

SOME PROBLEMS OF "APPROPRIATE" TECHNOLOGY AND TECHNOLOGICAL TRANSFER

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INTRODUCTION

IT IS TRUE that development, which I define as economic growth plus institutional and societal change, has other impetuses, yet "the greatest single impetus to economic growth is technological change which gets translated into goods and services—new goods and services and cheaper goods and services" [3, p. 69].

Thus, the best brief definition for the root cause of disproportion between demand for and supply of labor in poor countries is the disproportionate rate between population increase and all available technology. Without going into a lengthy description of traditional technology in the poor countries, let it suffice to say that, at best, it is the first in a continuum of technological progress. In fact, with few exceptions, in terms of indigenous creation and utilization of modern technology, they are pre-technological societies. In terms of the population, it has been estimated that an average poor country has a rate of population increase (with a higher rate of falling mortality and an increase in working population) of between 2.5 and 3 per cent per annum, in some countries even higher.

It is also known that the corresponding figure for a typical rich country is 1 per cent, in some cases even less. In this case, we have a disproportion of at least three to one, in the sense that, over time, the typical poor-country economy with a given population is expected to create many more employment opportunities than a typical rich economy with the same population, despite the extremely low level of scientific and technological development of the former.

I. THE QUESTION OF "APPROPRIATE" TECHNOLOGY

Each new stage in the economic development of the Western societies and Japan has been ushered in by technological transformations which took place in response to certain stimuli. In other words, the changes were mostly, but not exclusively, evolutionary and at each point in time mainly related to the relative level of sophistication and organization reached by their economies. In the Third World, the technology used in the few heavy industries is usually not different from that of the technologically advanced rich countries. This type of "technological transfer" has been severely criticized, and I will look at this

criticism in this section. I feel that there is nothing inherently obnoxious about this from the point of view of sustained long-term economic growth.

To break what H. W. Singer has called "the vicious circle of development," it is agreed that deliberate policies of shifting investment to the purposes of employment creation, relief of poverty, and reduction of income inequalities are necessary and there should be a selection and effective implementation of more "appropriate" technologies.

Julia Porter and Alfred Latham-Koenig of the Intermediate Technology Development Group in London (headed by E. F. Schumacher) have tended to interpret this postulate for "appropriate technology" to mean that developing countries, which they rightly regard as being at a low level of development, must also have "corresponding intermediate levels of technologies" [9, p. 43]. That is, a technology lying midway between primitive and utterly rudimentary gadgets such as hoes, and highly sophisticated, modern scientific technology as in the industrial structure of the economically advanced nations.

Those like the typical Soviet economists, who take the side of modern and advanced technology ("capital-intensive technology") in this controversy say: (1) that the building up of an industrial sector employing the most modern and advanced technology is the linchpin of economically developed countries, and of countries determined to take their place as rapidly as possible among the industrialized nations; (2) that it is advisable to invest with the future in mind, and that any machines and equipment which are not of the latest design are likely to become obsolete more rapidly; (3) that modern and advanced technology has a way of exposing those who come in contact with it to the forces of change and development, thus exerting modernizing influences on the ways of lives of the society and, in particular, enabling management and workers to acquire the technical skill and knowledge that are indispensable to a modern economy; (4) that industries which have the greatest growth potential are those that employ modern and advanced technology; (5) that a high degree of capital intensity allows much profits to be made and a large proportion of such profits to be plowed back for the promotion of further growth.

The proponents of intermediate or "labor-intensive technology" for the low-income countries argue: (1) that advanced industrial technology has developed in response to the needs of industrially advanced countries with large markets, relative abundance of capital, and, above all, sophisticated entrepreneurial and managerial skill as well as a shortage of labor; (2) that the transplantation of modern advanced industrial technology to countries where it will have to operate under conditions for which it was not designed is likely to be an expensive mistake; (3) that it is not advisable for countries to make a sudden, sharp break with the past, but rather build on the existing foundations, in order to develop and adapt traditional skills, knowledge, and techniques; (4) that in cases where capital is scarce, capital-intensive technology may mean concentrating it in a few large plants, while keeping the rest of the economy starved. That exacerbates the dualistic characteristic of economics and societies which operate within a low-level equilibrium, thus sharpening the contrast in living standards, oppor-

tunities, and outlook between the modern and the traditional sectors and limiting the number of people that can be absorbed into the modern sector and exposed to its modernizing influences; (5) that if capital-intensive technology enables a few large, modern plants to make big profits this may not mean that the total profits, for the economy as a whole, are necessarily greater.

