Technology, Trade and Industrial Development:

A Study of Indian Manufacturing Sector

ABSTRACT

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Historical evidences coupled with theoretical justification backed the notion that industrialisation has been an outcome and accompaniment of economic development. It was found that no major country has yet became rich without becoming industrialised and thus it was also regarded as an engine of growth in the literature. But the source of industrial growth has remained a concern for growth theorists since centuries.

Britain was the first country to industrialise way back in 1800 followed by some other countries from western Europe, United States, Japan, East Asia etc. But the process of industrialisation is unique for each country concerned and each followed a different path towards attaining industrialisation given the resources and constraints facing them.

Process of industrialisation in India started during the period of colonial rule, but the industries were largely developed to provide raw material for the industrial revolution in Britain. But, the major stance towards industrialisation in India was laid after independence, especially during the second five year plan. Based on the genesis of Harrod-Domar model, Mahalanobis model of growth accentuate the accumulation of capital stock through planned investment for industrialisation. For attaining self reliance, the model emphasised the development of capital goods industries like iron and steel, coal, machine tools, non-ferrous metals, fertilizers, refined petroleum products along with the industries like pharmaceuticals for enhancing mass welfare.

Secondly, for providing a good breeding ground for infant industries, the government resorted to protectionism against the theoretical justifications of free trade.

However while decomposing the source of growth for the United States (US) during 1909 and 1949, Solow has found that around 87 percent of growth in US output per worker was due to ‘technological change’. Thus, technological change replaced growth of capital accumulation as the primary source of growth. But the source of technology generation was regarded as exogenous in nature. Thus, the government in India also made various selective technical collaborations to import this exogenous factor to begin with.

These policies of initial planning accelerated growth in the industrial output as it grew at around 10 percent per annum during 1956 to 1966. But thereafter, the rate of
industrial output growth fell to around 3 percent per annum during 1966 to 1974. The stagnation in industrial growth initiated a debate for the probable cause for the downward trend in the sector and the ‘protectionist’ policies of the government were largely blamed for the reverse trend.

But during the late 1980s, the source of ‘technology’ generation was found in the theoretical models of endogenous growth. The models emphasised that long-run growth is driven primarily by the accumulation of technology which is generated through investment in research and development (R&D). Technology, in turn prohibits diminishing returns that accrue during capital accumulation. In addition, investment in R&D also leads to externalities due to its non-rival and partial excludable properties. These peculiar properties of ‘technology’ lead to emphasise that technology flow is an automatic process and is facilitated by free trade amongst those in the frontier of technology to the periphery.

Coupled with the theoretical justification, the empirical evidence from open economies of East Asia also lead the neo-liberalisers to propagate that greater integration with the developed countries lead to economic growth in the laggard countries. Thus, several countries from Latin America and Asia followed the globalisation policies, sometimes forcibly with the implicit assumption that these policies will lead to sustainable development.

But it was found that the literature stands divided regarding the issue of greater integration and development. These ramifications generated debate on the relationship among technology, trade and growth in open economies. These revelations lead to address issues that were long been central to the international economics, that is, ‘to what extent international trade serves as an engine of growth’. Precisely, there are studies that empirically found that trade lead to technology spillover to the host countries that spur growth and dynamism leading to sustainable development. On the other hand, the literature also exists that found that integrating the economies did not lead to technology spillover automatically.
The sceptics emphasised that accumulation of technology is rather a cumulative, evolutionary and path-dependent process that requires consistent effort, resources and persistent policy for technology absorption, accumulation and diffusion. Moreover, since the generation of technology is a costly and risky affair, the industries in the frontier of technology resort to various means to avoid the technology to spillover freely. It was also found that the latest technology is not always available for sale so as to maintain the technological edge.

Thus, the issue of source of industrial growth and sustainability remained inconclusive. So the present study is an attempt in this direction while taking the case of Indian organised manufacturing industries.

The choice for the case study was made on the ground that after following the protectionist policies for about three decades after independence there was an intensification of reforms in India’s trade, technology and industry policy in 1991. To make a comparative analysis regarding the impact of change in policies, the period from 1980-81 to 2005-06 was chosen for the study. It was assumed that a decade before the initiation of economic reforms seemed plausible to make comparison with the decade that follows. Thus, the period was divided into pre-reform period till 1991-92 and post-reform period from 1992-93 onwards.

It was assumed in compliance with the neo-classical endogenous growth models that the increase in imports following the economic reforms of 1991 has lead to greater embodied technology spillovers in the manufacturing industries in India which in turn would have lead to greater total factor productivity growth in the sector coupled with enhancing its efficiency in resource use. It was further hypothesised that there would have been a structural shift towards relatively high income elastic industries that would have lead to industrial sustainability.

