## Technology and Industrialization.

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Technology is one of the most important factors in the theory of industrialization as applied to the economics of development. In fact, changes in technology have been the main springs of action in the growth of the most developed countries in modern times. They have been "spontaneous and discontinuous changes in the channel of the flow, disturbances of equilibrium which forever alters and displaces the equilibrium state previously existing".

In underdeveloped countries, technology may not follow strictly the Schumpeterian System of spontaneity, but instead may take the form of transfered technology from the more developed countries. This in fact is one of the divergences of modern theories of development, as applied to the underdeveloped countries.

In our study, we are considering changes in two main factors, those of population and those of technology. We have seen the changes in population, let us now consider the technological disturbances which affect seriously the underveloped countries.

In studying the impact of modern technology upon the economically backward countries, we are faced with three fundamental problems. These are:

1.—Overpopulation and consequently the abundance of labor as an

Schumpeter, J. A., "The Theory of Economic Development" Cambridge, Mass., 1951, p.64.

idle resource. By this, we do not mean that there is an overcrowding of people in terms of land or an extreme intensity of population, but we are referring to it more on the economic standpoint of underdeveloped countries. In other words, that there is too many people and too little jobs. To use the economic term, capital accumulation is growing at a slower rate than the growth of population and so there are little opportunities and low standards of living, even though there may be abundant land in proportion to the population.

2.—Therefore, the next problem that concerns underdeveloped countries is that of lack of capital. Some economists considered it as the basic problem underlying the difficulties faced by underdeveloped countries, as if the introduction of capital would be like an injection which could cure a patient instantly. It seems to me, that although capital scarcity is basically relevant to underdeveloped countries, yet there are more striking problems that must be faced by them. To mention the simple fact, that capital without the knowledge of how to use it is irrelevant, makes our argument clear.

3.—This brings us to the third fundamental problem. That of low standards of living and consequently little knowledge and adaptability required for technological progress.

The crucial thing that we must consider, when giving the above mentioned facts is that actually the reverse facts are the conditions for introducing technology. As Singer's study mentions, the three assumptions of modern technology are: i) capital is abundant; ii) labor is relatively scarce; iii) wage rates are correspondingly high, which are the opposite to our problems mentioned above.

<sup>(2)</sup> Singer, H., "Obstacles to Economic Development", Social Research, Vol. 20, 1953, p. 24.

Let us elaborate upon these factors and realize the problems that emanate from them. One of the things that we must face is that most of the existing efficient technology is capital intensive. The reason is obvious, for it has been developed by countries like the U.S. and Britain, where labor was unavailable and so they had to apply labor saving devices. This is in fact more accentuated as modern technology develops and the process of production becomes more complicated. Therefore, underdeveloped countries are handicapped if they want to follow strictly the pattern of those developed countries.

First the initial expense on investment is very high if an efficient technology on the industrial standards is to be adopted. Then the complicated industrial goods that are necessary for technological progress are too difficult and require too much skill and knowledge for an underdeveloped country to produce by themselves. They will have to import them and so there will be a pressure on foreign exchanges and the balance of payments.

Furthermore, the technology introduced in backward countries will in some cases fail or be of short duration because of the lack of knowledge or adaptability and therefore, much capital is needed for replacement and for training of technicians, because the application of modern technology requires quite high levels of scientific training and understanding plus education which are lacking in underdeveloped countries.

From the standpoint of population, the labor saving property of modern technology is obsolete, for there is too much labor and too little capital to create new industries where modern technology may be applied. Therefore, it is more important for a country to improve the existing technology which compared with that of other countries may seem backward but which is best fitted for the country. By doing this, productivity per capita is rised and this will contribute to the rise of personal income and improve the standards of living.

Some economists like Singer, seem to think of technology, as merely that existing in the modern industrial countries, when they say that "older or inferior ones.....no longer exist, it has been scrapped in the industrialized countries, and the technology of industrialized countries is the only existing technology", but it seems, that this kind of reasoning is biased on the fact that it clearly states that there is no other technology than that of modern countries, without realizing what is a modern industrialized country and that there are many countries where even the slightest technical improvement, which requires little capital, increases considerably the productivity per capita of the laborer.

For example, during the Japanese occupation, the China Industrial Cooperatives, in the interior of China, found, that even a foot-powered cotton spinning machine made from lumber and old tin cans, quadrupled the output of old fashioned hard wheels.

Another example is that of the U.N.R.R.A. work in China, who reported that a 40 spindle foot-powered cotton spinning machine adapted from local design, would amortize its cost in a month if operated full (4) time.

