure. The solution lies firstly in making information a free, or an almost free, public service (i.e. heavily subsidising it from public funds), and secondly let organised multinational rather than national groups disseminate information.

Small entrepreneurs, artisans, farmers, etc. do not make use of organised centres for information and documentation. So first of all one has to examine how they seek and spread information. Demand for information arises only when the conditions are favourable to small entrepreneurial activity.
Competitiveness of aptech. From a study of actual practice, one can draw important conclusions: Individual entrepreneurs are important in promoting innovation in aptech. To survive and prosper it must be economically and socially competitive with both traditional and modern technologies. Cooperatives and collective organisations are far less successful in competing, lacking motivation, and lacking administrative and technical skills. An example: In the field of small-scale sugar manufacture in India, cooperatives were a dismal failure relative to the private individual entrepreneurs. Co-ops generate mistrust among local communities through misuse of community funds and public subsidies for private purposes and political connections with the government.

Aptech faces competition at three levels: technical efficiency, economic viability, socio-cultural acceptability. But these criteria themselves keep changing with time. Two examples: Agricultural workers in an African country refused to handpick cotton, so machines had to be used. Small-scale labour intensive sugar production was profitable in Ghana for a few years, but as wages rose it was abandoned in favour of large-scale capital intensive production. Therefore the aptech innovation system has to be dynamic, changing to suit the shifting balances between the above-mentioned criteria.

Obstacles facing aptech. The advantages of modern imported technology constitute some of the biggest obstacles. These advantages lie in that these technologies are "well tested, can be purchased in packaged guaranteed form, installed with relatively little risk or delay, implemented and maintained with external technical assistance, and controlled from a central point". Other obstacles are as follows: Capital-saving aptech is likely to require more managers at various levels than capital-intensive modtech;
A severe lack of local technical and managerial staff who can, and have to, plan, design, implement, manage and operate the new aptech;
The suppliers of technology from developed countries (in particular the multinational corporations) are unwilling to invest in the developing and manufacturing aptech. The
reasons they give are that markets are too small, costs of innovation and development are high in relation to available profits, investments have already been made in existing modern technologies, customers in developing countries themselves show strong preference for "western" goods and locally manufactured goods with western brand names; Multinational corporations are primarily interested in developing new products for high-income markets, and not interested in simplified modern products for low-income markets, and they use capital intensive methods to a very large extent; Capital tends to displace labour because of regulations fixing minimum rates, taxes that employers have to pay in relation to the size of the labour force and the total wage bill, tax concessions on capital equipment and investment, subsidized interest rates for borrowing investment capital; Small farmers and small industrialists have considerable difficulties in getting credit, allocations of raw materials and intermediate goods, technical and managerial help.

Conditions for promoting aptech. The developing countries must be willing to accept the dual policy that while their high-income populations (a small minority) can continue to have access to goods and services of standards comparable to those obtaining in developed countries, their low-income populations (who constitute the overwhelming majority) have to be content with much lower standards.

Because of lack of public funds, public subsidies must be avoided. The drudgery that goes with labour-intensive work paid at very low rates is unavoidable and must be politically accepted.

In the long run, aptech will not be viable unless market forces and market competition are allowed to determine the prices of goods, services and factors of production. The following measures although extremely politically sensitive, have to be considered:
Increase in the supply of wage goods (e.g. food) to reduce their prices;
Limit wages paid by the government and the public sector enterprises to their employees, because these set the standards for the wages in the private sector;
Removal of the minimum wage rule, reducing wages to levels operating in the craftwork sector;
Limit social security;
Foreign exchange rates to be determined by market forces, without government intervention in the form of tariffs and restrictions on imports;
Increase in the tariffs on imported capital goods to raise their cost in domestic currency;
No ceiling on interest rates;
Elimination of tax incentives on capital investment and capital use in production;
Elimination of licensing of raw materials import, which discriminates against small enterprises;
Providing small farmers and industrialists with appropriate production technology, access to credits, physical inputs, technical and managerial services, markets for new or increased production;
Agricultural mechanisation to be introduced into small farms as well, if it leads to increased productivity, even in areas with surplus of labour;
Production of cheap, small-scale farm machinery for sale, or hiring out large-scale farm machinery at prices that small farmers can afford.

Mechanisms used by the World Bank. For political reasons, the governments of developing countries find it difficult to change their policies in favour of aptech. Therefore the advice of the World Bank will have only a limited impact. But the Bank can work towards a gradual change in their policies, during discussions on projects and by intervening directly in World Bank financed activities that are biased against aptech.
Mechanisms to be used by USAID to involve U.S. firms. It is found that the manufacture of simple modern products for developing country markets may prove fruitful to small U.S. engineering firms. Further, opportunities exist for involving U.S. firms on a case by case basis. So it is recommended that the following measures be taken:

Locate (possibly through banks) medium-sized U.S. companies to cater to specific identified aptech needs in developing countries;

Conduct surveys and in-depth analyses of how to make small U.S. firms participate in technology and management transfer, and encourage their direct involvement in small-scale industries in developing countries;

Arrange two-way exchange programmes between managers of U.S. and developing country small businesses to facilitate the transfer of technology and know-how;

Training and organisation programmes on an industry by industry basis for U.S. equipment suppliers, manufacturing companies and consulting firms, together with entrepreneurs from developing countries;

Give grants to U.S. equipment manufacturers to develop aptech;

Commission U.S. investors in developing countries to develop new designs for plants which are more labour intensive than present ones. If, having developed a new design, the firm in question decides not to use it, USAID would pay for the expenses incurred and obtain rights to the design to make it available to other firms. If on the other hand the firm decides to use the design itself, no reimbursement would be made.

Role of foreign aid. Governments in developing countries and aid donors from advanced industrial countries are showing growing interest in aptech. The resulting institutionalisation gives political legitimacy to aptech and makes more money available for experiments. One example is the allocation by U.S. congress of $20 million to USAID for promotion of aptech in developing countries between 1976 and 1978. Hundreds of firms in the U.S.A. are now manufacturing alternate and soft
technologies to cater to the demands created by the environmental-conservationist groups who have migrated from the town to the countryside. These firms are looking for expanding markets overseas.

There is a misconception among aid-giving governments and agencies that aptech is primarily a matter for development aid. In fact, the opposite should be the case. The philosophy behind aptech is that it should be almost entirely based on indigenous resources and indigenous innovative capability, generated by the developing countries themselves. There are indications that with respect to aptech the same kind of foreign dependency may grow up that is now the rule in modtech. Developing countries should act to prevent this, by erecting import barriers to protect their indigenous aptech.

A CRITIQUE

There is nothing approaching even a rough and ready definition of appropriate, intermediate, low-cost, alternative and soft technologies that is universally applicable. Even within any one given underdeveloped country (UDC) the definitions vary from place to place, time to time, overlap and mutually negate each other. This fundamental weakness severely reduces the validity and utility of these concepts. To give an example: The ox-drawn plough which is "traditional" in South Asia is regarded as "intermediate" in Tropical Africa, where it represents a big step forward from the hoe. Whereas it is "low-cost" in relation to the two-wheel tractor which is considered "intermediate" in Southeast Asia, the buying price and upkeep to oxen and the ploughs are certainly beyond the means of numerous peasants in tropical Africa. Its "appropriateness" is certainly called into question in tsetse infested belts.

