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HOMEGROWING OF INDUSTRIAL TECHNOLOGIES

Did India bite more than it could Chew ?

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PREFACE

The Centre for Multi-disciplinary Development Research (CMDR) is a social science research institute in a moffusil area of Karnataka and is sponsored by the Indian Council of Social Science Research, New Delhi. The Centre aims at undertaking analytical studies of conceptual and policy significance on the socio-economic and cultural issues using multi-disciplinary perspectives and state level and micro level information.

As a part of its publication programme, the Centre has initiated a CMDR Monogrph Series, consisting of both invited contributions and the research studies completed at the Centre.

We are happy to present the fourth in the Monograph Series under the title ‘Homegrowing of Industrial Technologies : Did India bite more than it could chew?” Written by Dr. Vasant M Gumaste.

CMDR expresses its thanks to Dr. Vasant M Gumaste for contributing a useful analytical paper to the CMDR Monograph Series.

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THE PRELUDE

After winning the political self-rule in 1947, India's development philosophy was anchored around the goal of 'self-reliance.' The goal could have been influenced by the hangover of the long foreign rule over the country. All the development strategies and programmes were overtly or covertly guided by this goal. Self-reliance in food production, industrial output, defense requirements and in many other sectors was pursued with almost single minded zeal. Achievement of technological self-reliance was but a logical goal in this context. In fact, tech enological self-reliance (TSR) was considered to be a vital input for self-sustained economic development. Jawaharlal Nehru, for instance, strongly felt.[1]

> *Without enhancing its scientific and technological capacity, India could not be economically and politically independent.*

There were also some sporadic overseas provocations in the initial years of India's development experience which reinforced the pursuit of TSR.[2] Thus TSR became an avowed goal of India's post-independence economic reconstruction.

INESCAPABILITY OF TSR?

It is contended that the goal of TSR is natural one for India. The proponents of this view argue that considering its size, inventory of human resources and the time-honoured philosophy there could not have been any goal other than TSR. It is contended, for instance, self-reliance is nothing but our pristine adage,

Uddharet Aatmanaatmaanam
(One should raise oneself through the self)[3]

Going by the values cherished in our ancient scriptures, the question "Whether or not self-reliance" is found to have been answered in the affirmative. A shloka in the Bhagavad-Geeta, for instance, is cited in vindication of this point. It says,

Shreyaan Swadharmo Vigunah
Paradharmaat Swanushthitat
Swadharme Nidhanam Shreyah
Paradharmo Bhayavahah (3:35)

(It is good to practice one's own way even though it may be without quality than other's ways well-tried; it is better to die in one's own way than in other's ways which are frightful).

While our scriptures and cherished values endorse the goal of TSR, the proponents feel, the present inventory of human resources and other infrastructure reinforce the goal. India possesses over five lakh scientists and engineers. About 7 per cent of them are engaged in research and development activities. India has a very large infrastructure of scientific training and research. There are more than 100 scientific societies and nearly 1000 scientific journals. It ranks among the developed countries in the number of papers published in influential scientific journals. In brief, India possesses the capacity for TSR. To him TSR for India is not a question whether or not to pursue it, but how soon to reach it. He asks :

> *When will those people reorganize their strength and potentialities and learn to organise themselves up not only for a purposeful attack on poverty at home, but also for a substantial participation in the competitive international market for technology-intensive goods as Japan has done?*

The Government of India (GOI)'s Technology Policy statement of 1983 echoes Maddox. It says,

In a country of India's size and endowments, self-reliance is inescapable and must be at the very heart of technological development.

Thus India addressed itself to the goal of TSR as it was thought to be an axiomatic goal for the country.

WHAT IS TSR ?

TSR does not appear to be the same thing to every body[4]. Since GOI was to pursue the goal, it is desirable to know how GOI interpreted it. The GOI felt that TSR was import substitution with regard to technology. India's Fifth Five Year Plan, for instance views TSR as the "Strategy that envisages the fashioning of a mix of imported and indigenous technologies in which the proportion of the latter must increase with time". The generation of indigenous components of this mix is one of the prime objectives of Science and Technology Plan. Building up strong endogenous technological capability comparable to world standards was set us the objective. With this end in mind the GOI set up a chain of centrally funded research laboratories. Besides this, the corporate sector was given incentives through fiscal and other means to take up R&D activities. A number of policies such trade, industrial and science and technology policies were also focussed to bear upon the same objective.[6]

