How Technological Advancement Affects Economic Growth of Emerging Countries

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Abstract—With the advent of the era of science and technology, humanity at large has benefited from all new innovations. The new knowledge has made everything easy in every field of life from production of goods to marketing, distribution, transportation, delivery of services and even generation of new knowledge. Technological advancement accelerates economic growth of a nation but not all technologies are appropriate for all types of environments. This study investigates the effect of technological change on the growth of an economy with special reference to developing countries and macroeconomic problems faced by developing countries in adopting new technologies.

Keywords— *Technological change, Production function, Isoquant, Economic growth, Efficient technology, Appropriate technology.*

I. INTRODUCTION

The assumption of 'other things remaining the same' led the classical economists to assume a given state of technological knowledge. This unrealistic assumption deprived economic growth theories of a dynamic stature. Technological change takes place whenever there is an addition to the already present set of technologies, which can be termed as technological progress if the new set of technologies is more efficient than the previous one. Increased efficiency of the technology increases the productivity of the inputs and thus increasing production. Increased production leads to increased capital formation which accelerates the growth rate of the economy. But if all the new efficient technologies are suitable for all the economies? If increase in production can always be associated with increased welfare? If individualistic approach better than collective one? These are some questions which have been tried to be answered in the study.

II. HOW PRODUCTION FUNCTION WORKS

Goods are produced by converting factor inputs into output. This process of converting inputs into desirable outputs is called production. The production function is a purely technical relation which connects factor inputs and output; it describes the transformation of factor inputs into products at any particular time period. The production function represents the technology of a firm of an industry or the economy as a whole. The production function includes all the technically efficient methods. A method of production is a combination of factor inputs required for the production of one unit of product.

Usually a commodity may be produced by various methods of production. For example, one unit of 'x' may be produced by employing 2 units of labour and 3 units of capital or by employing 3 units of labour and 2 units of capital. Locus of these different combinations which produce same amount of output is called isoquant. These different combinations entail different costs of production as individual factor inputs have different costs. Concerning firm will choose that method of production which maximizes output for any given constant cost of production or which minimizes costs for given amount of production. This point of equilibrium can be represented diagrammatically as the point of tangency of isoquant and budget line as shown below-

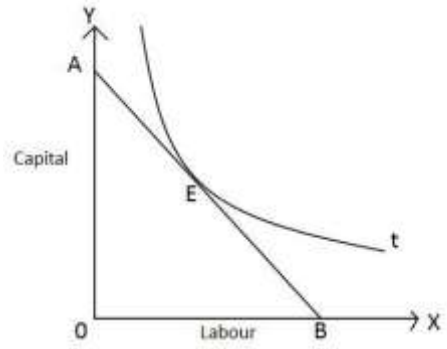

Figure 1. Isoquant and optimal point of production

Thus an isoquant represents a given state of technology. For a given state of technology, production of any good can be increased only by increasing the quantity of inputs. However, the empirical findings showed that increases in the stocks of conventional factors of production (capital and labor) accounted for only a modest share of economic growth. Robert Solow's study of US data for the period of 1909-1949 showed that more than 87% of the growth in the US economy could not be explained by the growth in capital and labour and hence the residual or unexpected portion of growth must be attributable to something else.[1]

This something includes all those things which were assumed to be given while forming a production function including technological change. Where increasing production through increase in quantity of inputs shifts the iso-product curve (isoquant) away from the origin which represents increased cost along with increased production; advancement in technology changes the scales of the whole production map. It increases the production by increasing the productivity and not the quantity of inputs. Thus production can be increased without increasing the cost and sometimes with lesser cost, through increase in efficiency of production process.

III. EFFECT OF TECHNOLOGICAL CHANGE ON PRODUCTION FUNCTION AND ISOQUANT

Technological change or progress consists of discovering new methods of production, developing new products and introducing new techniques. Thus a change in technology is synonymous to change in production function. It alters the production function shifting the isoquant towards the origin and even changing the slope of the isoquant depending upon the type of technological progress that has taken place (whether it is capital-saving, labour-saving or neutral).

Let us assume that the economy, having two inputs of production labour and capital, is in a state of equilibrium at a given point of time. A new technology enters the economy. If the new technology is more efficient than the previous set of technologies, producers will switch to the newer one. This switch of technologies alters all the production equations. Production function is changed and isoquant shifts towards the origin.

An isoquant represents those combinations of inputs which can produce same amount of goods. A technological change increases the productivity of either all inputs or some of them.