The presentation of the case for aptech begins familiarly enough with the assertion that UDCs cannot, within the foreseeable future, increase the size of their modern industrial sectors to meet the development requirements of their entire populations. The assumptions behind this assertion are as follows: Most UDCs face similar constraints in resources
and manpower. Their political economies will continue to be geared principally to exporting processed primary produce (mineral and agricultural) and simple consumer goods to world markets. Mass mobilization of labour for building capital projects will not take place. The internal and external political situations will not dramatically change leading to revolutionary regimes which can radically alter the structure of their economies in favour of the masses. Of these four assumptions, the last three are largely unspoken but they are nevertheless there between the lines. The first one, about resources and manpower hogs most of the space.

Resources and the political imperative. It falsifies the picture to lump all UDCs into one category, and apply the above arguments equally to them. To begin with, there is the incontrovertible fact that in the space of the last 25 years many UDCs have managed to acquire sizeable largescale modern industrial sectors. And these sectors are growing.

There are many countries in Africa, Asia and Latin America which certainly have potential resources and potential manpower to build modern industrial sectors to the required structures and sizes in order to cater to the needs of their entire populations, provided certain political changes occur. Some obvious examples come to mind: Indonesia, Malaysia, India, Pakistan, Iran, Nigeria, Zaire, Brazil, Argentina, Chile, Mexico.

Where individual nations cannot hope to do so, regional groupings may well provide the answer, as for instance in the Central American republics, the Caribbean countries and the Francophone nations of West Africa. The groupings that have been attempted so far have failed conspicuously, e.g. The East African Community. The reasons for the failure are not the lack of resources or manpower, but the divergent politico-economic interests of the ruling classes.

The United Nations yearbooks show that the overall resource capabilities and feasibilities exist in the UDCs. That the political situation can be changed in favour of the masses in
the present era has been demonstrated in different continents under different contexts by China, North Korea, Vietnam, Cuba, Mozambique and Angola: the first two have already built up impressive modern industrial sectors, the middle two are on their way, and it can be confidently expected that the last two will follow suit.

Therefore the argument that most UDCs, whether individually or collectively, cannot, or will not, build up mass-oriented modern industrial sectors is not generally valid, unless one makes the quite a-historical assumption that there will be no successful upheavals in the status quo of internal repression and external imperialist control and dependence.

However, this is not to deny that there are a number of countries in the third world which do not have the resources to go it alone. And the same is true of countries in Europe.

**Capital-intensity.** The next major assertion of the supporters of aptech (hereafter referred to simply as "the supporters") is that capital intensive technologies have socially disruptive consequences. It is based on the old refrain that urban-based industries create expectation of jobs among the rural population, causing large-scale migration from the countryside to towns. Such industries, because of their capital intensity, cannot satisfy more than a small fraction of the demand for jobs. This leads to massive urban unemployment, growth of slums, increase in crime and great social discontent.

This line of argument is erroneous, for it confuses the function of the level of technology with the function of industrial growth as they relate to employment generation. In the next chapter I will give a detailed technical critique of such "choices of techniques" arguments. So here I will deal with the employment vs capital-intensity issue only very briefly.

Throughout the history of industrial capitalism, from late 18th century onwards, industries were not created because jobs
had to be provided. Rather, large-scale wage labour was created because of the needs of capitalist industry. The exigencies of competition, profit rate and capital accumulation have caused an unbroken continual increase in the capital intensity of technology. The reasons why the absolute number of industrial jobs kept growing in Europe and America, despite accelerating capital intensity, are to be found in the increasing volume of production and the increasing number of industrial establishments. Within the advanced capitalist system nobody seriously attributes to capital intensity the waves of unemployment that came with the periodic recessions in the capitalist system. Conversely, as recession ends and capitalist economy heads for a boom, and there are more jobs than available labour, this shortage of labour is not attributed to any growing labour intensity. In the centrally planned economies of the Soviet Union and Eastern Europe too one notes that technologies are continually striving towards higher and higher capital intensity, but nevertheless maintaining full employment in their respective economies. And in both systems, there are "socially disruptive" phenomena in towns like slums, crime and alcoholism, but the blame is not shifted to capital intensity.

In UDCs today the migration to towns has several causes, besides the expectations of industrial jobs. The principal cause is the breakdown in agricultural production and agrarian systems, the crisis having started as part of the colonial impact in the early part of this century, i.e. it predates by more than 40 years the growth of modern industry in UDCs. The secondary causes are: the need for essential social services like education and health care which are concentrated in towns; the positive cultural and material impulses of urban life which have always acted like magnets on the rural youth.

To drastically reduce their growing and enormous unemployment the UDCs need a twin pronged strategy: very high rates of growth in industrial and agricultural production geared to mass consumption and producer goods. Mere tinkering with capital-intensities in this or that branch will not do the trick. Halting the growth of modern industrial sectors to combat
urban migration and unemployment is like taking away vital medicine in the belief that it will cure the patient.

Innovative capacity. It is claimed that the growth of the modern industrial sector inhibits indigenous capacity for technological innovation. The evidence for, and the motivation behind, this line of argument comes from those instances where large-scale industrial manufactures have led to the demise of small-scale artisan production of the same goods, the latter being unable to survive in open competition with the former in price and quality. The prime examples are textiles, processed foodstuffs and domestic utensils. Let us recall that industrialization in Europe has had the same impact on European craftwork, but while destroying artisan production and artisan skills, it simultaneously led to a tremendous growth in indigenous capacity to innovate in the field of modern technology.

During the colonial era (roughly from 1860 to 1960), the unrestricted sale ("free trade") of European industrial manufactures in the colonies had the effect of destroying local production methods in some kinds of goods, but did not affect petty production in a number of other commodities, which continued to flourish as for example in pottery, ceramics, implements, tools and leatherwork. Today, in the post-colonial situation, the general pattern is the same, except that "free trade" has been replaced by import restrictions and local manufacture. While traditional methods and skills of production have disappeared with respect to certain goods, in others not only are they thriving but also undergoing constructive change under the impact of local innovation and adaptation. This is particularly true of East, Southeast and South Asia, North and West Africa. We will revert to this point later on when discussing the role of petty capitalism (the informal sector).

We would in fact argue that modern technology and modern industry have stimulated rather than inhibited the awareness of the need to innovate locally. Twenty years ago the UDCs were content just to import modern technology. But today, while
import continues as before, there is at the same time an increasing demand for acquiring engineering capability not only to repair and maintain machines but also to make machines. Those who have worked in the UDCs are struck by the strength of this awareness. Although far from being quickly translated into actual reality, this demand has led to the first tentative steps of action in the form of engineering faculties and technical schools. It will no doubt take another 20 years before a large proportion of the UDCs make their own modern industrial technology. But the historical process has begun. The psychological breakthrough came when the "classical" UDCs like China, India, Brazil, Mexico and Pakistan showed that they too could innovate and manufacture modern machines, both for internal use and for export.

**Petty capitalism (or the so-called informal sector)**

The informal sector is the name given by neoclassical economists in 1971 to what marxian political economy long ago identified and analysed as the petty commodity production mode in which petty capitalism plays a dominant role.¹⁰ (In the following, we will abbreviate the petty commodity production by the term "petty mode"). In the petty mode, artisans with diverse skills produce on their own (self employed), or as wage labour in workshops owned by petty capitalists (small entrepreneurs), a multiplicity of goods and services which are cheap enough to be bought by the majority of the population. The low prices of this mode are made possible by the extremely low wages paid to labour and by the use of local materials. The skills and technologies employed in this sector pertain to carpenters, blacksmiths, cobblers, masons, tinkers, vendors, cooks, butchers, tanners, etc. The workshops and small industries owned by petty capitalists also produce inputs into the modern industrial sector.