TSR : A BALANCE SHEET

If one draws a balance sheet of achievements of TSR at the end of 40 years of its pursuit, one would be alarmed to find a large number of entries on the debit side. There are, however, a few entries on the credit side also.[7] But confining the assessment to industrial technology only one has to say that the performance on the whole is woefully poor. There is hardly any technological dynamism to be seen in the industrial sector. Measured by any yardstick the achievements in industrial technology field leave much to be desired. For instance, take the growth of total factor productivity (TFP) Ahluwalia et al (1988) found that India's TFP growth was negligible in the first half of 60s, declined to –1.5 per cent per annum in the ten years between 1965 and 1975, but marginally improved to 0.8 per cent between 1975 and 1981. During the last period alone TFP of South Korea grew @5.7 per cent per annum, Japan's @3.1 per cent and Turkey's @2 per cent.[8] Desai (1988) observes that India's industrial performance is one of the worst among developing countries. The costs of production of Indian industries are perhaps highest in the world. For instance, India has the dubious distinction of being the costliest producer of steel in the world.[9] Comparisons of energy consumed per tonne of crude steel production are given in Table 1. These data would give an idea as to where India stands compared with other countries. Since steel is the basic input in most manufactured items, the high cost will get reflected across the board. Not only is cost of producing steel in India the highest in the world, India also does not produce high grade and specialised steel even today. For instance deep drawn, extra deep drawn and electro technical quality steel are not produced in India.[10]

Indian manufacturing industry thus today produces high cost, low quality and poor grade items which are sold in a captive market. The main reason for this is to be traced to poor technological inputs. Hajra (1989) shows that technological growth of Indian industry averaged just 1 per cent in the two decades between 1965 and 1985. During this period technology inputs showed a growth rate of 3.6 per cent in Japan and 2.2 per cent in South Korea. The policy of import substitution of industrial technology seems to have had disastrous consequences on the Indian industry. It had created wide technology gaps in the Indian industries. Data in Table 2 gives an idea of the extent of technology gap. On an average Indian industry lagged behind by at least 10 years in technology. There are some Indus tries where the technology gap is less i.e., 2-5 years and in some products when the gap is quite

Table 1

Energy consumption per tonne of crude steel in select countries

(in 10^9 calories)

Country	Year	Energy Consumption
Japan	1980	4.5
U.S.A	1980	6.2
Germany	1980	5.2
France	1980	6.7
U.K.	1980	5.6
TISCO	1987	9.2
Bhilon	1987	10.6
Rourkela	1987	11.7

Source: ASSOCHEM (1990)

large viz 15-20 years. Lall (1984) has shown that India's technological capability in many areas has not resulted in internationally efficient products and processes even after two decades.

IMPORTS OR IMPORT SUBSTITUTION OF INDUSTRIAL TECHNOLOGY ?

TSR, it was shown above, was interpreted as import substitution of technology. Homegrowing of industrial technologies was raised to the status of religious dogma. Hence if not technological autarky, at least severe restrictions of technology imports became main policy measure pursued by the GOI – supposedly to help build strong endogenous technological capability.[11] Even the little technology that did enter Indian industry was paid ridiculously low prices and hence some argue that the contents of imported technology were rather poor.[12]

Technological delinking from the rest of the world had a different set of supporters for different reasons. These supporters of technological isolationism can be called "ideologically aligned" advocates. Such advocates were to be found both in India and abroad. Their advocacy of technological delinking and therefore homegrowing of industrial technologies was not for the pursuit of TSR per se but for keeping away the 'wolf of technological imperialism'. This group of economists had cast heavy influence on the planners and policy makers of the GOI.[13] Hence the policy of GOI of policing the technology imports became further reinforced.