To test these hypotheses, the following data sets were used in the study. Data for the organised manufacturing industries were taken from Economic and Political Weekly Research Foundation (EPWRF) and Annual Survey of Industries (ASI) published by Central Statistical Organization (CSO), Government of India. Data on trade was taken
from UN-COMTRADE while data for the indigenous R&D done by manufacturing industries in India was taken from various issues of Research and Development in Industry, Department of Science and Technology, Government of India, New Delhi while the data for the R&D done in the industries of various OECD countries were taken from OECD database. To espouse the issue of industrial sustainability, the dataset was classified into four different technology intensive industrial sub-groups [high technology (HT), medium high technology (MHT), medium low technology (MLT) and low technology industries (LT)] according to the Organisation for Economic Cooperation and Development (OECD), 2007 classification.

For measuring the trend growth rate of various variables for the whole period under study the semi-logarithmic method is applied but for the comparative analysis of pre- and post-reform period single kinked method is used. In the method, one regression line determines the trend growth in the two periods simultaneously rather than estimating the trend growth for the two periods using the two separate semi-logarithmic regression models. Apart from this, panel regression model has been used when the numbers of industries (N) are larger than time period (T) and time series cross section (TSCS) analysis has been used otherwise. For measuring the total factor productivity (TFP), translog index have been used while stochastic frontier approach was used for the decomposition of TFPG into technological progress and technical efficiency.

To begin with, the empirical analysis first undertook the issue of determining the patterns of industrialisation in India since 1980. The hypothesis assumes that adoption of economic reforms lead to structural transformation within the manufacturing industries towards relatively high technology industries that would lead to industrial sustainability. Several descriptive statistics were undertaken to understand the underlying phenomenon of structural transformation within the manufacturing industries in India.

It was found that for the period of analysis (1980-81 to 2005-06), the share of industrial sector averaged to about 26.3 percent of GDP and the share of manufacturing industries averaged to about 16.2 percent during the period. Regarding the overall trend growth
rate of the value added in the organized manufacturing industries, it was found that it fell to 5.33 percent in the post-reform period as compared to 7.25 percent in the pre-reform period.

Further, it was found that during the 1990’s, there is minor diversification within the manufacturing sector as the few MHT (notably chemicals, machinery, motor vehicles) and HT industries (particularly pharmaceuticals) came up. But, there was a shift more towards MLT industries as its share in total manufacturing value added increases from 27 percent during 1980-83 to 38 percent during 2003-06. Thus, the pattern of industrial development is not as if moving up the technological ladder while discarding the lower technological industries. Rather, the development of the higher technological industries along with the traditional industries, that is, more of a diversification with picking few from each technology intensive sub-group.

Secondly, regarding the share of employment in manufacturing industries, it was found that in 1980-83 the average of 26.5 percent was the paid employment in manufacturing sector out of the total paid employment in India, which fell to an average of 23.8 percent during 1990-93 while in 2003-06, its share fell further to 21.6 percent.

Since it is found that the process of industrialisation is associated with structural changes beyond a simple increase in share of manufacturing in output and employment. Changes in structure of demand, in international trade and the share and availability of inputs and the pattern of productivities all contribute towards the evolutionary path of sustainable industrialisation. For the purpose, the study focussed on the changing structure of trade and change in intermediate factors and the partial productivities.

The proportionate share of various technology intensive industries in exports and imports, the respective export and import intensity and the relationship between them were undertaken to understand the structure of trade from the manufacturing industries in India. It was found that the major exports were basically comprised of relatively low technology industries. Although, the period of liberalisation has witnessed an increase in the volume of trade but the relationship between import and export intensities does not show any direct and positive relationship. It was envisaged that the increased
imports permitted after reforms would lead to technological change characteristic of industrialisation and for enhancing the exports, clearly citing the strong positive relationship. But, the analysis shows that in the post-reform period the import intensity of several industries have risen as envisaged in the policy reforms but the real motive of enhancing the export intensity of the industries has failed to materialize. Thus, the pattern of the trade followed in the Indian manufacturing sector does not witness a massive change among the different technology intensive industries; rather a diversification on both the counts of imports and exports are quite evident. Further, it was found that the trend growth rate of exports for about 60 percent of industries fell in the post-reform period as compared to the pre-reform period whereas that of the imports the trend growth rate for about 50 percent of industries increase in the latter period as compared to the former.

Further, panel regression analysis was used to find out the factors that determine the structure of industrialisation in the country. It was found from the analysis that irrespective of technological complexity and the policy adopted, employment and domestic demand are the determining factors of industrialisation in India.

Thus, the analysis refutes the claims of neo-classical theories in which structural transformation is regarded essentially a by-product of growth produced by greater liberalisation and less intervention. Rather, structural transformation towards relatively high technology intensive industries is a process of moving purposefully often with considerable effort and cost with greater planning and conscious policy interventions.