The petty mode in the urban areas has grown phenomenally in step with increasing urban population. On the one hand, the increasing demand by the poor majority (including the employed working class) for cheap goods and services which the modern
industrial sector will not provide them with, and on the other the "demonstration effect" of the highly productive technologies of the big capitalist sector, together spur on the petty capitalists and the craftworkers to make technological and organizational innovations. There is strong and striking evidence for this connection in many cities of Africa and Asia. The innovations made in the urban petty mode spread fairly quickly into the rural petty mode.

Access to resources in petty capitalism. Under the prevailing political conditions in most UDCs, the upper ranks of the petty bourgeoisie control access to and have the use of finance, raw materials, energy and information, none of which are really available in any meaningful quantity and quality to the poor vast majority of peasants and workers in per capita terms. Accordingly, the manner of promotion of aptech varies. Since hardware is not a problem to the petty bourgeoisie, it figures prominently in the innovations undertaken by them or that affect them. It is they who can take over the innovations developed by organised groups, whether local or foreign, which tend to concentrate heavily on hardware. The case studies and the publicity literature which aptech groups and movements have put out bring this out fairly clearly.

The one resource that is abundantly available to the poor majority is their own labour. Innovations that benefit them, and which they themselves undertake, have to be based mainly on the mobilization of labour. It is a truism by now that collective labour constitutes a big qualitative jump and can perform qualitative wonders that individual or family labour can hardly dream of.

Community needs and the role of labour. As the OECD admits, much of the aptech work done by groups and movements will have to be related the needs of small communities in the field of clean water, drainage, food storage, fighting pests, health care, primary education, etc. Organization of collective labour at the small community level is therefore the prime software that will be required. To accord with the publicly
professed aims of aptech movements, which is to generate among poor people an enduring drive and confidence to innovate for themselves, this mobilization of labour has to be initiated and led by members of the local community with a maximum of participation and a minimum of coercion. No foreign personnel or external bureaucrat however well intentioned, can achieve this. A necessary though not sufficient condition for leadership in this context is a thorough knowledge and personal experience of local conditions - political, economic and social. The necessary condition becomes also a sufficient one if one includes acceptability by the majority in the community.

The utter failure of even local bureaucrats to successfully mobilize labour on a fully participatory basis in a non-socialist context has been often demonstrated, as for example in the community development projects launched with much fanfare in India in the 1950s, and the Ujamaa village campaign in Tanzania in the early 1970s.\textsuperscript{12} There are bound to be individual exceptions to this, where dedicated knowledgable foreign personnel and local bureaucrats have initiated marvels of mobilization. But our concern is not with a few examples here and there, but with the viability of a strategy for hundreds of thousands of small communities in the UDCs. The same remarks apply to co-ops as well, whether they are marketing or production types.

This is also the standpoint taken by the OECD approach. One is forced to the inescapable conclusion that it is futile for aptech groups which are based abroad, or organised on national rather than local level, to attempt to involve themselves directly in "community technology".

**Function of aptech groups.** Since they can neither enter the petty mode as producers and distributors, nor contribute directly to the satisfaction of community needs, the only function that organised aptech groups can perhaps perform meaningfully is in the spreading of technically detailed information about hardware. This function does not extend to software, because software loses all appropriateness on being transferred from one place to another.
However it is known that petty capitalists and self-employed artisans do not generally use the existing organised information networks. Nor can they afford to pay the relatively high amounts charged - about $150 per piece of information. Thus, as the OECD approach correctly concludes, the job that was left to do is firstly to find out how information is sought and spread in the petty mode, and secondly devise ways and means of making information available at very cheap prices.

**State support for petty capitalism.** Of the numerous suggestions advanced by the supporters to promote aptech, the one that is realistic and viable is state support to petty capital. In fact, such support has been the order of the day for nearly a decade or more in a number of countries of Africa and Asia, examples are Senegal, Ivory Coast, Kenya, Zambia, Philippines, Pakistan, India. These governments have put into effect much of the anti-working-class strategy devised by the World Bank (which we outlined earlier in section 1 under "conditions for promoting aptech") : They are providing loans on soft terms to small capitalists both in industry and agriculture, protecting them from foreign imports, not intervening to regulate wages, prices and profits in the petty mode, and laying on subsidised infrastructure such as industrial estates, commercial vehicles, electricity, water and roads. And where government support is not forthcoming, the clamour for it is growing.

The alacrity with which the state in many UDCs has moved to support petty capital is readily understandable. The governments and the bureaucracies represent, and themselves belong to, the petty bourgeoisie who are increasingly gaining ownership and control of the means of production in the petty mode. It is a booming sector given the huge demand for goods and services which are much cheaper than those available through the big capitalist mode. Concomittantly, this petty mode is showing bursts of activity in local technological innovation.

Given the diversity, disorder and fierce competition in petty capitalism, we agree with the supporters that neither central nor local planning can direct and control the development of aptech in this mode.
One of the strongest arguments put forward by the supporters is that the petty mode creates far more jobs than the big capitalist mode, with its modern technology. But empirical studies indicate that the volume of employment in the former is roughly the same as in the latter.\(^13\)

**Innovation and inequality.** The supporters attribute to the innovation process an inherent non-egalitarian impact. This is because their analyses are restricted to those societies where only the powerful and the well-to-do have political and economic access to innovations through credits, material inputs, markets, etc. This is the "gatekeeper" model of innovation, where only those have the means to pay for the entry ticket demanded by the gatekeeper can use the innovations for their own gain. The Green Revolution is the classic example. Admittedly this is what happens in almost all UDCs. But there are a few socialist countries like China, Vietnam and Cuba where innovations are most definitely used for the benefit of the poor majority. In such socialist third world societies, innovations are egalitarian in their effects. It is a serious shortcoming of the supporters not to point out that the non-egalitarian impact of innovation arises from the class nature of society, whether in the UDCs or in the advanced industrial countries.

**Protection for domestic industries.** It is argued by the supporters of aptech that protecting domestic industries from international competition, and giving protection to the local subsidiaries of MNCs leads to artificial increases in the cost of labour, which is economically unsound and socially undesirable. It is implied that if this protection were removed, capital, foreign exchange and labour would naturally find their way towards economic activities that benefit the poor majority. This is part of the credo so beloved of the World Bank and goes by the name of "the Taiwan strategy".

If one takes the trouble of studying what has actually happened where the "Taiwan strategy" has been vigourously applied, as for example in South Korea, Thailand and Malawi, capital has used the low wage rate to increase production for export and
not for the local poor. But these are the "fortunate" cases. In most UDCs, the likely outcome of removing protection and support would be the collapse of the existing modern industrial sectors, throwing their economies back to the purely colonial situation of producing only raw materials for export to world markets.

It is hardly necessary to point out that countries in Western Europe and North America built up their national industries in the 19th century by erecting high tariff barriers against one another. The same strategy has been successfully followed in the first half of the 20th century by Japan, South Africa and Rhodesia, and over the last thirty years by Brazil, India and Mexico. Centrally planned economies of Eastern Europe too have afforded great protection to their own industries.