Most Western-oriented economists seem to subscribe to the opinion of the proponents of intermediate or labor-intensive technology for the developing countries. This preference for low-level technology, it is claimed, is buttressed by the interactions on the factor markets which influence the decisions of entrepreneurs with regard to their choice of production techniques, as illustrated by Table I. But, like law, economics is an ass.

The arguments in favor of intermediate or labor-intensive technology, especially in view of the overwhelming nature of the unemployment problem, are logical, but it seems essential to point out that the term "appropriate technology" has invariably been applied by its proponents in regard to the entire economy of developing countries without sufficient distinction made with regard to specific projects in a given developing country. There are projects which, owing especially to their inherent operative nature and also to their optimum factor proportion as determined by factor markets, do not easily lend themselves to as sufficient a degree of labor substitutability in the production processes as

TABLE I
FACTOR MARKETS IN LESS DEVELOPED ECONOMIES
AND CHOICE OF TECHNIQUES

Factors	Firms	
	Group I	Group II
Domestic factors:		
Labor		
Unskilled at legal or below legal rate	A+	A+
Skilled	A-	A-
Supervisory	A-	A-
Capital		
Short-, medium-, and long-term funds	A-	A-
Foreign factors:		
Labor		
Skilled	NA	A-
Supervisory	NA	A-
Managerial and technical	NA	A-
Capital		
Short-, medium-, and long-term funds	NA	A+
Optimum factor proportion	Capital-saving	Capital-intensive

Source: This is a modified version of the figure presented by Guy Pfeffermann in his "Men and Machines in Africa," *Finance and Development*, Vol. 11, No. 2 (March 1974), p. 18.

Note: A: firms have access to factor, NA: firms do not have access to factor, +: abundant, -: scarce.

one would rather prefer from the viewpoint of *socially* optimum factor allocation.

Thus, while modern and relatively advanced technology may be "appropriate" in industrializing subsectors such as the oil and production goods industries such as basic iron and steel, petro-chemical, building material, and construction, intermediate or labor-intensive technology may apply more to areas such as certain subsectors of agriculture, medium and small-scale or "cottage" industries, and the services sector [6, p. 438].

In any case, if we accept that only intermediate or labor-intensive technology is "appropriate" for developing countries in all the sectors and subsectors of their economies, are we then proposing that other "growth industries," some of which are heavy industries, must be neglected simply because investment in them would, as is often the case, involve more modern, advanced technology? If this were so, the Soviet Union and many developing countries today would not have had the opportunity to exploit and utilize (in some cases, with the assistance of foreign technology and funds) natural resources such as mineral oil and copper whose products have astronomically raised the foreign exchange earning capacity of these countries, and therefore increased their ability generally to execute larger parts of their development programs than hitherto.

In addition, it must be conceded that some countries of the Third World are increasingly in the position where they can provide indigenous factor counterparts—skilled labor and capital—which, in Table I, are characterized as "foreign factors," that is, in addition to the availability of raw materials in some cases.

This goes a long way to refute the argument that the use of large and modern technology must concentrate profits in few hands and exacerbate income inequalities. This is more likely to happen if the private sector owns such plants. But the state, if it controls such profits or a large part thereof, is more likely to be in a position to redistribute them through the expansion of social and economic infrastructure, and through the establishment of labor-intensive and rural-based development projects.¹

It may be instructive to know, in passing, that during a recent seminar on "The Management of Public Enterprises" organized in Ibadan, Nigeria by the African Association for Public Administration and Management (AAPAM) attended by experts from many African countries one major point of consensus was that, while effort must continue to increase the performance of public enterprise, the too-prevalent tendency of deriding public enterprise in Africa was wrong, because both by comparison to indigenous-managed private enterprises and to government itself, many public enterprises in Africa have not performed badly, especially considering the regulatory (legal) and social situation in which they operate [4, p. 19] [7, p. 83].

