CHAPTER 8

INTERNATIONAL COOPERATION FOR SCIENCE AND TECHNOLOGY POLICY IN ASIA

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In this chapter we deviate from the general process of outlining steps in science and technology policy formulation. Instead, the article focuses on ways in which the countries of Asia can get and share information and assistance in the policy-making process.

In the article, **Falguni Sen** and **V.L.V.S.S. Subba Rao**, build a strong case for regional cooperation in science and technology for development. Such cooperation, they argue, should extend far beyond the limitations of policy development. It should include assistance in technology acquisition, adaptation and dissemination.

This article makes a significant contribution to the compendium because the whole exercise of putting this book together stemmed from a desire to formulate an Asian network on science and technology issues. These authors make a number of very practical suggestions about ways in which such a network could benefit all the participating countries of the region.

SCIENTIFIC & TECHNOLOGICAL COOPERATION BETWEEN SOUTH ASIAN COUNTRIES *

BY
FALGUNI SEN
&
V.L.V.S.S. SUBBA RAO

INTRODUCTION

The world today is being increasingly affected by developments in technology. Ease of travel, trade and mutual dependence on resources has forced a mixing of different cultures. Advances in communication technology have facilitated sharing of ideas and information. Medical technology has succeeded in prolonging life to such an extent that the very definition of death has become controversial. Technology has also changed the occupation of people by creating new opportunities and breaking down older ones. From agriculture and cottage industries it moved workers into the factory. Today, automation is closing down opportunities in the factory and creating new ones in information management, data processing and other service sectors. And yet, war, pollution, devastation of nature, new diseases and a greater distinction between developed and less developed countries, are also the outcomes of this very same advancement of technology. Managing technology to maximize the positive aspects and minimize its negative consequences is thus a critical task for each nation.

Developing countries have viewed technology as a major vehicle for development. It was felt that these countries would not have to go through the arduous and expensive process of developing new technologies but could adopt existing ones from developed countries and "leap-frog" into a new era of development. Part of this optimism came from the experiences of developed countries. Denison claimed that technological innovation was responsible for more than half the increases in the post World War II rates of economic growth in the USA. Similarly, many of the recent Japanese successes in capturing the Western market, especially in consumer electronics and the automative sectors have been attributed to technological innovations. The high technical capability of Singapore in the assembly and processing of imported raw materials and intermediate goods has catapulted the economy to high levels of growth. Industrialization has been a well articulated and

*Adapted from Falguni Sen, and V.L.V.S.S. Subba Rao, "Scientific and Technological Cooperation Between South Asian Countries: Some Issues"; Administrative Staff College of India (Hyderabad: 1983)

widely accepted strategy for rapid economic growth. The pace of industrialization, in turn, is strongly influenced by the rate of technological change. However, technology has not always been the hope for cure in developing countries. The latest technology has not been made available; the technologies acquired have often not been appropriate to the resources and needs of the country; the costs of acquiring these technologies have been prohibitive and various restrictive clauses have often impaired a complete assimilation and diffusion of the technologies.

The underdeveloped countries of the world have an embarassing gap compared to the technological storehouse of advanced countries. The consequences of this gap are reflected quite clearly in the low growth rates of GNP, low per capita incomes, a poor industrial base and an inefficient export sector. The developing countries are faced with the need to create additional employment to the tune of about 50 million jobs in order to just be able to maintain the existing levels of employment. Physical limitations and already high rates of underemployment restrict the potential for job creation in agriculture Technology would go a long way in accelerating the pace of industrial development of these countries.

Technological development in developing countries has often been plagued by the problems of small markets in those countries coupled with the need for economies of scale. Some recent developments in technology may necessitate a re-examination of these assumptions. For instance, in the energy sector the feasibility of decentralized technologies like biogas has been demonstrated. In the information and data processing fields, the availability of microprocessor kits has opened up new possibilities for small-scale production of two appropriately designed data processing equipment. To a certain extent, the division of labour between software and hardware development in the computer area has opened up possibilities for a true participation in technology development by specialists in the developing countries trained in software development.