If productivity (marginal product) of labour increases relative to that of capital, at a constant capital-labour ratio, new technology would be capital saving and labour augmenting. As producers tend to keep their cost of

production at minimum they will produce at the point where budget line is tangent to isoquant. 't' is the isoquant before the change in technology and 't_1' is the isoquant after the change.

FIGURE II

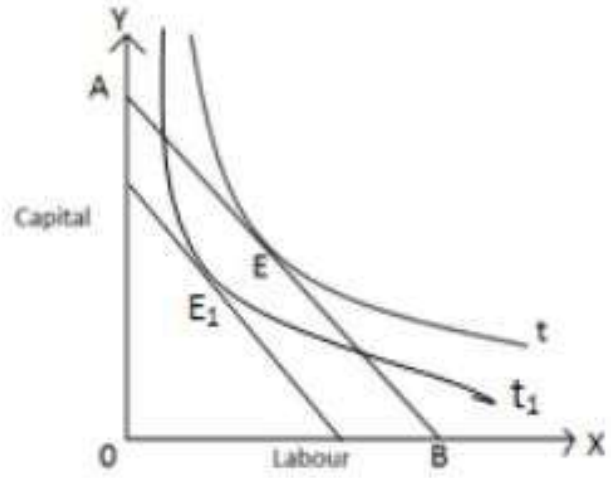

Figure 2. Labour Saving Technological Change

As the change is capital saving or labour augmenting, less capital is required relatively to capital for a given capital labour ratio, the equilibrium point will always be closer to labour axis than before.

On the other hand, if marginal product of capital increases relative to that of labour, new technology would be labour saving and capital augmenting.

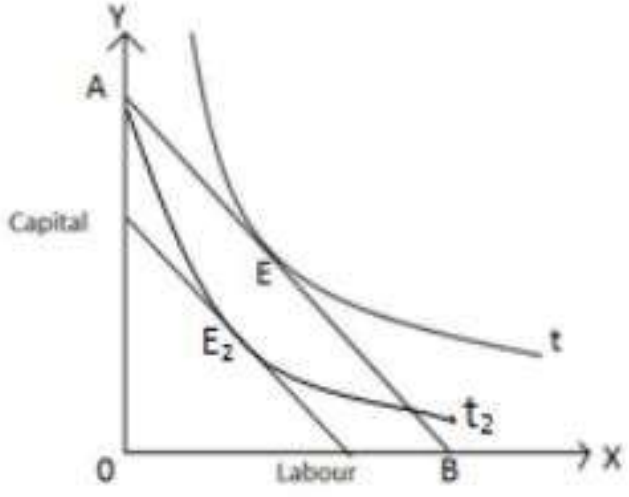

Figure 3. Capital Saving Technological Change

There can be neutral technological change too, which increases the productivity of labour and capital in the same ratio. Thus different types of technological changes have different effects on the iso-product curve. But all these increase the marginal product of factors of production and consequently increasing the production of goods for an individual firms and the rate of growth for the economy as a whole.

IV. ROLE OF TECHNOLOGICAL CHANGE IN ECONOMIC GROWTH

As explained before, with a given production function there is not much possibility of increasing the production as the cost of production also increases with increased production. Together with this, increased stocks of conventional inputs have not been able to explain all the economic growth in real life scenario. This shifted the locus of attention towards technological progress as the driver of economic growth. There are two main proponents of theories of technological progress. Neo classical economists consider technological advancement as an exogenous factor which is independent of saving rate. As the long run growth rate depended upon exogenous factors, this theory had few policy implications as it never really mattered what the government or the administration did.[2] This paved the way for new growth theory, which extends the neo classical theory by introducing endogenous technical progress in growth models. The endogenous growth models emphasise technical progress resulting from the rate of investment, the size of the capital stock and the stock of human capital.

This theory relates the economic growth to technological progress which itself is dependent on R&D(Research and Development). An increase in R&D can thus translate into higher long-run economic growth. However, how this increase in R&D is related to increase in production is a matter of debate. All the R&D based models have tried to predict the scales effect, by how much the production will grow if the amount of resources employed in the R&D are increased by a certain amount. If the resources are doubled, will the per capita growth rate of output double? Empirical evidences answers in negative of course. Resources and persons indulged in R&D have increased manifold in last 40 years without exhibiting any similar trend in growth rates. Growth rates by and large have either been constant or showed a declining tendency. For example, the number of scientists and engineers engaged in R&D in the United States alone has increased by almost 5 times during 1950-1987, but per capita growth rate exhibits nothing remotely similar to this fivefold increase.[3] Reason being, R&D sector is not like conventional sectors of production. The production of conventional goods is ordered in certain stages with a predetermined sequence. First there are primary activities, like extraction of minerals, followed by production of intermediate good and ending in the production of final goods. Technological advancement or innovation cannot be produced in such a way. R&D sector is much less structured than the conventional sector. However, the absence of correct prediction of scale effect has not implied that there is no correlation between economic growth and R&D.