¹ This could be one reason why most governments of developing countries now insist on effectively participating in ownership and operation of large industries and other concerns such as banks and insurance companies which hitherto were invariably owned and run by private foreign entrepreneurs.

It must also be pointed out that the labor-saving heavy industries, although they utilize sophisticated technology themselves, do induce smaller ancillary industries and services, usually under control of the private sector. This invariably takes advantage of the availability of cheap labor.

Thus, the multiplier effect of capital-intensive industries can be assured to a large extent and in a number of ways. Thereby, national social objectives of employment creation and dispersion of income will receive a good measure of attention.

All this goes to show that rather than nurse dogmatic opinions of technological panaceas for developing countries, a healthier and more rational attitude it would be for these countries to strive toward indigeous creation and adaptation of technology on all fronts while, placing high premium on investment and other policies for directly or indirectly creating employment, to relieve poverty and reduce income inequality. In other words, both advanced and intermediate technology can efficiently coexist in a developing economy on a complementary and not competitive basis. The relative proportion of each at any given time is of course a question of the realism of planners and decision-makers in regard to resources and circumstances of the individual country.

For instance, the Second National Development Plan (1970-74) of Nigeria boldly recognizes the necessity "to promote expansion of the intermediate AND capital good industries" but the planners and the government are, at the same time and in regard to heavy industry, "not oblivious to the problem posed by the relatively low economies of scale under present Nigerian conditions" [5, p. 144]. Thus, the government intends to overcome this problem not by forgetting about building heavy industries that make use of modern and advanced technology using local raw materials, but rather, by giving greater support to those capital good industries seeking additional markets for their products outside Nigeria, in order to raise their scale of operations [5, p. 144].

This point obviously underscores the necessity for poor countries to strive towards the establishment, in various regions or sub-regions, of their own economic communities, so that optimum utilization can be made of the economic and technological advantages of widened markets.

II. TECHNOLOGICAL TRANSFER THROUGH INDIGENOUS TECHNOLOGY CREATION

Modern technological development is not possible without adequate facilities for research, development, training, and technical servicing. A proper infrastructure and institutional base will have to be built in order to ensure proper identification, selection, modification, transfer, and development of technologies.

Therefore, one major area where the advanced countries should show more interest is the financial and technical support of agencies in the Third World which have been or will be created for research and development in order to

find out what type of technology is most suitable for the various facets of technological progress.

Although the less developed countries hold about 70 per cent of the known natural resources for non-centrally planned economies, they themselves are estimated to consume less than 30 per cent of these resources. Besides, their combined share of the group's research and development expenditure, undoubtedly one of the major indices of the level of scientific and technological advancement, is at present about 2 per cent. The United States and others in the Organisation for Economic Co-operation and Development (OECD) spend about 70 per cent and 28 per cent, respectively.

An example of a developing country's agency established for research and development is the Nigerian Institute of Industrial Research at Oshodi (NIIR). Another is the Projects Development Agency (PRODA), Enugu, East-Central State of Nigeria. Some objectives of PRODA are: (a) where necessary to develop projects from laboratory or design stage through pilot schemes to mass production of prototypes; (b) to technically analyze projects developed at the pilot stage; (c) to publicize proven projects including plant, equipment, and products; (d) to develop standards, both for manufacturing processes and the quality of the goods to be used by projects whose viability has been demonstrated.²

The agency's primary objective is the adaptation and application of research, known processes, plant, and technology to local conditions in a new approach to the problems of industrialization, using local raw materials as often as possible. PRODA's aim is not only to discover new things but to adapt and apply existing scientific research and workshop or field techniques in logical combinations so that local industrial problems can be solved and local economic circumstances improved.