Breakthroughs in the field of biotechnology may open up new possibilities wherein the actual organization of new technologies may become more simplified--no longer requiring the establishment of complex backward and forward linkages for successful implementation. Thus, the nature of technological change in some sectors may itself provide newer opportunities for more appropriate and efficient exploitation by developing countries.

The industrial sectors in the countries of South Asia have begun to grow rapidly. In 1981, Bangladesh, Pakistan, India and Sri Lanka had growth rates between 5.8-6.8 percent. India's growth rate was 5.2 percent in the electricity, gas and water sector in 1980 while Sri Lanka's grew at almost 12 percent in 1981. Pakistan's manufacturing sector grew at the rate of 12.1 percent in 1982, and Bangladesh's at 8.9 percent in 1981. Such growth in industrial sectors has been associated with massive technology acquisitions mostly through the import of technology. This has, in turn, caused

a dependence on suppliers of technology, leading to a number of adverse consequences. This will be discussed in greater detail later.

The South Asian countries fall into three categories:

1. Those having definite policy guidelines and instruments which can be directly applied to terms and conditions in contractual agreements and have regulatory agencies for technology acquisition;

2. Those who have no definite guidelines but rely on indirect regulations like the French Exchange Act to implement its decisions;

3. Those who follow an open door policy to technology acquisition. Based on available information, India falls in the first category, Pakistan and Sri Lanka to varying degrees in the second category, and Bangladesh in the third category.

Each of these policies have their advantages and disadvantages. Regulation has often succeeded in reducing the adverse consequences of technology import and yet it has often acted as a disincentive to the suppliers of technology who have been reluctant to supply the latest knowhow under stringent regulations. Lack of regulation on the other hand has often led to a number of adverse consequences. The sharing of experience between the countries of the South Asian region regarding the effects of different policies in each country would be very useful.

The unequivocal acceptance of the need for technology in South Asia calls for cooperation amongst the relevant countries. At the conceptual (R&D) level and at the level of production, the South Asian countries, which share identical problems of poverty, slow pace of industrial growth, and adverse external payments situation need to devise a working strategy of mutual scientific and technological cooperation, so that areas for feasible collaborative ventures can be identified.

This paper argues that all the countries in the South Asian region are increasingly depending on technology to be the major vehicle for development. And yet, they lack the capacity to produce these technologies and are essentially dependent on the developed countries. This dependence can lead to a number of adverse consequences of technology import especially in terms of high costs of technology, restrictive clauses, inappropriateness of the imported technologies and inhibition to the development of a local innovative base. While a number of measures may be taken by each country to minimize these adverse consequences, collective efforts by developing countries, or at least by certain regional groups like South Asia, are likely to be more effective. Any attempt to institutionalize scientific and technological cooperation in South Asia should thus be based on this philosophy of mutual interest. Any guidelines for technology transfer between the countries of the region should ensure that the recipient countries do not suffer from the

same adverse consequences of technology import as experienced due to heavy dependence on technology from developed countries.

TECHNOLOGICAL DEPENDENCY

Dependency theorists have argued that "the underdeveloped state of third world countries was attributed not to the fact that they were at an earlier stage of history than the advanced countries, but to the fact that the impact of the advanced countries on the Third World had caused their underdevelopment. Further, the availability of technology and other support systems in the developed world at the time when the productive sectors in the developing countries were just beginning to grow, caused a dependency on foreign suppliers at the expense of the development of local technical capabilities. Specifically, the location of R&D in the home countries of foreign suppliers, especially the multinational companies, put the developing countries in a state of almost permanent technology import dependency. "Technological dependence" occurs when the major sources of a country's technology is from abroad. This dependence arises "initially from the imbalance in technological capacity, i.e. the capacity to produce technology".