Secondly, the important component that catches the factors other than the tangible factors of production that determines growth is the estimation of total factor productivity growth (TFPG). It is the composition of technical progress and the efficiency with which the resources are used. It reflects the advances in technology and organisation of production. It was assumed that there is an increase in TFPG in the post-reform period as compared to the pre-reform period in manufacturing industries. A huge literature although exists that studies the impact of reforms on the TFPG of Indian manufacturing sector. Some studies have found that the total factor productivity has
increased in the post-reform period as compared to the pre-reform period while others found the opposite. Thus, a clear consensus about the total factor productivity performance in the post-reform as compared to the pre-reform period does not exist. Thus, estimation and comparison of technological factor productivity growth (TFPG) in the pre-reform period and the post-reform period was done. The results, using the growth accounting approach (translog index) show that the TFPG slows down in the post-reform period as compared to the pre-reform period for all the industrial subgroups except the LT industries wherein its rate remained intact.

Again, the results using stochastic frontier production approach shows that there exist inefficiencies in most of the industries, which rejects the hypotheses that this sector has become efficient. Further the results also show that there is greater efficiency in the production of relatively low-technology industries which put in jeopardy the question of sustainability of the industrial sector since these industries have a lower income elasticity of demand.

Next, the study tests the hypothesis regarding the relationship between technology, trade and growth in open economics. It was assumed that import weighted technology spillover will be greater in the post-reform period and in relatively high technology industries that could explain the productivity growth in manufacturing industries. Thus, panel regression analysis was used to find whether TFPG in the manufacturing industries were due to indigenous R&D investment or it was the result of import weighted technology spillover from the major OECD countries. The results shows that investment in indigenous R&D remained an important factor in determining productivity for the pre-reform, post-reform and also for the whole period under study while the magnitude of technology spillover stock remained insignificant. The analysis also shows that during the period 1980-81 to 2005-06, technology spillover remains low irrespective of the ‘technology gaps’. Further, the analysis also showed insignificant amount of spillovers irrespective of ‘productivity gaps’.

So, the overall results refutes that greater integration would lead to technology spillover that enhance growth and development. For understanding the mechanism of
technology accumulation, the impact of indigenous investment in R&D and the quantum of capital intensity in generating spillovers were analysed. With regard to the former, it was found that the investment in R&D is an important factor in generating spillovers but for the relatively high technology industries, the quanta of R&D investment were not sufficient to attract spillovers in these industries.

Thus, the results points to the fact that generating productivity growth is a continuous and path dependent phenomenon in which the investment in indigenous R&D is an important factor. The investment in R&D not only generates new technology but it also enhances the absorptive capacity of the country to reap the benefits from greater trade relations with major R&D investment countries that are in the frontier of technology generation. But to regard, the neoclassical paradigm of technology being a public good character and its spillover being an automatic process is refuted by the present analysis.

Investment in indigenous R&D not only leads to new innovations, it also enhances the absorptive capacity of the sector. But this mechanism of technology accumulation is a continuous and path dependent process for which the evolutionary economics regards the role of the government as the paramount factor. Thus, an analysis of various policies that has been undertaken since Independence to enhance the technological capability of the sector was done.

After Independence, the policy makers with an aim to build the technological base relied more on importing technology from abroad through various foreign collaborations and by inviting FDI very selectively. Apart from this, various initiatives were undertaken for building indigenous science and technology structure. By the mid 1960s, a number of research institutes came up. But due to the deteriorating fiscal position, foreign collaborations were made restrictive in nature and emphasis was given for indigenous R&D investment and for building structure. By the end of 1970s, in wake of second oil crisis and deteriorate foreign exchange position government adopted a strategy for the promotion of exports through encouraging FDI, especially in high technology areas. Various measures were taken to attract foreign investment. Further, capital goods imports were kept in the list of open general licence (OGL). But a phase
of greater globalisation was marked with the adoption of comprehensive macroeconomic and structural adjustment policies in 1991. This phase is marked with greater flexibility in importing technology from abroad through embodied and disembodied means.

These policies were framed with the aim to enhance the technological capability in the sector, but it was found that only 0.8 percent of GDP is spend on R&D in the county and only 0.2 percent of GDP on R&D in industry from 1980 onwards. In the education sector too, it is seen that around 3.8 percent on an average is being spend on this sector during early 2000s. Thus, there is a need to enhance the resources towards R&D and education sector. Next, greater emphasis should be given to need based research and government should encourage more research in relatively high technology industries. Further, greater incentives should be given to researchers.

Thus, the study concludes that the claims of neo-liberalisers to regard ‘market’ as the panacea of all ills failed to produced the much acclaimed results. Rather, the sustainable development coupled with structural transformation from low technology intensive industries to high technology industries requires consistent effort and resources towards generating and accumulating technology. This process is time and path dependent as regarded by ‘evolutionary economics’, for which the role of the government became paramount.