This is what J. A. Schumpeter calls the concept of "Induced Innovation" which he uses to denote "those additional improvements which present themselves in the process of copying the first innovators in a field and of adaptation . . ." [10, p. 76, footnote 1]. For instance, Japan buys technologies outright in most cases after careful selection and develops them according to its needs before use. According to H. A. B. Parpia, "it is estimated that Japan spends \$7.00 on research for every dollar worth of technology imported. Without such competence being built, the full benefits of technology transfer cannot be derived" [8, p. 100]. Major emphasis is thus placed on applied technology. NIIR and PRODA are not the only institutions that Nigeria has established for technological research.

In comparison, the situation in India is geared towards a more conscious national policy of home-based industrialization (technological self-reliance) than in Nigeria. After political independence, India proceeded to set up a wide network of scientific institutes for work on industrial, power, and construction development. These include the National Chemical Laboratory of India, the National

² For more details, see East-Central State of Nigeria Edict No. 11 of 1971.

Physical Laboratory of India, the National Metallurgical Laboratory, the Fuel Research Institute, the Central Glass and Ceramic Research Institute, and the science and engineering faculties of India's universities. In addition, a great deal of work is being done at the Atomic Research Centre near Bombay, the results of whose research could, depending on the priorities of the political leadership, be profitably used for industrial purposes.

In the area of agricultural research, there is the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria. IITA is seeking, with the assistance of a multinational corps of scientists and engineers, to develop new high-yield seeds and varieties of staples of the African diet, and it is also testing new farming systems to raise both soil productivity and the amount of land under cultivation.

There are similar institutes in other parts of the Third World. The best known, perhaps, is the pioneering International Rice Research Institute in the Philippines, where the now famous "miracle grains" were developed that sparked the so-called green revolution in South Asia, Latin America, and elsewhere. Also in this link are: the International Centre for Tropical Agriculture in Colombia concerned primarily with improving tropical livestock production; the International Crop Research Institute for the Semi-Arid Tropics at Hyderabad, India whose purpose is to raise yields of sorghum, millet, and other crops adapted to the conditions of the semi-arid tropics; the International Potato Research Institute in Peru; and the Asian Vegetable Research Centre in Taiwan. Apart from practical research, these and other institutes, centers, and agencies help to train specialists in the national economy.

PRODA and IITA-type organizations must be regarded as catalysts for self-sustaining technological progress, indispensable to developing nations if rapid home-based industrialization is to be realized. The national technically educated intelligentsia and the national scientific base in the form of specialized research institutes and laboratories are bound to be a powerful factor in the economic development of the present low-income countries, provided however, that the problem of the effective dissemination and application of research results is solved.

I want to emphasize that much of the essence of technological cooperation and technological transfer is the involvement of interested governments and organizations (including private, national, and multinational enterprises) of advanced countries in a serious study of the potential of indigenous technologic institutes and laboratories to offer them relevant assistance, especially in the area of technological know-how and finance. The potential exists in the poor countries to establish new research units in various fields. If the technologically advanced countries really care, they must henceforth substitute their present halfhearted action with sufficiently sustained involvement.

It is not particularly exciting to know that there are groups in the economically more advanced countries whose stock in trade is to peddle machines and equipment manufactured in their home countries for profit-making with industrialists

in the developing world. Invariably such groups continue to indulge in self-glorification in international conferences and seminars with regard to technological cooperation and technological transfer to the Third World. It is as if all a country needs in industrialization is to indefinitely continue to import all its requirements in terms of machines and equipment.

If the industrial countries are willing to cooperate, they should, literally, "come over to Macedonia and help us" to promote indigenous technological creation and adaptation through well-organized and well-financed scientific research and development programs in the various fields.

III. SECONDHAND MACHINERY

We are told, for instance, that secondhand machinery is often less complex than "present-day" machinery, so that it is easier to operate and maintain where certain skills or experience are lacking. In addition, they say, it is usually much cheaper than new equipment [2, p. 57].

This is true, but it is certainly not the whole truth. For one thing, the international machine peddlers are not used to giving their clients in the developing countries all the information they should have on the machines and equipment they buy. This is partly due to lack of expertise of the partners from the developing countries, and partly due to the bad faith of profit-hungry sales representatives from the advanced world. Evidence abounds to show that local industrialists in the developing countries have often bought machines and equipment in the belief that they were genuine and new, while in fact they were not only secondhand but also damaged. In such cases the price of such machines and equipment has been little different from the new ones, especially where the system of "suppliers credit" is employed.