This shows that underdeveloped countries will do no good if they just merely imitate or adopt the techniques of the advanced nations, for besides the difficulty and hardships in doing so, it may result

<sup>(3)</sup> Singer, H.W., op. cit., p. 25.

<sup>(4)</sup> Aubrey, Henry G., "Small Industry in Economic Development", Social Research vol. 18, Sept. 1951, p. 280.

ineffective. This can be shown in a product contour map,<sup>(5)</sup> where we may introduce different types of technology.



Here we assume that there are only three variable factors. Namely, labor, capital and technology,(the later shown by A.B,C,D, technique lines). Assuming that all other factors are constant and that only a single commodity is produced, we can say that in order to produce that commodity, there are several combinations with which it can be done.

A line which joins all these combinations is known as isoquant, shown by curves (i) in our figure. Having certain amount of resources, we can produce a certain amount of goods which will be represented by a point in our product contour map. Now let us say we have "a", of capital and "b" of labor. Then we can produce 1,000 units of that commodity using technique A, which is the output that can be more efficiently produced with given factors and a certain technique.

Before continuing, we can observe that the technique lines, A, B, C, D, show a series of methods that are of a better nature as we go to the right of the graph. That is as we shift from A to B and so on,

<sup>(5)</sup> The reader is urged to make reference to K. Boulding's "Economic Analysis", New York, 1948, in his section, 'Advanced studies in analytical techniques' especially chapter 31, 'Three variable analysis of a firm', pp. 671~709.

the technique will be one using more capital and becoming more efficient. Now, if in our model, the country in question decides to adopt an improved technique, transfered from an advanced country, we shall represent it by a shift to technique B in our graph. The result is that since this is a more advanced technique, the capital-labor ratio is higher and thus it will employ less labor which will be unemployed, because being economically underdeveloped, our country lacks the sufficient capital to employ the workers laid off due to improved technique.

We should be able to employ only the amount of (b') workers out of the total of (b), which in our diagram we find ourselves operating on the 800 isoquant rather than on the 1,000 one. Therefore, besides unemployment, we shall be producing less amount and so individual welfare will be harmed. This is the case in many over-ambitious programs of undeveloped countries where naturally capital is scarce. This makes us realize that a lower technique using the available factors in the country will be more effective in rising the standards of living than a sheer imitation of advanced countries who are capital intensive and highly skilled.

The next problem to be discussed is how do we account for technological change. In general we can say that there are two ways. One is the use of already available techniques and the other is the Schumpeterian spontaneous innovation, that is, the introduction of a new technology.

In the first case, these will happen if the available resources (7) change. Let us suppose that there is an increase in investments; let us

<sup>(6)</sup> This is known as technological unemployment and must be distinguished from disguised unemployment.

<sup>(7)</sup> Otherwise, it will be inefficient and may lead to serious disturbances.

say from a loan by a foreign country, so that there is more capital available. Assume this to be "C", in our diagram. Then we can see that the country's economy will do good in using techniques "B". The result will be that, due to more efficient techniques, the economy will be producing at a higher isoquant, that is, will have an output of 2,000 units. The existing labor will be more efficiently used as more capital per worker is available. And as productivity per capita increases, the income of workers also rises. The result is a higher standard of living.

Let us take up the second method, that of a spontaneous change in technology without any change in resources. Let us assume in our diagram we are in a position using technique B, with the corresponding amounts of labor and capital. Now if a new technique "C" shown by the dotted lines, comes forth we shall have that the isoquant will change its position. In other words, the new technique is more efficient and will be producing the same amount at a lower cost as the factors are reduced. Consequently that country will do better to shift into that new technique.

We can see however that a new technique without further capital accumulation will create a problem of technological unemployment. Therefore, it is necessary to stress that in a developing economy it is necessary that we have a constant progress in order to achieve a balanced rising growth.

We have seen the interaction of technology and labor. Since technological progress is related to the rate of capital accumulation and both are closely interconnected with the rate of population growth. In order to have technological progress it is necessary to have a continuous accumulation of capital; but as accumulation goes on, the population

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ratio must be balanced for if technology and accumulation of capital are at a higher rate, there will be a scarcity of labor which will be manifested by a rise of wages, and the use of capital intensive methods of production to overcome the lack of labor.

On the other hand if population growth is at a higher rate as in underdevloped countries, where besides there is no actual rate of capital accumulation, we shall only have increased unemployment which can be overcomed by using simpler techniques and rising output per capita, inducing an improvement in the standards of living of the people.