Export performance. While the 1960s were characterized by large-scale import-substitution industries, the 1970s are noted for the fact that MNCs, either by themselves or in joint-ventures with domestic capital (private and state), have set up a series of both labour and capital intensive large-scale industries in Asian and Latin American countries to produce consumer and producer goods mainly for export. This export drive has been successful from the point of view of international capital and the ruling classes in the UDCs. It is therefore puzzling, to say the least, to be told by the World Bank and other supporters of aptech that the export drive should be discontinued because the export products of UDCs are generally not competitive enough in international markets.

In fact, if the World Bank is consistent in its philosophy, it should be advising the advanced industrial countries to give up producing those goods in which clearly they are no longer internationally competitive (such as textiles, iron and steel, certain electronic and optical goods, etc), and remove all tariff barriers for imports of manufactures from UDCs, and lower the wages of their work forces. Why then do the UECD and the World Bank not prescribe this universal remedy of theirs
to the industrialised countries? It seems to us that the explanation lies in the fact that the World Bank and some "aid donors" are seriously worried about the political-economic impact on the capitalist countries of allowing a growing number of UDCs to sell their export manufacture (of increasing quality and quantity) at really competitive rates on the international market. One of the political tasks that these two organizations have been performing is to divert attention from the real reasons for alleged "non-competitiveness" by throwing one red herring after another across the paths of the UDCs. The UNCTAD debates bring this out clearly.

Structural change

If the objections to modern large-scale industry were genuinely motivated by a concern for the welfare of the poor majority (it is reported that the World Bank discovered poverty in 1975), the arguments advanced by the supporters of aptech are not convincing. What is required is not a halt to, or a slowing down of, modern industry, but a thorough structural change in modern industry to cater to the requirements of the poor - and since the poor are so many, what is imperative is a very rapid growth in such restructured industrial production.

Domestic capital and domestic markets. In many UDCs, considerable amounts of capital have been invested in mining and plantation agriculture. Mining capital belongs nearly entirely to MNCs, while ownership and control of plantation capital is spread between corporations and individuals, both foreign and domestic. These two sectors produce almost exclusively for export to the advanced industrial countries. To keep them going efficiently a lot of running capital is pumped in. The visible profits that flow out from the UDCs to the West, from mining, plantation and other related export activities, is estimated to reach $9 000 million by 1980 (at 1971 prices). It is estimated that visible outflows form about 10 per cent of the total outflow, the rest, 90 per cent, going out through invisible means, such as transfer pricing and multi-channel payments. Therefore the total outflow from UDCs by 1980 will amount to several times $9 000 million. Under such circumstances it is no good pretending that there is a scarcity of
domestically generated capital. Huge amounts of domestic capital are being generated out of the surplus value of labour in UDCs. It is not being accumulated within the geo-political confines of the UDCs, but outside.

Admittedly, it is very hard for UDC governments to retain much of this huge surplus within their own boundaries for reinvestment without at the same time exposing themselves to the real "danger" of MNCs not only pulling out but also preventing other foreign capital from taking their place. However, it may be possible to evolve strategies to gain the upper hand over possible economic blackmail by MNCs, for example by decreeing that minerals and plantation products will not be allowed to be exported in their raw form but only after they have been coverted into fully finished manufactures which both domestic and foreign markets demand. A further move would be to push mining and plantation capitals to reorient themselves towards domestic rather than foreign needs, such as mass consumption goods and producer goods for domestic use. But there is not even a whisper of such thoughts in the recommendations made by the World Bank, the USAID, the OECD and other assorted supporters of aptech.

Domestic skills. The expert studies commissioned by the World Bank and USAID show that labour intensive smallscale projects require a great deal more skilled personnel per unit output, both technical and managerial, than are available at present. The numbers required will be several times that presently employed per unit output in capital intensive projects, as pilot runs have shown in those industries where capital intensive bits were replaced by labour intensive ones.

Labour intensity means that on the technical side many more workers will have to acquire basic industrial crafts like turning, shaping and drilling on lathes and allied machine tools, welding, joinery, mechanical and electrical fitting, plumbing, etc. On the managerial side, it demands many more personnel with practical knowledge of planning, designing, implementing and supervising.
The situation is quite the reverse with highly capital intensive automated technology. Firstly, it has de-qualified skilled labour to a large degree. Secondly, it requires fewer managers, supervisors, engineers, technicians and skilled workers - the last category doing mostly routine repair and maintenance work. The largest proportion of employees in capital-intensive industries are semi-skilled machine attendants, who perform one or two repetitive tasks in relation to given machines and given points on the assembly line.

A number of case studies in different UDCs have revealed that modern industrial enterprises train on-the-job most of their routine repair and maintenance crews and almost all their machine attendants. The former take about two years to become proficient in their work, the latter from a few weeks to a few months. That being the case, the initial lack of either of these groups has not proved critical to the setting up of modern factories. However, what is essential for them is a small initial pool of managers, engineers and technicians with previous practical experience.

One has to determine, country by country, sector by sector, which alternative is more acceptable, feasible and beneficial in the allocation of resources for creation of skills: either training numerous people in basic industrial and simple managerial skills to start and run any number of small-scale labour intensive units, or having crash programmes to train small numbers of managers, engineers and technicians. It is quite spurious and misleading to argue in a blanket fashion as the protagonists of aptech do that more modern industries cannot be set up in UDCs because of present lack of sufficient numbers of skilled workers.

Boost to foreign firms. We have established that in a non-socialist context, outside resources, even in the highly unlikely event of actually reaching small communities in rural and urban areas, cannot promote community technology, because of the preponderance of software which only local people can develop. The case studies published in the OECD volume show
further that appropriate hardware loses most of its "comparative advantage" when transferred from advanced industrial countries to the petty mode in the UDCs. In addition, there is the self-evident dependency and debt burden that foreign aid and loans create, which is supposedly completely contrary to the professed aims of aptech. In the light of this, what is one to make of the apparently growing interest of the U.S.A., Holland and a few other countries in the West giving aid to promote aptech?

An accurate interpretation would be that these countries want to corner the potentially huge markets for small-scale industrial technologies, which at the same time reduce skilled labour content, because there will be a growing demand for such technologies in UDCs with small domestic markets and present lack of skilled personnel, in particular in Africa.

This interpretation gains force when we realize that USAID has set itself the task of getting private U.S. firms to develop and sell small-scale advanced technology to UDCs. The software it is promoting relates to this: outright grants to private U.S. industry for developing commercially viable small-scale capital intensive technologies, information flow unidirectionally from UDCs to the U.S.A., transfer of management techniques from the U.S.A. to the UDCs. The USAID is certainly not interested in low-cost things like animal and hand drawn carts, village grain storage, village water purification, etc.

Who benefits from appropriate technology?. Better wages and greater employment are not really the motivating factors behind the World Bank policies. To decrease the cost of production and increase productivity and profitability are its overriding aims, if need be by further reducing the already catastrophically low wages being paid to unskilled labour in UDCs. A revealing example is the World Bank's tentative shelving of labour intensive methods in road building, not because of the horrible drudgery it involves for the extremely low-paid labourers, but because capital intensive techniques are cheaper unless wages are further reduced to about $1 a day.
So who benefits? Certainly not the poor, under the present
political-economic configurations in non-socialist UDCs.
Aptech will benefit innovators in the petty mode, the
established and emerging small capitalists in agriculture
and industry, and perhaps most of all the business firms in
North America, Western Europe and Japan.