Furthermore, from an analysis of information from reliable sources, one principal cause of poor performance in some Nigerian textile factories is that, either out of ignorance or collusion by the local owners of the factories with foreign suppliers, much of the manufacturing equipment is simply used but well-polished machines which the advanced countries had long ago discarded. Add to this the usually high spare and maintenance ratio required for secondhand equipment, and cost, over time, cancels out any advantages.

Now, considering that developing countries produce and export the same basic products as rich countries, it is clearer that performance of obsolete machines and equipment cannot, qualitatively, compete with that of highly sophisticated, modern machines and equipment. This is true, even when people of proven professional caliber tend this obsolete equipment.

The result is, of course, that not only are products from developing countries barred from advanced markets but they also have to fiercely compete with foreign goods in the markets of poor countries. Even with fiscal measures to curb imports of foreign products, superiority in the quality of foreign goods partly due to better technology has increased the incidence of smuggling. Thus the effect has been the same: an increase in the predicament of local industries,

and an increased dependence of local consumers on foreign industries.

However, this argument must not be overemphasized, because, on the other hand, it does not seem reasonable to expect a typical developing country, with the limits imposed on it by radical scarcity of inputs such as capital and know-how, to effectively and profitably take part in fast-moving competition in scientific and technological changes in the modern production process, changes which Schumpeter has aptly described as "the process of creative destruction" [11, p. 83].

There seems to be a distinction though between unused machines and equipment whose use in the advanced countries has been replaced by newer more rapid processes, and those machines and equipment which have been discarded as scrap, but polished and sold to developing countries as "appropriate" technology.

IV. TECHNOLOGICAL TRANSFER AND FOREIGN TRADE POLICY OF DEVELOPED COUNTRIES

Changes in the strategy of technological cooperation and technological transfer must involve great changes of heart and mind, not only for the planners and people in the poor countries but also for those in the rich countries.

One essential ingredient of change must be a new system of international trade based on the principle of nonreciprocity. This is because it is logical that the two partners, from a purely economic viewpoint, are unequal, and therefore, should not compete on equal terms in international trade. As is well known, the trend toward external imbalance in the developing countries is mainly a manifestation of disparity between the rate of growth of exports (primary and manufactures) and that of imports of industrial goods. In other words, there is generally a tendency for poor countries to import more than they export. Hollis B. Chenery puts it succinctly: "Of the several potential limits, the most serious obstacle to achieving self-sustaining growth at rates of 5 per cent or more is currently the balance of payments. . . . Of the countries in which both savings and trade performance have been disappointing . . . there is strong evidence that a primary cause has been the sluggish performance of exports and the widening trade gap" [1, p. 275]. For example, "according to estimates made by the UNCTAD Secretariat, the developing countries have paid in recent years as much as \$1,500 million annually for patents, licensing, know-how, trademarks and consultant services. But the export earnings of manufacturing industry in the Third World over the period 1966-70 totalled \$30.75 million" [13, p. 104]. This means that payment for the transfer of scientific and technological progress to the Western countries was as much as 21.7 per cent of manufactured exports during this period. This has led Arnost Tauber to say that, "There must be something wrong in this kind of [technological] transfer" [13, p. 104].

Obviously, as Table II shows, some distinction has to be made between the international trade performance of petroleum and non-petroleum exporting developing countries. The terms of trade for 1971 of all less developed countries

TABLE II
 INDEX NUMBERS OF UNIT VALUES OF EXPORTS AND TERMS FOR TRADE OF
 LESS DEVELOPED COUNTRIES BY REGIONS
 (In U.S. dollars ; 1963=100)

	Unit Values of Exports			Terms of Trade		
	1969	1970	1971	1969	1970	1971
Less developed countries, total	106	110	114	101	101	101
Less developed countries excluding petroleum producers ^a	111	117	111	106	107	99
Africa	115	116	123	109	103	105
Asia	102	103	114	100	99	107
Middle East	100	100	121	92	89	105
Middle East, excluding petroleum producers	110	103	97	102	93	85
Other Asia	103	106	109	103	104	105
Latin America	109	117	112	100	102	93
Latin America, excluding petroleum producers	114	124	116	104	108	96
For comparison: North America ^b	115	122	126	104	103	101
Europe	106	112	119	101	102	103
EEC	105	111	118	100	102	103

Source: United Nations, *Monthly Bulletin of Statistics*, July 1972.