The illusory picture drawn by these economists was made up of 'pastiche' elements. At the top of these pastiche elements was a hypothesis of 'Centre and periphery' and periphery being 'dependent' on the Centre. According to this hypothesis underdevelopment in the periphery i.e. poor countries, is to be explained in terms of technological hegemony of the Centre i.e. developed (capitalist) countries. Development process in the poor countries, according to this hypothesis, can be initiated and accelerated only by technological delinking of the periphery from the Centre on the one hand and building up of endogenous technological capability based on recovery of the traditional technological base of these countries. Sagasti (1979) and Cardoso (1985) were the leading proponents of this hypothesis.[14]

The other elements of the pastiche –particularly with reference to India are as under[15]

(1) Technology markets are highly

monopolistic (or at best oligopolistic)[16],

(2) Exploitative prices for technology are extracted from India[17]. Other terms of technology sales are also quite onerous,[18]

(3) Castoff or museum technologies are sold to India,

(4) Even if technologies are of recent vintage, they are inappropriate to India in terms of factor proportions and in terms income levels,

(5) Independent and autonomous technological capability of India is killed or severely impaired by the technology exporters so as to keep India under their perpetual hegemony,[19]

(6) Indian burgeosie would keep importing technology if free access to advanced countries' technologies was made available and

(7) Multinational corporations being the main sellers of technology would spread their tentacles on the Indian economy[20].

How many and how far the elements of this hypothesis of these economists are valid? First of all, the Periphery and Centre hypothesis came crumbling down with the emergence of Japan, South Korea and a number of European continental countries as independent, autonomous and technologically dynamic countries. The emergence of these countries as technology suppliers also made the thesis of monopolistic technology markets look ridiculous. Technology markets became buyers' markets blowing out the 'folklore' of the 'aligned' economists that the markets are sellers' markets. Hence almost all the elements of the pastiche were proved to be figment of imagination. As far as high and exploitative prices of technology, onerous terms of its sales, older vintages etc. are concerned, none of them was found to be valid. Alam (1988) speaking about India's experience on technology imports has shown that neither higher prices were paid by Indian firms for the technology they imported nor did they receive technology of older vintage. One more element of the pastiche that the technology sellers are MNCs with global commercial ramifications was found to be baseless by a study made by the present author of the paper on the technology sales by small and medium firms abroad to Indian firms[21].

With regard to inappropriateness of technology from the 'Centre", it can be said that a growing number of technologies related to production of steel, power plant equipment, power generation oil drilling (both on-shore and off-shore), heavy chemicals (the list could be pretty long!) etc. have rendered the neoclassical concept of factor proportions obsolete. These technologies are of the type 'take it or leave it'[22]. Whether technologies are appropriate or inappropriate to the importing countries is a redundant question so long as those countries are in need of the technologies in question and also cannot develop them by themselves. In fact, Emmanuel (1982) ridicules the whole idea and equates appropriateness to underdevelopment.[23]

Emmanuel Thesis

Arigihiri Emmanuel stands at the other pole of Sagasti, Cordoso and their Indian friends. He advocates Violently that less developed countries (LDCs) must import technologies from developed countries freely. He pooh-poohs the concept of TSR and learning-by-doing route to building up endogenous technological capability. He argues that the technology development by LDCs is costly, time consuming and wasteful. Hence the well-tried technologies from the developed countries must be imported wholehog by LDCs. According to him, in the course of productionising these technologies LDCs gradually but surely build up strong endogenous capability. He cites the example of Japan in support of his argument. Thus to Emmanuel import and not import substitution of technology is the route to TSR.

Emmanuel argues that private marginal cost (PMC) of production of technology is lower than social marginal cost (SMC). This is because a large part of the cost of producing technology is borne directly or indirectly by the society. Thus PMC<SMC. Similarly, private marginal utility (PMU) of technology is less than social marginal utility (SMU). This is because there are a number of difficulties in the private appropriation of technology. Thus PMC<SMU. The two inequalities viz.

$$PMC < SMC$$

And

$$PMU < SMU$$

Together make it advantageous to import technology and discourage homegrowing it.

Emmanuel is not alone in discouraging LDCs from venturing into home growing of industrial technologies. There are many others. This group of economists and technologists[24] base their main argument on the plank that R&D is enormously expensive. They feel LDCs would be better advised not to waste their meager resources and time in reinventing the wheel.

Resource Costs of

Developing Industrial Technologies

Maddock, former Controller (Industrial Technology), Ministry of Technology, UK. Has given some idea of the resource cost of developing industrial technologies for some important industries and products. He calls them threshold levels of expenditures. Failure to reach the threshold levels of these R&D expenditures to develop these industrial technologies usually means complete failure, as opposed to partial success in other industrial activities. The thresholds are set mainly by the scale of operation of large enterprises in the field. It is folly therefore to attempt a technology which has threshold which is beyond reach. Many of these thresholds have been set by countries which have large economic and technological base, particularly USA and USSR.