In India, this dependency is manifest by over 7500 foreign collaborations which have been approved since independence. While India averaged around 300 collaborations per year for many years, 1983 saw a spurt in foreign collaborations when 673 agreements were signed. Of these, 129 had foreign financial investments. While this spurt in collaborations is associated with a general increase in industrial activity and liberalisation of import policies, a number of these collaborations are in areas where production technologies already existed in the country. In other words, either the existing technologies could not be diffused or they were not indigenously improved, necessitating import of more efficient versions. In either case, these collaborations highlight India's dependence on foreign suppliers for technological updating and growth. Data on foreign collaboration in other South Asian countries is not available.

India's investment of around Rs.7000 million on R&D in 1982 was less than one third the amount spent by a company like General Motors alone on R&D. Even if all the resources of the South Asian region are put together, they will not be able to match a developed country's capacity to produce technology. What is essential, therefore, is the collective identification of "technological thrust areas" where the entire region may benefit by the development of a "capacity to produce technology".

The positive consequences of technological dependence are often referred to as the advantages of being a "late-comer". These "late-comers" have been able to use technologies without having to go through the difficult and costly process of developing them. Furthermore, the availability of such technologies has often "inspired the desire for technical change". The case of Japan is often cited in this regard.

There are four major disadvantages of this dependence:

1. Costs explicit and implicit in acquiring external technology
2. Loss of control over decisions including restrictions on the use of the technology
3. Unsuitability of the technology received
4. Adverse impact on the local innovative base

Some details regarding these disadvantages are presented below:

1. Costs

   Direct payments like royalties, licensing fees, costs of plant and machinery, consulting fees, fees for technical services and salaries to personnel from the supplier company.

   Contractual agreements often "tie" part or all of the inputs in a given technology to a single source. The result is "over pricing" of such inputs.

   There are costs associated with being the weaker side of the bargaining process.

   Technology is sold in an imperfect market, far in excess of its marginal cost.

   Insufficient knowledge of available alternatives results in "ideals" which are not necessarily the best available at that time or the most appropriate to the receiver's needs.

   The advantages of acquiring a "true and tested" technology coupled with the prejudice in favour of foreign technology in the developing countries may raise the price of the technology being sold. Further, the receiver country may not have anything to offer to the supplier country/firm. The only attraction may be entry into the domestic market. But the small size of the market may not fully offset the costs the supplier incurs in parting with the technology. "Cross-licensing" and "give-back clauses" which are offered as incentives by technology-acquiring firms of the developed countries to potential suppliers are rarely available from firms in the developing countries.

   There are costs associated with the training of local manpower for managerial and production skills.

2. Lack of control and restrictive clauses

Restrictive clauses in the contract may limit the sources from which inputs such as machinery, materials and spare parts may be acquired, resulting in inefficient purchases.

Contracts have been reported to determine the prices at which the output will be sold and the amount of output produced.

Restrictions on possible adaptations or change to process design can make the technology inappropriate to the specific needs of the country.

The supplier firm may have control over the recipient firm's R&D in the area of the purchased technology.

Restrictions on export can reduce the sales potential of the receiver firm in the developing country.

3. Unsuitable characteristics of the technology received

Besides the macro issues of imported technology being capital-intensive and essentially articulating the aspirations of a small elite, there are a number of micro firm-level issues as well:

The small domestic markets may not be able to support "optimal" production levels and "scaling-down" may be necessary to cut production costs.

Locally available raw materials may not be suitable due to higher variability or differential quality, requiring costly design changes.

The specificity of the local market needs may necessitate product and process design changes.

Waste-products which may be designed to be cast off as a slurry in a developed country may need to be recovered in a developing country.

Redesign of operating characteristics may be needed to suit local skills.

4. Impact on the local innovative base

There is a demoralizing effect on indigenous R&D when technology, especially in the areas where R&D has been intensive, is imported.

Externally acquired technology inhibits the "learning-by-doing" process in general and makes it more difficult to develop the required skills to maintain, improve and modify plant operations.

APPROACHES TO DEAL WITH THE ADVERSE CONSEQUENCES OF TECHNOLOGY DEPENDENCE

A number of countries have attempted to reduce the adverse consequences of technology dependence through a variety of mechanisms. These have been both at the macro governmental level as well as at the level of the firm which receives the technology.