^a Excluding Israel and the less developed countries of Europe.

^b Excluding Mexico.

with the market-economy developed countries compared with terms of trade for 1970 remained unchanged partly because of the rises in petroleum prices. But for non-petroleum exporters the fall in 1971 was large, from 107 in the previous year to 99.

However, with or without crude petroleum exports, the problem of the poor countries trading position with reference to any manufactures or processed industrial and other items they may produce for export remains as acute as ever.

It would be mere lip service to the idea of technological cooperation and technological transfer if the developing countries are still barred in export trade from the industrialized markets after the developing countries, through the use of technology, produce marketable commodities from their agriculture, textile industries, food processing industries, leather as well as simple goods such as bicycles with simpler kinds of mechanical engineering.

Protectionism in these sectors is rife among the rich countries.³ So-called measures for trade liberalization are carefully devised to avoid these important and sensitive points.

According to Singer, "Economists can point out until they are blue in the

³ Protectionism is rife in some developing countries too, but a disinterested appreciation of the "infant-industry" postulate will show that the two types of protectionism are different in concept and objective. Even this situation is given some consideration in Article 18 of the General Agreement on Tariffs and Trade (GATT).

face that this is against the self-interest of the rich countries. The classical economists would be turning in their graves if they knew about the present agricultural policies of the rich countries, whether U.S. price support policies or the European Economic Community's Common Agricultural Policies or the [former] British policy on Income Subsidies to Farmers" [12, p. 61].

These, therefore, are problems which must be resolved if the industrialized countries are seriously concerned about changing the development outlook for the low-income countries.

But there is an argument that, generally lacking in the essential raw materials for productive purposes vis-à-vis the generality of the poor countries, the technologically advanced countries seem to be reluctant to give adequate impetus. This, it is sometimes argued, could, in the long run and in spite of development of substitutes, release the poor countries from their present position as agrarian and raw-material appendages on the industrially developed nations. It could also cause a drastic contraction of the latter's markets for industrial machines and equipment, thus constituting a major threat to the growth of production in the advanced countries with adverse effects on their income and standard of living.

Nonetheless, there is historical evidence to show that such a picture is over-drawn and that it is rather in the self-interest of the economically advanced countries to forge a new hopeful outlook in the poor countries. Since, for example, as a result of the "international disparity in demand" mentioned earlier, trade concessions granted by industrial countries to developing ones tend to rectify this disparity and are soon shown in the expansion of exports to the developing countries, the element of self-interest on the part of the rich countries is evident. Even in the long run, this situation is more likely to lead, not to a general lowering of living standards in the economically advanced countries, but rather to some readjustment in the international division of labor which should eventually lead to a more prosperous world.

There is, for instance, the experience of the Marshall Plan. In establishing the Marshall Plan, Secretary of State George C. Marshall laid down the precept that "normal economic health" in Western Europe was the first condition, and it alone could achieve world political stability. The objective of the Marshall Plan was not political warfare or to win the Europeans as friends, but to assure economic recovery. It was given without an attitude of paternalism on the part of the United States and without ever considering such assistance as charity.

The result today is a prosperous Western Europe and a prosperous United States of America.

CONCLUSION

The argument has been given that one major reason for poverty in low-income countries is the disproportion between the rate of population growth and that of technological growth. Economic progress in all rich countries has been ushered in by increased scientific and technological progress, and this is expected to

happen with the present poor countries provided appropriate technology is applied, technological education is promoted, and technologic agencies there are given sufficient support. Further, the term "appropriate technology" could mean either intermediate (labor-intensive) technology or advanced (capital-intensive) technology, depending on the carefully analyzed needs of each economic sector.

Finally, technological cooperation will have little meaning if the protectionist and extortionist trade policies of the rich countries remain.

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