From the perspective of theories of technological change main concern is how to include technology variable in the model of production, if the technological change is exogenous or endogenous, if its embodied or disembodied. However, from growth perspective, main concern becomes that of how this technological change affects the growth and overall state of economy.

From the microeconomic point of view, any firm would adopt a technology if it lowers its cost of production, increases the efficiency and thus raises its profit. The technology is labour augmenting or capital augmenting is of little importance for individual firms. Being rationalistic economic agents, firms will decide from two alternatives keeping in mind economic costs and benefits it will accrue.

However, from the macroeconomic point of view a conflict of interest is prevalent. Every country wants to best utilise the available resources in order to accelerate the growth rate of the economy. But majority of emerging economies, including India, have abundant labour but scarce capital. These two major factors pose the problem of

choice of techniques- that of using the traditional or the modern methods of production.[4] An efficient technique is one that minimises the costs of a given output or maximises the output from given inputs. The ultimate object is to choose that technique which is more efficient than another technique keeping in view the existing factor proportions. Thus if new technology, which is more efficient than the previous ones, ignores the factor proportions prevailing in the economy, it will suffer from social cost-benefit analysis angle.

IV. DILEMMA OF DEVELOPING COUNTRIES

As per classical economic assumptions, if all the agents take decisions best suited for them, the economy as a whole will always be in equilibrium. If a new set of technologies are introduced which are capital augmenting, adoption of that technology would not lead to any kind of unemployment because when there will be excess labour force present in the market, price of labour (wages) would decelerate increasing relative cost of capital thus inducing producers to substitute capital with labour. Market will automatically reach a solution to the problem of unemployment. Market is efficient at resource allocation.

However, empirical evidences suggest otherwise. The uncritical notion that it would be easy to orient science and technology towards productive purposes in the less developed countries has been superseded by a more analytic approach. Scientific activities in these countries themselves tend to be a form of consumption rather than investment and the reason for this lie in the dependence on external sources of technology and in the structure of underdevelopment itself. These borrowed technologies are inappropriate both because it produces over-specified commodities and because it makes intensive use of resources which are scarce in these countries.

Thus in spite of a new improved technology being available, these emerging economies are unable to make most out of them. These capital intensive technologies do improve the production and productivity which lead to generation of capital further. The growth rate is faster under capital intensive techniques than under labour intensive ones. But the social cost of this growth remains higher in terms of employment loss.

V. CONCLUSION

It may be concluded that in these emerging economies, main problem is not that of adopting new technologies or not. The foremost hurdle is absence of indigenous innovations which take cognisance of the factor proportions in these economies. R&D should focus on increasing the marginal product of labour, which is by default the abundant factor in these countries.

Technological advancement is inevitable for growth to take off. In the absence of technological progress economy is trapped in a low level equilibrium static state. But new technologies must not ignore peculiarities of an economy. There is a dire need of appropriate technologies. The appropriate technology for an area depends on its resources, methods, techniques, patterns and its markets.[5] There should be an amalgamation of skills, methods, techniques, appliances and equipments that can contribute towards solving the basic socio-economic problems of the concerned economies. It should be economically viable, technically feasible and should be able to produce some surplus so as to encourage capital formation and stimulate further growth. It should be ecologically sound and should be in complete harmony and conformity with local environments.

By directly accepting technologies imported from developed countries, these nations bypassed the route of discovering new technologies first and then adopting them in production processes. As a result these innovations have not been apt to fulfil their needs. Instead, low-cost high productivity equipments and machines can be imported from

advanced countries and their prototypes manufactured within the country with indigenous skill and raw materials which would suit their needs.

The R&D sector needs to be boosted. To make R&D attractive, a cost benefit analysis for this sector has to be done and efforts made to increase benefits and reduce costs. R&D sector being an unconventional sector, its profit cannot be increased by technological methods. Failures needs to be insured against and successes rewarded, economically, through stringent patent laws, tax-incentives, research collaboration and other ways and means.

Each country has to word out its own salvation, and particularly to find out which production methods are feasible for it.[6] There is no shortcut for growth; developing countries can learn from developed countries but imitating them will only quench the problems for a shorter span of time.

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