Table 3 presents in descending order some rough figures for the thresholds levels of expenditures of select industrial technologies. These estimates are for late 1950s. They will have to be extrapolated to 1991 prices to get an idea o present threshold figures of R&D.

A point which is frequently missed in considering the thresholds is the progressively growing costs throughout the innovatory process. Taking R&D costs as Unit 1, the relative costs in many industrial technologies are[25]:

a. R&D 1Unit

b. Engineering, Prototypes production planning, initial manufacturing facilities, market preparation, specifications, inspections, staff training etc. 10 Units

c. Mass production facilities, packaging, transport, marketing, post-sales services and maintenance, write offs of previous products, updating etc. 100 Units

It is a common error to consider only the costs of the first (and the cheapest) stage and to overlook the much larger costs ahead. Lord Blackett in his 1973 Jawaharlal Nehru Memorial lecture describes this as "Innovation chain". A high level research and development alone is not sufficient to ensure successful innovation. The industrial and commercial elements are equally important. Actually R&D claims only a small part of the total costs of successful innovations. For instance, 'Terylene' was invented in a British research laboratory, whose annual budget was just $60,000 per annum. When imperial Chemical industries obtained the commercial rights for UK for this invention, it spent around $11 million on pilot plant development and for the first major commercial production the new plant cost around $40 million[26]. The economics of innovation chain therefore needs to be borne in mind if the investments in R&D have to be profitable. It is better to bite as much as one on can chew.

Exponential Rise in R&D Costs

As time passes R&D Costs keep rising exponentially. For example, International Telephones and Telegraphs (ITT) of USA spent $ 30-40 million to develop Penta Conta Telephone switching system in 60s. By the late 70s. the same company had to spend $ 300-500 million to develop its '1240 Analogue' electronic telephone switching system and in early 80s. it had to spend over $ 1 billion to develop its latest digital telephone switches 'System 12'. It is currently spending close to $ 100 million a year just to adapt System 12 to US Standards. It will require $ 14 billion for ITT to recoup its initial investment on System 12[27]. Halrid Corporation (later named Xerox Corporation) spent $ 4 million between 1950 and 1953 and a further $ 16 million between 1953 and 1959 on R&D to develop and perfect the Xeroxing copier. RCA, another US company is said to have spent more than $ 65 million on colour television R&D before anything resembling a mass market materialised.[28]

Economist brings out another dimension of the harsh world of R&D. In a survey of corporate R&D in OECD Countries, it revealed that as development costs rise product lives contract. For instance, the old electro-mechanical telephone switch had a sales life of 10 years. The new electronic switches which cost $ 500 million to $ 1 billion to develop are obsolete within 5 years of the first sales. Hence it becomes hard to recoup investment in R&D in a single national market.[29]

New Strategies and New Equations

Rising costs of development of industrial technologies have compelled the firms to evolve new strategies and find out new ways to cope up with the situation. The first and the most important consequence of this is that strong survives, weak withers away. Costs of remaining technologically competitive have raised the minimum viable size of companies to such an extent that mergers, takeovers and simple deaths of firms are to be seen in all industries. In the United Kingdom, for instance, the number of heavy electrical equipment manufacturers has come down from 10 in 1950s to 2 at present. On the continent of Europe, ASEA, another heavy electrical equipment manufacturers of Sweden has merged with Brown Boveri of Switzerland to form Asea Brown Boveri (ABB).[30]

If not straight mergers, there are technology exchange agreements. General Electric of US, for instance, has know-how exchange agreements with AEG of West Germany, Alsthan of France, AEI of UK and Toshiba of Japan. Westinghouse another US company manufacturing heavy electrical equipments is the largest spender on R&D in the whole world. Its R&D expenditure is more than twice the total business of some of sizable European firms. But still it has transboder technology exchange programme with Siemens of West Germany, Jeumontschniedes of France, ACEC of Belgium, English Electric of UK, Marelli of Italy and Mitsubishi of Japan.[31] Heywood and Wikes (1980) have found that when firm level R&D is insufficient, firms in automobile industry in the US have pooled their resources for R&D of fundamental nature such as fuel efficiency. Cooperative Automobile Research Program (CARP) is such a body with a budget of $ 100 million per annum.

Indeed, technology today is most traded commodity not between developed countries and LDCs but amongst developed countries themselves. The largest buyers of technology are also the largest producers of technology. The reason these countries buy technology is nothing but the time-honoured principle of comparative advantage. In Table 4 are shown some select countries' technology trade balance for some recent years. The data in Table 4 (see next page) points out unmistakably that the two fastest growing countries viz Japan and Germany are both net importers of technology. Indian imports of technology are ridiculously low compared with the developed countries. There appears to be intimate relationship between technology imports and high growth rates and development.

Conclusions

The messages from the

previous pages should be loud and clear. In a world linked by markets, division of labour, specialisation and governed by the principle of comparative cost advantage, it appears to be a folly to stick to Para Dharmo Bhayaavahah and romaticise Swadharme Nidhanam Shreyah. Indeed what is Para Dharama today would as well as be Swadharma tomorrow. Economic expediency lies in getting technology we need from wherever it is available. If it costs more to produce than to buy (a la Smith) prudency warrants buying rather than attempting to produce it. After all technology is knowledge. Why be ashamed of getting knowledge from wherever it is available? Did not our elders say

Aa No Bhadraah Rutavo Yantu Vishwatah?

(Let Knowledge come to us from every side)

Even a small household knows that it is folly to buy a cow when the milk is cheap.

NOTES

1. Eisemon (1989) has quoted Nehru thus. Dag Hammarskjold Seminar on Development of Third World Autonomous Capacity in Science and Technology, 1978, also felt that there is a strong nexus between TSR and Economic Development. See Gumaste (1988) pp.4-5

2. Nayar (1982) says that developed western countries and Japan refused to share their techonology with India, in particular industrial and defense technology in those years

3. Udgaonkar (1985) is of this view.

4. For an elaborate discussion see Gumaste (1988) Chapter 1.

5. Katrak (1985) also holds this view of TSR.

6. See Lall (1984) for elaboration.

7. The entries on the credit side are, launching of a space satellite in 1980, building up of an atom bomb, spinoffs of the atomic energy such as cancer research and treatment, radiation sterilisation of seeds, use of atomic energy research in high energy physics, electronics, metallurgy and medicine etc.

8. See Goldar (1987)

9. See World Development Report 1987, Box 2.4.

10. The author of this paper got this information in his studies of automobile and heavy electrical equipment industries.

11. Imports of technology were also restricted due to paucity of foreign exchange.

12. See Scott-

Kemmis and Bell (1988) for endorsement of this point.

13. Desai (Presently Secretary and Chief Consultant, Ministry of Finance, Department of Economic Affairs, GOI) calls this group of economists."Leftist Mafia."

14. Mostly this thesis originated in the Latin American countries, but it had many ready buyers in India. Economic and political Weekly became the in-house journal of this group of social scientists.

15. The important names which can be associated with these elements are Kidron (1964), Subrahmaniam (1972), Stewart (1977), Pillai (1979) and Bagchi (1982).

16. Subrahmaniam and Pillai (1976), for example, feel, "The suppliers of technology have been mostly multi-national corporations oligopolistically organised on a global scale". (p.1730)

17. Bagchi (1982) says " the relatively ill-informed and ill-equipped client can be made to pay through nose for advanced technology" (p.621)

18. Export restrictions, discouraging modifications of the technology sold are some of the other onerous terms. See Pillai (979).

19. Pillai (1979), for instance, says," [technology] assimilation is of pseudo character and as a result technological dependence is real and dominant (p.M.124)

20. See note 16 above.

21. The study was sponsored by an Argentinian research body.

22. The isoquants of these technologies are 'L' shaped

23. The title of his relevant book is quite suggestive. It is Appropriate or Underdeveloped Technology.

24. Chief amongst them are Maddock, Blacket (1973).

25. See Trivedi (1969)

26. Prof.Menon cites these figures in a speech delivered at the Indian Science Congress. 1984.

27. See Pinto (1986).

28. See Scherer (1971). Even a minor innovation requires large sums of money and considerable lead time and becomes viable only with large down stream

market. For instance, General Broach and Engineering company devoted $ 0.5 million and 3 years to develop an 80 tone –275 h.p. broaching machine which will turn out 380 car. Truck and other internal combustion engine fly wheels per hour. See Financial Express Sept 19, 1985.

29. Economist December 4, 1984.

30. See McGoven and Thomas (1989) p.543.

31. Ibid

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