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CHAPTER II

A CRITICAL REVIEW OF CHOICE OF TECHNIQUES ARGUMENTS IN MANUFACTURING INDUSTRY

PREFACE

The industrial strategies being pursued in underdeveloped countries (UDCs) have revived debates between academics on
1. whether there exists a choice of techniques in manufacturing industry and
2. to what extent can manufacturing industry absorb more labour if it can be shown that there are economically efficient, or optimal, labour intensive techniques which can compete with capital intensive ones.

As part of its World Employment Programme, the ILO has published a book covering these two questions.¹ It consists of three articles of a general theoretical nature and eight empirical case studies. They are representative of the latest arguments being advanced for labour intensive techniques. Significantly, the book does not include any studies which are critical of the positions taken by its chosen collection of authors. Since the book has been issued under the prestigious insignia of the ILO, it may conceivably have some impact on the officials of some UDC governments. It is therefore important to take a close and critical look at it, which is what the present chapter sets out to do.

In almost all underdeveloped countries, urban unemployment is on the increase. At the same time, the industrial and service sectors, which are almost exclusively situated in urban areas, have been growing too. One of the many questions that arises is why have industries made such little impact in reducing unemployment? Two broad reasons are usually advanced: First, the absolute size and the rate of growth of the industrial sector are still too small. Second, creation of a large number of jobs is not one of the main purposes of the industries that are established.
It is now openly acknowledged by many, including the authors represented in the anthology under review, that maximisation of employment has not been, and is unlikely to become, one of the principal goals of the actually implemented industrial policies of the UDC governments. Given this political fact, is there anything that development economists can realistically do to persuade capitalist firms (so called entrepreneurs) and UDC governments to employ more people in the industries they set up?

The neo-classical economists who have contributed to this volume believe there is a way: since profit maximization is the overriding objective of most UDC industries, if one can demonstrate that, under the prevailing availability and prices of factors of production, the use of more labour and less capital is more profitable, then more employment may result.

LIMITATIONS OF THE METHOD, ASSUMPTIONS AND MODELS USED IN CHOICE OF TECHNIQUES CALCULATIONS

Method used. In neo-classical economic theory, which is used throughout this book, profitability is judged via economic efficiency, which in turn is related to maximization of output with minimization of production costs. As Bhatta points out in his introductory theoretical paper, in looking for economically efficient techniques which are labour intensive, one has a choice among four indicators, which are not mutually exclusive: labour productivity (output-labour ratio), capital productivity (output-capital ratio), share of wages in value added (value added-wages ratio), and capital-labour ratio.²

But capital-labour ratio, which is the most commonly used indicator of labour-intensity, does not by itself test economic efficiency. Therefore, one looks for those combinations of capital and labour, which, at prevailing interest rates and wage rates, minimise unit cost of production. Such optimal combinations are regarded as being economically efficient.

An indirect method that is often used for making these optimal choices of techniques is to evaluate the Constant Elasticity
of Substitution function (CES), which is an estimating form of the production function. CES links the capital-labour ratio to labour productivity. It is a measure of the substitutability of labour for capital, without sacrificing efficiency.

Realistic calculations of economic efficiency should be based on a number of inputs. But most of the calculations in the literature, including the present book, are done with very simplified models using only two factors - capital and labour.

In one kind of empirical, direct calculations the labour-productivity (output per unit of labour) and capital-productivity (output per unit of capital) of techniques are compared. If A has a higher labour-productivity than B, then for B to be economically efficient in comparison with A it must have a higher capital-productivity than A. Having classified techniques this way, one proceeds to identify those with least total unit cost of production, and in particular the wage rates (break even and shadow wages) below which labour-intensive techniques become competitive with capital-intensive ones. This is the procedure followed by Cooper et al. on the manufacture of cans, Pack on textiles, Baron on sugar and Stewart on cements blocks.

Of all the case studies, Baron on sugar is the only one that attempts to go beyond the purely "economic" cost-benefit analysis to a sort of "social" cost-benefit analysis. He tries to take social costs into account by using a shadow-price for investment (rather than the market price), which is inversely related to the social rate of discount. However, shadow pricing of wages is not resorted to here, because wage costs per unit of output are nearly the same in the two methods of producing white sugar in India.

In the CES calculations, one first identifies techniques that have equal efficiency for equal scales of production. Then one ranks them according to the amount of additional labour they can absorb, and correspondingly the excess amount of capital they can shed, if wage costs are raised by a small magnitude. The greater the capacity of a technique to absorb
additional labour in this way, the higher its value of elasticity. Gaude reviews several examples of such calculations and Della Valle provides one on copper and aluminium mining and refining.

Even to work these simplified models, a number of assumptions are made and a great many aspects neglected. We list them below, separately for direct and CES (indirect) calculations.

**Assumptions made.** In the direct calculations the assumptions are:

- Both capital and labour are homogeneous and undifferentiated. Most often only fixed capital and unskilled labour are taken into account, neglecting working capital (stocks of raw materials and finished products) and skilled labour, and non-labour inputs like intermediate products.
- Average earnings are the same across industries and countries.
- Perfect competition in the market for factors of production and final products.
- Output can be adequately measured in terms of value-added, neglecting the impact of changes in the physical volume of production.

One neglects:

- The effects of variations in capacity utilization across industries caused by a variety of reasons. For example an increase in shift work reduces the capital intensity of investment. Further, unused capacity raises labour productivity more than capital productivity.
- Differences in relative factor prices across industries.
- The effects of the size and organisation of the market for factors and products, the organisation of the labour force, government legislation and trade union pressure on wages.
- Role of monopoly in fixing value added, profits and wages.
- Distortions due to part-time and seasonal work.
- Variations in depreciation of capital goods across countries.
- Time patterns of output yields.
- Changes in capital or output which are due to non-technical effects such as applying better methods of work organisation to old plants.
In CES (indirect) calculations the assumptions are:
- Capital to labour ratio is independent of wages, labour productivity, and hence of factor proportions and scale of output
- Capital and labour are homogeneous
- Increasing returns to scale. This assumption is compatible with profit maximization, only if there is no perfect competition in the market for factors and products
- The same technological alternatives are available for all countries and all sectors
- Share of intermediate products in gross output is constant, so that value added becomes an adequate measure of the final output
- Wage rate has to be determined exogenously for international comparison of the same industry
- Firms will make the most economic use of factor inputs reflecting the actual prices prevalent in the market.

Limitations of major assumptions analysed. Some assumptions like perfect competition in factor and product markets, equality in average earnings over industries and countries, and independence of capital-labour ratio with respect to wages and labour productivity are so patently untenable that it is perfectly legitimate to reject calculations based on them. As to the rest, it is difficult to envisage real life situations where they would hold good, and the highest degree of scepticism is justified in examining results founded on them, as the authors themselves frankly acknowledge. Since the protagonists of choice of technique do not want their arguments to remain academic exercises pure and simple, but demand practical implementation by capitalist enterprises and UDC governments, we will take a closer look at some of the less drastic major assumptions:

Measurement and homogeneity of capital
As Stewart points out, there are insuperable theoretical problems about the measurement of capital within the neoclassical paradigm. 3 (Hence, we will refrain from making a critique from outside of this paradigm — for example, in marxian political economy capital is a relation of production and its examination calls for class analyses of social relations of production).
Although one talks about capital, what one is doing is not taking an aggregate measure of capital, but investment costs of techniques. Investment costs change with time, introducing two constraints: 1. One must have a reliable way of converting to comparable values investment made at different times. 2. The level at which one may hope to obtain reliable figures of investments made at different times is at the disaggregated level of the firms, and not at any higher level of aggregation such as a whole branch or sector. In practice, neither of these two constraints are properly allowed for.