Macro approaches including the following:

1. Government policies
2. Strategies for technology development
3. Strategies for technology infrastructure
4. Policies to improve technology acquisition

Government policies: A number of developing countries have introduced policies regulating the flow of technology. Some of these explicitly ban the import of some types of technologies while others impose strict conditions on import. Even where explicit policies regulating the import of technology do not exist, governments may use financial and other indirect means to impose some restrictions. Such policies are aimed at reducing the negative consequence of technology dependency outlined above, both in the short and the long term. These policies may identify areas where indigenous technology is to be promoted, areas where technology in an "unpackaged" form only is to be allowed, and other areas where a free import of technology may be allowed. Such policies may also provide guidelines regarding permitted channels through which technologies may be acquired, the maximum permissible royalty payments, the duration of collaboration agreements and restrictive clauses to be avoided.

Strategies for technology development: Since the negative consequence of technology dependence arises primarily out of a lack of "capacity" to produce technology, many governments have evolved strategies to enhance their technological capacity, either in general or in some well-defined areas.

Strategies for the development of infrastructure for better absorption and assimilation of technology: This involves financial assistance for the development of special skills and promotion of indigenous technologies; building up relevant R&D infrastructure to generate "know-why" rather than "know-how"; and development of trained manpower. These strategies are designed to permit and facilitate the acquisition and absorption of

"unpackaged" technologies. In this context, special attention is often given to development of design engineering and engineering consultancy groups.

Policies to improve the technology acquisition process: Governments may prefer bilateral agreements in order to reduce the negative consequences of being the weaker party in the negotiation process for technology acquisition. Compulsory screening and evaluation of alternatives may be required before approval for technology purchase is given. In order to facilitate this, there may be a conscious effort to improve the information base which is so vital for a proper evaluation of available technological alternatives.

Many governments have attempted to set up appropriate agencies and organizations to formulate and implement the above policies. Countries of the South Asian region may share their common experiences in the formulation and implementation of these policies. It may even be possible to collaborate with a view to jointly setting these policies and appropriate agencies may be created for that purpose.

Micro approaches include the following:

1. In-house R&D units: Various firms have set up in-house R&D units with the specific purpose of adapting, adopting and assimilating imported technology.

2. Independent Research: Through independent research based on published information some firms are generating their own knowhow. It increases their capacity to produce technology. Even though some of these indigenously developed knowhows may be inefficient, they have, at times, exerted pressure on foreign companies to part with their proprietary technologies.

3. Informal Network: Companies are developing informal networks to generate information on operating characteristics, costs, prices, etc. of foreign technolgies of their interest.

4. Involvement of Technical People: There is a greater involvement of technical people in some firms in the evaluation of alternatives and in the negotiation process.

5. Modernize Vendors: Some firms are attempting to help vendors modernize so that they can quickly gear up to meet the needs of any technological change.

Opportunities should be created for sharing these types of experiences between firms in the South Asian region. This will allow for the establishment of informal linkages which are vital in the area of scientific and technological collaboration.

REDUCING THE ADVERSE CONSEQUENCES OF TECHNOLOGY DEPENDENCY: SOME OPPORTUNITIES FOR COOPERATION

In this section, we will outline how cooperation within the South Asian Region can help reduce some of the adverse consequences of technology dependency.

Costs: The high costs of technology stem from our being the weaker partner in the negotiations process; lack of information regarding the prices at which similar technologies are sold to other customers; and lack of information regarding the availability of alternatives. Our bargaining power may be low due to the lack of capacity to produce technology, as well as small market sizes (which make it unattractive for the supplier). It may be possible to look at the entire South Asia region as a single market for certain commodities, thereby increasing the bargaining power during negotiations for technology. Another way would be to collectively ensure that potential suppliers of technology will not be able to sell their product in the region unless they settle for local production.