In many industries, a large proportion of the investment costs are in raw materials and intermediate products, which go under the name of "working capital". This is neglected in most calculations, which assume that capital is homogeneous fixed capital, i.e. investments in machinery and buildings. How misleading this can be is forcefully illustrated by Baron's study on sugar production in India, where he shows that the choice between the capital-intensive and labour-intensive technologies of production is decided in practice entirely by the cost and supply of raw materials, i.e. price of sugar cane and the length of the crushing season.

Measurement and homogeneity of labour

There is a high degree of skill differentiation in the labour that is used in different techniques. In advanced capital-intensive techniques, most of the labour consists of semi-skilled machine operators with relatively few supervisors; the latter are highly trained skilled personnel with the task of supervising machines rather than men. In labour-intensive technologies, the labour spread resembles a slowly rising pyramid with a flat top, the unskilled category forming the base and the skilled category the top, with a relatively high number of supervisors who supervise both men and machines. Almost all enterprises in UDCs train their semi-skilled and skilled personnel on the job. This training introduces an investment cost into the measurement of labour, which is different for different technologies. Labour-intensive technologies have in general a higher absolute number of skilled workers than capital-intensive technologies, and
correspondingly may end up investing more in training. But by treating all labour as homogeneous unskilled labour, the empirical calculations are neglecting the considerable investment costs entailed in skills (so-called human capital) and severely distorting the measurement of capital-labour rations attributed to different kinds of technologies.

**Intermediate products**

A whole host of materials that go into manufacture as inputs are not in raw material form, but are themselves the final products of other enterprises. Examples are metal products, chemicals, plastics, synthetic fibres, paper products, ready-made electric, electronic and automobile parts awaiting final assembly, etc. Such manufactured inputs, which are called intermediate products, are themselves carriers of value added by labour in earlier manufacturing processes, whose labour intensity could well be different from the enterprise under consideration. In many UDCs, particularly of Africa, most of the intermediate products that go into import-substitution factories are imported from the advanced capitalist countries, and therefore represent products of higher capital intensity. Unless their labour or capital intensities are properly included through weighted averages, the labour or capital intensities of the final products would be highly unrealistic, because one would be neglecting the high investment costs that go into the purchase of the intermediate products. For example, the manufacture of pure cotton and pure polyester cloth occurs in one Tanzanian enterprise on the same kind of looms, which may lead one to construe them as being of equal capital intensity, but this would be to ignore the fact that the cotton yarn is locally produced by labour-intensive technology whereas the polyester fibre which is imported from Japan is highly capital-intensive. If one compares the manufacture of tyres and assembly of radios in Zambia, the latter appears much more labour-intensive than the former because of the larger number of semi-skilled workers employed to assemble the components. But this would be an altogether false conclusion, because the readymade radio components are of high capital intensity, imported from Western Europe. Comparisons between different industrial branches in the same country are therefore
meaningless unless the intermediate products are properly taken into account.

Effect of monopoly

In a great many UDCs, the production and marketing of goods are under the control of individual multinational corporations. Only one MNC monopolises fertilisers, another MNC soap and detergents, a third one cement, and so on. There is no competition. This has several repercussions: 1. A subsidiary of a MNC imports machinery, intermediate products and know-how from other subsidiaries of the same MNC based in DCs. Between them they agree to charge grossly inflated prices for the imported technology and inputs. Thus a much higher level of capital-intensity is achieved than is actually reflected by the technology under open market condition. 2. An MNC can more or less dictate the prices at which it will sell the final product inside the host UDC. This leads to a pseudo increase in value-added, a contribution in which neither machines nor workers have a hand. 3. MNC technology is highly specialised. Correspondingly, workers who are trained to operate the machines acquire the skill to perform one or two very narrowly defined tasks (say in steel-rolling). In a situation of considerable urban unemployment, these semi-skilled workers are not in a strong enough position to bargain for higher wages, because there is usually no other enterprise in the same industrial branch (e.g. steel-rolling) which wants to compete for their skilled labour, while for other branches (e.g. beer, footwear) their machine-specific semi-skills are useless. The upshot is that the wages that MNCs pay to the bulk of the labour force are considerably lower than would be the case if there were an open market in skills. So monopoly leads to pseudo capital-intensity, pseudo value-added and low wages.

RESULTS OF CASE STUDIES

The empirical studies presented in the book do not take account of the heterogeneity of capital and labour, and the impact of intermediate products and monopoly. In addition, each one of them adopts a number of other assumptions as well
from the above list. We present their results below. But the assumptions under which they are derived are rather far fetched and it would be hard to find a real life situation in UDCs which corresponds to them even approximately.

Further, Bhalla and Gaude caution us quite rightly that the higher the level of aggregation, the less meaningful results become. In descending order of aggregation we have first the CES calculations reviewed by Gaude, and Della Valle on copper and aluminium which are at the level of countries and sectors, then Pack on textiles at the level of branches, followed by the rest at the level of the firm. The most disaggregated study is due to Boon on metalworking tasks in Mexico. The report on the capital goods sector in Colombia is a brief descriptive history of the development of that sector, and not a study of choice of techniques like the other articles in the book. It is the odd man out and as such is not taken up in the present section.

Results of CES calculations

We recall that the higher the elasticity of substitution, the greater the ease with which labour can replace capital for the same degree of economic efficiency.

The countries studied are Argentine, Chile, India, Israel, Philippines, Nigeria and the U.S.A.

The elasticities of substitution are nearly the same for the manufacturing sector as a whole across a number of UDCs.

Comparative studies reveal that the average elasticities by industrial branches are about equal for the Philippines and the U.S.A.; this casts a doubt on the general hypothesis that elasticities in UDCs are higher than in the advanced industrial countries.

The estimates arrived at by time-series calculations, cross-section calculations and a pooling of time-series and cross-section estimates are highly contradictory and conflicting: -
For heavy industries, time-series give low elasticities, cross-section estimates give much higher values from 4 to 30 times the time-series ones, while the pooling of time-series and cross-section estimates give very low, almost insignificant elasticities. Examples of heavy industries: Basic metals, metal products, chemicals, textiles, paper and pulp, rubber products, non-electrical and electrical machinery, transport equipment, etc.

For light industries (like food processing, beverages, tobacco, etc.) cross-section estimates give 2 to 3 times the elasticities of heavy industries. No figures are available from time-series calculations.

All these estimates differ sharply from the direct estimates made by Clague in Peru, based on factory level data on capital-labour ratios and factor prices. He finds that elasticities are strikingly low for all industrial branches in Peru, for example, for light industry about 1/4 the values derived by cross-section estimates. Della Valle's study says that copper mining and refining in Zambia and Zaire have twice the elasticity and one-third the wages of U.S.A. Bauxite mining in Jamaica and Guyana is highly elastic in comparison with aluminium refining in U.S.A. which has a very low elasticity. The mining wages in Jamaica and Guyana are about 1/4 of the U.S.A. wages in refining.

Results of direct calculations

Making of cans in East Africa and Thailand

For products of comparable quality, efficient alternative techniques exist, some more labour-intensive than others. These labour intensive alternatives were evolved in Japan and are adaptions of the techniques prevalent in Western Europe and the U.S.A. in the 1920s. They are efficient at the low wages paid in UDCs.

The greater employment per unit of investment and employment per unit of output that relatively labour-intensive techniques provide as compared to most capital-intensive techniques differ
extremely widely according to product and country: - For kerosene tins in Tanzania, the figures are respectively 2 times and 2 times, while for round open-top cans in Thailand it is 300 times and 26 times. Between these two extreme cases there are a number of intermediate ones.

The wage costs of supervising personnel are highest for the two extremes of the most labour-intensive and most capital-intensive techniques, and lowest for intermediate technologies. The kinds of supervising involved are respectively supervising mostly workers, mostly machines, both workers and machines.

**White sugar production in India**

Purely economic cost-benefit calculations say that for a given amount of investment, small-scale open pan sulfitation (OPS) production generates 10 times the employment and 1 1/2 to 3 times the output of largescale modern mill production.

But if one does a social cost-benefit analysis at a social rate of discount of 10%, taking into account the cost of raw materials, i.e. sugar cane, which is nearly 70% of the total expense, and the length of the average crushing season in India which is about 150 days per year, then there is nothing to choose between OPS and mill production: they generate the same amount of employment and output for given investment, at same social costs.

**Cement blocks in Kenya**

In comparison with the most capital-intensive technique, the most labour-intensive one provides about 11 times and 4 times more employment per unit investment and per unit output respectively. Between these two extremes, a number of other techniques have also been considered. Compared with the two sets of more "typical" techniques, the most labour intensive technique gives the figures 3 and 2, and 6 and 2, per unit investment and unit output respectively. As scale of production increases labour-intensity decreases and investment-labour ratio increases. Transport costs being high, scale of production is decided by how far or near the market is. When producing at full capacity, the total cost of production per block
is lowest for a "typical" capital-intensive technique and highest for the most labour-intensive; the former is one-fourth the latter.

Hand driven techniques require less investment per output than power driven techniques. The operation of the cement block making machine is only one stage of a production process consisting of many stages. When the whole process was considered and the choice of technique at each stage was examined, it was found that the choice at one stage largely determined choice at another stage in such a way that techniques at different stages had the same character.

When the choice of building material was extended from one product namely cement-blocks, to cover a number of other possibilities, such as mud and wattle, sun-dried clay blocks, bricks, stone, timber, pre-cast concrete panels, it was found that the choice of techniques was widened quite a lot.

**Metalworking in Mexico**

Of the 88 metalworking tasks considered (on lathes, drilling machines, etc.), there were no alternative technologies for 33, i.e. only one kind of machine for each task. Among the remaining 55 tasks, some showed no choice of techniques, some revealed themselves to be predominantly sensitive to scale of production, some to variations in factor prices, the biggest number being sensitive to both scale and factor prices.

For products with unusual and irregular physical shape, choice of techniques was very small. The choice was wider for products with regular and usual shapes, but increase in scale favoured capital intensity. For the most common of shapes, only one technique proved optimal, i.e. no choice at all.

**Second-hand machines**

Both Cooper et al. and Pack have looked into the possibility of whether used equipment proves to be an efficient labour-intensive alternative in textiles. Cooper and his co-authors have studied second-hand jute textile machinery actually operating in Kenya, while Pack examines the usefulness of used
equipment for cotton and synthetic fibre textiles based entirely on U.K. data.

Second-hand machines are not just used machines, but used machines which have been dismantled, transported and re-installed - it is very important to bear this difference in mind, because dismantling, transporting and reinstalling leads to further deterioration. Based on the theory of used machines, Cooper et al. argue that if the following assumptions are satisfied, then capitalist firms in UDCs will find it more profitable to employ second-hand machines imported from DCs:

- The lowest possible unit costs are being paid to factors of production
- The rates of output, machine productivity and labour productivity are the same in UDCs and DCs
- Transport, installation and maintenance costs are no higher than for new machines
- Rates of interest are higher and wages are lower in UDCs than in DCs.

We claim that in practice, none of these assumptions hold, except the one on low wages. In fact, the opposite assumptions are valid for most UDCs.

The result of the Cooper study are:

- The above assumptions do not hold for Kenya, except the assumption about low wages
- The mistakes that are generally made are in optimistically overestimating the output-investment ratio of second-hand machines. These mistakes are very costly, because firstly investible surplus is used up in inefficient technology and secondly this loss of investment makes second-hand machinery in effect more capital-intensive than new machinery
- Second-hand jute machinery in Kenya provides 3 times the employment of new machinery for the same investment
- Risks and uncertainties associated with second-hand machinery are always much greater than in the case of new machinery.

Pack's study does not examine the validity of the above four assumptions in any UDC, but just assumes them to be valid,
which is highly unrealistic to say the least. Like Cooper et al, he too uses a simplified two factor model with homogeneous capital and homogeneous labour, and uses the least total unit cost of production as the criterion for choice. He finds that second-hand equipment presents an efficient labour-intensive alternative to new machines, provided "realistic" break-even wages and interest rates are assumed: At a break-even wage $800 per annum and 20% interest rate per annum a 1956 spinning plant and Lancashire type loom would together provide about three times the employment of a 1968 spinning plant in combination with the most modern weaving loom, namely the Sulzer - in absolute figures, 8224 and 2633 respectively (this break even wage is about twice the average wage currently paid to textile workers in India and Pakistan).

However, Pack admits that the labour-intensive second-hand equipment requires a much greater number of skilled workers than the latest capital-intensive technology, and if there is a lack of skilled workers as is usually the case in UDCs, the output of the second-hand equipment goes down to levels at which it loses all advantage against new machines.

**Indirect employment**

Krishnamurthy says that if one is concerned with identifying techniques which generate greater employment, it is just as important to consider possibilities of creating indirect employment as direct employment, because the proportion of the indirect component may be greater than the direct component in total employment created. Industries which produce large outputs and large direct employment may not necessarily be those which yield large indirect employment.

To estimate the magnitude of indirect employment that inter-industry links generate, one has to know two things: first, the relationship between the composition of final demand and structure of output, second resource implications of alternative choices in composition of final demand.

The method used is the static input-output model of Leontief, with the Leontief assumption of constant capital-labour and capital-output ratios, for given sector and scale.
Further, one makes the following assumptions:
- There is no choice of technique in production. For each commodity, there is only one technique
- Each industrial branch produces only one commodity
- Inputs are fixed proportions to outputs
- All external economies and dis-economies are discounted
- No room allowed for the non-occurrence of anticipated expansion in output and direct employment.

So what one is actually investigating is the effect of final product choice (i.e. alternative patterns of final demand) on the use of factors of production and the structure of output. It is obvious that most of the above assumptions are highly unrealistic, and calls to question the validity of the model.

The importance of differentiating between the situations on the one hand of going from under-employing jobs to fully-employing jobs, and on the other of just creating more under-employing jobs, in agriculture, is illustrated with the input-output study that Iftikar Ahmed made of the Bangladesh economy of 1964-65. Denoting the latter as the "unadjusted" and the former as the "adjusted" situation, one finds that the impact of this "adjustment" in agriculture is quite dramatic in altering the ranking of sectors by total employment generation. In the "unadjusted" case, the ranking was, in descending order of total employment: agriculture, industry, trade, construction, government and services, transport, electricity and gas. After "adjustment", agriculture goes to the very bottom of the list after electricity and gas, while trade and industry swap places with the rest retaining their placing. In the process, agriculture "loses" about 10,000 under-employing jobs, industry about 2,500, and construction about 1,800. This has obvious implications for policy makers when deciding on employment generating policies.