There may be areas where resources of the region may be collectively pooled to develop regional capabilities for producing certain technology items. The development of such capacities could either result in the actual production of regionally needed technologies or create conditions for better absorption and assimilation of such technologies. They could also increase the bargaining power in the negotiation process.

One way of resolving this problem of cost has been through the effective use of unpackaged technology. However, the capability of any country to take full advantage of unpackaged technology depends on its own capital goods sector, its own design and engineering strengths and its own materials science base. Here too, the collective efforts of a region in selectively developing mutually complementary capabilities are more likely to succeed than the individual efforts of any given nation. This may require the setting up of complementary production facilities for capital goods in different countries of the region. Training in technological skills in developed countries is another area where costs can be prohibitive. The South Asian countries could identify specific technology training priorities for which member countries could share opportunities and resources.

Countries of the South Asian region have imported technology for a number of years. Information regarding specific kinds of technologies imported by each country is available within the countries. This information could be very meaningfully shared within the region so that more efficient decisions could be made. This may require involving people from different countries in the region with relevant experience as members of teams conducting feasibility studies and negotiating purchases.

Due to different relationships in the international political arena, South Asian countries may have differential access to information from different countries in matters of technology. Pooling such information could prove valuable for them all.

Restrictive Clauses: Developed countries provide us with a useful source of new technolgies. It should be possible for the developing countries to share this production knowhow among themselves. However, this may not be possible due to a number of restrictive clauses which are often included as part of collaboration agreements. As a matter of policy, the South Asian countries could ensure that restrictions on diffusion of technologies among countries of the region should not be entertained. Policies may be evolved to ban contracts which restrict the purchase of machinery, materials, and spare parts from within the region. Similarly, restrictions on export, especially to countries within the region, should not be allowed.

Inappropriateness of imported technology: A number of technologies developed in the advanced countries may not be suitable to the needs and characteristics of many developing countries. The inappropriateness of imported technologies may originate with the following factors:

1. Labour
2. Capital
3. Climate
4. Energy utilization
5. Unrecoverable waste products
6. Operating skill requirements
7. Maintenance infrastructure
8. Levels of operation

It may be necessary to make changes in the design, composition of materials, raw materials specifications and scale of operations for optimal application of imported technologies. The South Asian region shares many of the factors which may cause a technology to be inappropriate. Information on modifications and adaptations made in one country should be available to member countries. Moreover, the inappropriateness of a given technology in one country should be explained to other countries in the region.

India has developed considerable expertise in the small-scale sector. Much of this knowhow is easily transferable and very appropriate to the needs of other countries in the region. This is especially true in leather, textile and other consumer goods industries, as well as in assembly operations in the electronics sector. Many innovations from government laboratories as well as independent inventors have resulted in the development of production equipment which would be suitable to the needs of the small-scale industry throughout the South Asian region.

In the area of waste product utilization, a number of techniques developed by Indian industry could find useful application in other countries. Similarly, local innovations in the

agriculture machinery and farm implements could be very appropriately used within the region.

Impact on the local innovation base: According to Charles Cooper, the local innovative base in a developing country, i.e., R&D laboratories in the government and private sectors, is necessarily "marginalized" from the production activites. Even where the local R&D base has been developed, scientists find that technologies which they have been trying to develop are suddenly imported. This can have a demoralizing effect on local R&D. In certain areas, where the region as a whole may benefit from local development of a technology, cooperative research projects may be set up with participation of scientists from all the countries of the region. This could be done on the lines of CERN in Europe. It will be necessary to identify specific areas of collaboration and mutual interest to all the countries of the region for such cooperative research to be successful. Besides the conventional areas like biogas and other alternative energy sources, small scale food processing and packaging technology, newly emerging areas like biotechnology and electronics may also be considered.

In sum, South Asian countries can greatly benefit by mutually reducing the adverse consequences of technology dependency. This cooperation should be based on a philosophy of interdependence and mutually shared concerns regarding technology imports.

OTHER AREAS FOR REGIONAL COOPERATION

Besides the cooperation to reduce the adverse effects of technology dependency, some other areas of general cooperation in S&T may also be identified.

Adaptation and assimilation of knowhow: Adaptation and assimilation of imported technology has been problematic. This has often been due to lack of appropriate technical infrastructure and management knowhow. It may be useful to pool common resources where skills for adaptation and assimilation of technologies do exist. This would imply cooperation in design and engineering consultancy and research.

Maintenance of technology: For new products or new technologies introduced into developing countries, the cost of maintenance may be very high. Maintenance management including quality control and testing facilities may be very expensive, while the small number of products or technologies introduced into the market may not create sufficient demand for these maintenance facilities. It may be possible to develop regional maintenance services combining the skills available in all the countries of the area.

Sharing of essential services: The knowhow developed in some sectors in India, like flood control, ground water surveys, oil exploration, etc. could very easily be applied in other

countries of the region. It may, therefore, be possible to work out collaborative arrangements in these areas.

Inventory of capabilities: One problem in organizing meaningful cooperative programs has been the lack of detailed information on available production and research capabilities in each country. A centralized information system which will inventory all capabilities within the region, as well as those likely to develop in the near future, could be set up.

Technology monitoring and intelligence cell: The rate of technological change in many sectors is very rapid. Developing countries have often faced the situation where "new models" are introduced by the supplier soon after the acquisition of older versions. Thus a technology monitoring and intelligence cell should be set up which will monitor information regarding technological change in all areas of interest to South Asian countries.

Specific Areas for Possible Cooperation

A number of commodities traded by the countries of the region in 1982-83 are identified in the attached table. Based on the commonality of export and import, it may be possible to identify some areas for technology collaboration. For instance, in the area of jute manufacture, it may be possible for India and Bangladesh to collaborate on research related to the creation of equipment for different types of jute blends with synthetics; new designs in jute fabric; and new applications for jute. This would help the jute industry compete with synthetics and other substitutes that may be a threat to jute products from both these countries.

In the areas where countries of the same region should compete for exports, cooperation may be more useful in conducting common R&D projects rather than in direct sales of technology. In the area of textile machinery, on the other hand, equipment manufactured in India and adapted to the Indian conditions may find acceptability in other textile manufacturing countries of the region. In areas such as petroleum, petroleum products and fertilizers, where most of the countries in the region are importers, it may be possible to identify common production facilities. In paper products, research facilities available in India could be used to improve productivity and to find alternative applications for paper produced and exported by other South Asian countries. Thus, there is a potential both for direct transfer of manufacturing equipment as well as collaborative research on adaptation and modification of imported knowhow.

In some areas like chemicals and allied products including drugs, some countries in South Asia have been licensed to produce certain drugs and chemicals for which other countries in the region have not been given permission. Some of these licences may have expired and it may be possible to work out bilateral agreements for sharing knowhow in these areas.

Certain new technologies, such as genetic engineering and other forms of biotechnology may find massive applications in the developing countries. This knowhow is currently monopolized by companies in the developed countries. In these areas, the South Asian region may be well served by investing collectively in massive research projects in order to either acquire this knowhow or at least create the capability which would improve bargaining power vis-a-vis the monopolies. Moreover, such research programs may be directed to areas of specific applications relevant to the needs and conditions of the region. They could also prepare infrastructure for better assimilation and maintenance of these new technologies once they become commercialized. In Europe, in both the aerospace industry, and the nuclear field (CERN), such collaborative ventures have proved very successful.

It is not the intention of this paper to argue that useful cooperation in certain specific areas can take place only in existing items of import and export. The South Asian countries may be well advised to also identify certain areas where local resources can be used to produce exportable commodities. One such area is computer software (e.g. India) where the skilled manpower is available. But the necessary physical infrastructure and organizational linkages required to develop the product as an exportable commodity are still lacking.

To conclude, this paper has argued that the basic philosophy for S&T cooperation in South Asia should be one of interdependence and mutual interest. It is suggested that the adverse consequence of importing technology can be reduced most efficiently by cooperative efforts. Specific areas for regional cooperation have been identified.

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