Other empirical input-output case studies to which Krishnamurthy points are rankings of different sectors on the basis of employment potential per unit of final demand (including indirect employment) and direct employment per unit of output. It is found that for the Philippines the rankings are very
close, while for India they are not close at all - the correlation is very low. In other words, nothing decisive can be said about indirect employment effects at the present stage.

Krishnamurthy claims that in the choice of public works, indirect employment effects are ignored. He cites examples from India, where certain public works are not entered into by the provincial and the central governments on the grounds that 96% of the total cost goes to raw materials and establishment, and very little to direct employment. He argues that the indirect employment effect of this expenditure on raw materials and establishment may be quite high. He raises the following pertinent question: If maximisation of employment per unit of expenditure is the aim, which is better: large-scale construction work, or subsidies to small-scale labour-intensive rural industries which make fuller use of capital stock and rural skills? This question is certainly worth investigating, in view of the fact that the top ten branches in terms of total employment per unit of final demand in India and Philippines are small-scale, labour-intensive agro-processing industries.

CHOICES ACTUALLY MADE BY FIRMS AND GOVERNMENTS

In the manufacture of cans, textiles, sugar, cement blocks, in the mining of copper and bauxite, and in the use of machine tools, the authors find that there is no correlation between the theoretically optimal labour-intensive choices their calculations reveal and the actual choices made by capitalist firms. They discover that in the UDCs, both the MNCs and the non-MNCs invariably opt for highly capital-intensive, standardized new technology. The same is true for the capital goods sector in Colombia, which began to grow in the 1960s under the protection of import barriers; at first, this sector made poor copies of imported capital-intensive equipment, but under the incentives of the export promotion policy of the late 1960s and the availability of the big Andean Pact market, designs improved rapidly. Today the Colombian capital goods sector satisfies the domestic demand for, and has a vigorous export of, highly capital-intensive technology in
iron and steel, chemicals, petroleum, petrochemicals, woodwork and building materials.

For sugar production in India, if the cost of sugarcane and the length of the crushing season are included, the calculations show that there is nothing to choose between largescale modern mill production and small-scale OPS production. Both have same unit costs. This is confirmed by the geographical situation of the plants that already exist and that are still coming up, which reflects the patterns of availability of sugarcane.

In Kenya, for some building materials which the high-income groups buy, capital-intensive techniques are used. Similarly, for some materials there is a preferred connection between low-income and labour intensity. However, this is not a necessary connection. Counter examples exist. For instance, high-income groups buy highly labour-intensive products like stone and timber building materials, while some low-income groups purchase capital-intensive bricks.

Explanations advanced
The book tries to explain along the following lines the complete indifference shown by capitalist firms and UDC governments to what the authors claim to be economically efficient labour-intensive alternatives:

- Decisions are made by certain ignorant and/or imprudent individuals in the firms, in wilful disregard of the opportunities and constraints provided by local factor costs, skills, markets, information, etc.
- Standardized capital-intensive technologies produce high quality goods, speed up diagnosis in case of breakdowns, simplify repair and cut down operating costs.
- Choices by MNC subsidiaries are strictly guided by the MNC parents who insist on the latest technology, especially if the firms are vertically integrated.
- Large firms have easier access to credits, reducing the cost of capital for them.
- Managers, engineers, chemists, accountants, etc. are professionally biased towards highly sophisticated technology.
National pride is also involved.
- Machines are easier to manage than workers. They don't demand higher wages, and don't go on strike.
- Government regulations and trade union pressure make it virtually impossible to dismiss or lay-off workers in many UDCs. Further, firms are under pressure by governments to increase their employment by a certain percentage of their existing labour force, irrespective of the fact that it leads to inefficient overmanning. So the smaller the number employed initially, the better it is for the firms in the future.
- Domestically produced capital-intensive technology saves and earns foreign exchange, producing high quality goods for competitive internal and external markets.
- Lack of information about, and lack of confidence in the performance of alternative technologies.
- Lack of intensive promotion campaigns to get manufacturers and users interested in labour-intensive alternative.
- Second-hand machines are not bought because of the following risks: equipment deteriorates during dismantling, transporting and reinstallation; variable costs tend to become so high as to make production unprofitable; present lack, and future drying-up of spare part sources; problems of technical assistance in installing and maintaining the machines; heavy maintenance costs; technological advance in certain branches is so rapid that even relatively up-to-date and new second-hand equipment becomes unprofitable soon.

Suggestion for action
The authors believe that the following measures will improve the chances for use of labour-intensive techniques:
- In the public sector, the UDC governments should explicitly prescribe social cost-benefit analyses in project appraisal, insisting on employment-increases as a criterion.
- UDC governments should intervene in the market to: increase the cost of capital through higher interest rates, decrease the cost of labour through lifting wage regulations, make capital-intensive products more expensive than labour-intensive products.
- UDC governments should establish (i) institutions for the collection and dissemination of information on choice of techniques (ii) training schemes which will create a pool of technical and managerial personnel who can judge the opportunities, risks, advantages and disadvantages of the different techniques, second-hand machinery, etc. (iii) procedures for decision making which favour appropriate choices from within the existing stock of techniques (iv) machinery for planning and organising the implementation of such choices once they are made (v) demonstration centres (so-called centres of excellence) where under conditions of actual production the profitability of labour-intensive techniques can be displayed to capitalist firms and (vi) massive R & D facilities for developing appropriate techniques where they do not already exist, in particular allocating a high proportion of R & D funds to innovation and problem-solving in small-scale production in the informal sector.

CONCLUSIONS

It is clear that there are some technologies which generate considerably more employment than others in the production of a number of consumer goods of comparable quality. However, the authors of the case studies claim to have gone further and demonstrated the existence of labour-intensive techniques which have equal, or even greater profitability than capital-intensive techniques for products of similar quality, at prevailing prices for factors of production. This claim we simply reject: the calculations have been done with such highly simplified models and under such unrealistic assumptions that their practical validity is open to question.  

The merit of the book lies precisely in showing by negative example how unreliable all such calculations are, how difficult it will be to improve them even marginally, and what pitfalls they constitute even for those national policy makers, who swear by profitability.
That being the case, we cannot share the amazement of the authors at the fact that the choices that capitalist firms make are so very different from the choices the book arrives at.

It is hopeless to attempt to persuade capitalist firms and governments in UDCs to employ more people in their industrial firms on the strength of un-proven claims that labour-intensive techniques are more economically efficient than capital-intensive ones under the present circumstances in UDCs. Why should they bother to change, when they are already making huge profits anyway?

It is rather amusing to note that the suggestion for action made by the book is flatly contradictory to the neo-classical ideology of its authors - it calls for massive state-intervention in the market for factors and products to make big-capitalist industry employ more people, and to boost petty-capitalist small-scale production (informal sector).

The important questions are therefore: Why are most UDC governments in practice not really interested in rapidly creating more employment despite the lip-service they pay ad nauseum to this objective? And where a very few UDC governments are really keen in achieving the objective of full employment, what are the forces, national and international, that hinder them? These are the questions that merit studies in depth. And not more pointless juggling with factors of production.

NOTES AND REFERENCES

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For a masterly review of the debate on, and the pitfalls of, choice of technique theories, models and calculations, see Sutcliffe, R.B., Industry and underdevelopment, London 1971.

For further details, see:


