Technological Capability Building in Low-income Developing Countries towards Understanding their Problems*

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Abstract

Most developing countries are finding it very difficult to make the desired change towards industrialization and, in particular, raise their manufacturing output share in GDP. The issue is of particular concern to low-income developing countries. Their most notable advantage in cheap labor fails to be materialized in the goods produced and they find it difficult to compete in the international market. Being imitators rather than innovators of technology they face a disadvantage: Though the literature on how best imported technologies can be used to the advantage of the recipient is not yet extensive and does not allow us to see the experiences of various countries and, in particular of the few successful ones, a consensus has more or less emerged about the need for developing some strategy. For example, Enos and Park (1987) talk about improving negotiations with the suppliers of technology. Lall (1987, 1992) emphasizes the need to enhance technology learning by manufacturing enterprises, Freeman (1988) finds the national system of innovation as a decisive factor, Ansden and Hikino (1994) argue for subjecting borrowed technology to continuous incremental upgrading though improved shop floor management, and Bhalla (1996) advocates for developing S&T infrastructure and R&D activities. While there is some variation in emphasis by the various authors as to the type of action required, there is a common strand which binds them together: it is in their emphasis on the need for improving the ability of a developing country to operate the imported technology efficiently and effectively. The paper reviews the various strands of thinking and then goes on to identify some of the main problems which have hindered the promotion of technology capability building in developing countries. References are made to a number of Asian and African low-income developing countries, although it must be admitted that the empirical findings are of a fragmentary nature.

Keywords: Incentives, Indigenous capacity, Industrialization, Market forces, R&D, Technology Policy.

Introduction

The main objective of this paper is to reflect on technological capability building (TCB) with a view to understanding some relevant issues in the context of low-income developing countries (LIDCs).

To start with, let me mention that in the paper I have used much of my own research (especially that carried out on Bangladesh), although I have also used some other relevant studies.

In an age when the case for liberalization is being followed by most developing countries, often pushed by the IMF and the World Bank, the ability to compete effectively at home and in international markets will largely determine the survival of a production venture. Being borrowers (or say imitators) of technology rather than innovators places the developing countries at a distinct disadvantage since they are unable to gain monopoly profit in any of their production activity. In fact, most of the manufactured goods exported by the low-income countries are low technology manufactures produced long after the technological methods were invented; the LIDCs are keen to take advantage of the cheap labour that prevails. On the positive side, there is the advantage that the technology is widely known, there are many sources available to procure the technology and the technology can be bought at competitive prices so long as there are no obligations towards suppliers' credit or tied foreign aid. On the negative side, however, there are a number of disadvantages. Firstly, because LIDCs do not produce the technology themselves they are heavily dependent on technological suppliers. Secondly, as the products are made using little technology there is intensive competition among the LDCs and within an LDC, with hundreds and thousands of firms competing against each other (for example in carpet and...
studies on the subject of technology capability building. This intensive competition is an important factor for keeping the prices down, thus causing deterioration in the net barter terms of trade even for their manufactured exports. Thirdly, in relation to the first point, there are cases where LIDCs manage to move to medium and high level technologies but have to depend heavily on the importers for the necessary support in design and so forth because of lack of local R&D.

Furthermore, in an age which is increasingly advocating the liberalisation strategy any direct involvement by the state these days could possibly be frowned upon. The neoclassical economists are expected to be particularly critical to any state involvement as they believe that government intervention in the trade flows of developing countries (a strategy which many developing countries followed vigorously with little success for a number of decades from the 1950s onwards) has done serious damage to resource allocation. They are, therefore, keen to see a return to the days when laissez faire prevailed with a minimal government role.

One may be tempted to draw some obvious conclusions, such as the ones, when examining the liberalisation strategy now being vigorously pursued:

(a) Technological capability building should be left to market forces, thus enabling it to develop efficiently without any government intervention;

(b) With regard to the first point, in the free enterprise model of development as pursued by the industrialised countries, technological capability building does not need any government intervention.

At the outset, let it be mentioned that the available theoretical arguments and the empirical evidence do not support the above standpoints which follow from the orthodox liberal approach.

The next section (Section 2) will briefly provide some theoretical background to technology capability building (TCB). Section 3 will present a brief survey of the state of TCB in some low-income developing countries (LIDCs). In Section 4, we discuss whether LIDCs should have a policy with regard to the promotion of TCB. Finally, in Section 5, we discuss the conclusions that have been reached.

Theoretical Background

Since the 1980s, there has been a healthy amount of studies on the subject of technology capability building (TCB) with particular emphasis on some of the dynamic aspects (see, e.g. Enos & Park 1988, Lall 1987, 1992; Huq & Islam 1992; Huq et al. 1993; & Bell & Pavitt 1992). Some of the initial technological evaluation studies which took place in the mid 1970s (Strathclyde University, Pickett 1981, Huq & Aragaw 1981) were rightly criticised for focussing on the static cost-minimising approach. At the time when the studies were carried out, the wastage of capital which went along with the import of large-scale capital intensive technologies by most developing countries was a matter of serious concern and, understandably, these studies tried to draw attention to the proposal that by careful selection a developing country could easily go for a better technological alternative than the one adopted. (Huq 1996). However, the approach failed to take into account the dynamic features of technology assimilation, diffusion and innovation. Thus, for a closer understanding of technology capability building the need was felt to define the concept in a much broader way in particular by incorporating the capability to select, assimilate, use, maintain, adapt, design, and even create technology, thus ensuring the capability to develop products and processes in response to a changing economic development.' (Huq 1996)

Following a UN study (1987), three main aspects of TCB are listed below:

(a) The selection of machinery and equipment for producing specific goods and services;

(b) The assimilation and diffusion of those technologies in the host economy; and

(c) The development of indigenous capacities for innovation.

One can also think of some extra features which, for example, have been observed by Bhalla while examining the case of advanced technologies (Bhalla 1996, Huq 1998):

(d) an organisational capacity for manufacturing new products using new technologies;

(e) indigenous capability in production, design and engineering at a stage where technology can be produced/assimilated and efficiently utilised;

(f) opportunities of collaboration with industrialised countries; and

(g) the speed and extent of technology diffusion.

Bell and Pavitt (1997) are keen to focus on technological learning enabling technical change to take place. An important feature of the dynamic elements is of "technology learning" and this has been strongly emphasised in relevant literature (Lall 1987, 1992). The learning process involves a number of components including (a) development of human capital; and (b) Research and Development (R&D).

Development of Human Capital. An important prerequisite of technology capability building is a labour force which can select, install, maintain,
assimilate, design, manufacture and even create the technology. The workers do not need to be the inventors, but must have the ability to absorb borrowed technologies successfully. The mass educational development which took place in South Korea (and also in Singapore, Taiwan and Hong Kong) preceding their success in industrialisation is often provided as an example.

R&D. This is considered to be the core of technology capability building. Freeman (1987) associates R&D with the national system of innovation and describes it as the decisive factor. The ease of absorbing new technologies in agriculture, thanks largely to the successful R&D carried out in Asian and South American countries, has greatly contributed to the success of the Green Revolution. There is a very high social rate of return from R&D in agriculture, typically exceeding 20% and often higher than 40% (Khan & Akbari 1986). Unfortunately, however, investment in R&D in the manufacturing sector is negligible in most LIDCs.

However, information on R&D expenditure is often not readily available for low-income developing countries, which is perhaps understandable considering that R&D activity is almost non-existent in many of these countries. In Table 1, we have tried to give some idea of the huge gap that exists between developed and developing countries in this regard. It is apparent that the developing countries are fairing badly when it comes to investment in R&D and also the number of scientists and engineers engaged in R&D. There is a positive correlation of GNP per capita with R&D variables, the lower the per capita income the lower is the investment in R&D as a percentage of GDP. A similar relationship is also observed between GNP per capita and the number of scientists and engineers in R&D, the correlation coefficient being stronger here (0.8740, n = 19) than in the former relationship (0.7142, n = 19).

Table 1. Investment in R&D and the Availability of Scientists and Engineers in R&D in Selected Developed and Developing Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>GNP per capita 1995, US$</th>
<th>Year</th>
<th>Research and Development As % of GDP</th>
<th>R&amp;D per capita (US$)</th>
<th>Number of Scientists and Engineers in R&amp;D (1987-1997) (per million people)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed Countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK (18,700)</td>
<td>1996</td>
<td>2.04 (1.4)</td>
<td>384</td>
<td>2,448</td>
<td></td>
</tr>
<tr>
<td>Canada (19,380)</td>
<td>1997</td>
<td>1.66 (n.a.)</td>
<td>315</td>
<td>2,719</td>
<td></td>
</tr>
<tr>
<td>France (24,990)</td>
<td>1997</td>
<td>2.25 (1.5)</td>
<td>545</td>
<td>2,659</td>
<td></td>
</tr>
<tr>
<td>USA (26,980)</td>
<td>1996</td>
<td>2.64 (1.7)</td>
<td>655</td>
<td>3,676</td>
<td></td>
</tr>
<tr>
<td>Germany (27,510)</td>
<td>1998</td>
<td>2.41 (1.5)</td>
<td>675</td>
<td>2,831</td>
<td></td>
</tr>
<tr>
<td>Japan (39,640)</td>
<td>1996</td>
<td>2.8 (1.9)</td>
<td>1,226</td>
<td>4,909</td>
<td></td>
</tr>
<tr>
<td>Developing Countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bangladesh (240)</td>
<td>1995</td>
<td>90.03 (n.a.)</td>
<td>0.1</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>India (340)</td>
<td>1994</td>
<td>0.73 (0.22)</td>
<td>2.4</td>
<td>149</td>
<td></td>
</tr>
<tr>
<td>Pakistan (440)</td>
<td>1997</td>
<td>0.9 (0.0)</td>
<td>4.4</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>China (620)</td>
<td>1995</td>
<td>0.61 (n.a.)</td>
<td>3.8</td>
<td>454</td>
<td></td>
</tr>
<tr>
<td>Indonesia (980)</td>
<td>1994</td>
<td>0.07 (0.04)</td>
<td>1.0</td>
<td>182</td>
<td></td>
</tr>
<tr>
<td>Thailand (2,740)</td>
<td>1996</td>
<td>0.13 (0.04)</td>
<td>4</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td>South Africa (3,160)</td>
<td>1993</td>
<td>0.7 (n.a.)</td>
<td>21</td>
<td>1,031</td>
<td></td>
</tr>
<tr>
<td>Mexico (3,320)</td>
<td>1995</td>
<td>0.24 (0.17)</td>
<td>11</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>Brazil (3,640)</td>
<td>1996</td>
<td>0.81 (n.a.)</td>
<td>37</td>
<td>168</td>
<td></td>
</tr>
<tr>
<td>Malaysia (3,890)</td>
<td>1996</td>
<td>0.24 (0.17)</td>
<td>11</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>Korea (9,700)</td>
<td>1994</td>
<td>2.6 (2.0)</td>
<td>271</td>
<td>2,193</td>
<td></td>
</tr>
<tr>
<td>Taiwan (12,400)</td>
<td>1993</td>
<td>1.7 (0.8)</td>
<td>180</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>Hong Kong (22,590)</td>
<td>1995</td>
<td>0.1 (n.a.)</td>
<td>23</td>
<td>98*</td>
<td></td>
</tr>
<tr>
<td>Singapore (26,730)</td>
<td>1995</td>
<td>1.13 (0.6)</td>
<td>300</td>
<td>2,318</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Figures in brackets show: in col. (1) GNP per capita in US$ and in col. (3) R&D expenditures incurred by industry. * Data for Hong Kong for the number of Scientists and Engineers refer to the period 1985-95. Figures have been rounded off.

Sources: Given the difficulty of obtaining the relevant data especially for developing countries, we have depended on various sources and in some cases there may be some slight discrepancies, e.g., the year of data relating to the percentage of R&D in the industrial sector may not exactly match with that of R&D expenditure as % of GDP. However, the discrepancies are not of a magnitude as to provide any misleading information. The sources of data are UNESCO, Statistical Yearbook (various issues); World Bank, World Development Report (various issues); and OECD, The Future of Asia in the World Economy (edited by Foy et al).

In the technology learning process, two other factors which have been strongly emphasised in the literature are:

* improved negotiations with the suppliers of technology (Enos and Park 1987); and
* development of S&T infrastructure (Bhalla 1996).
The State of Technology Capability Building in Developing Countries

Since the 1980s there have been a number of studies on technology capability building and some of these studies, which are of an empirical nature, have focussed strongly on the success of the industrialisation drive in the Newly Industrialising Countries (NICs). While various authors including Dahlman and Westphal (1981) and Katz (1987) have focussed on Latin America, others such as LinSu-Kim (1980), Lall (1987), Enos and Park (1988), Hobsday (1991), Huq et al. (1992, 1993) and Chen and Sewell (1996) have focussed on Asian countries.

South Korea. South Korea in particular has been closely studied by a number of people and the overwhelming conclusion is that technology capability building in Korea has been strongly coordinated by the government (Kim & Dahlman 1992, and Chen & Sewell 1996, p. 760). In the words of Chen & Sewell (1996, p.760):

“For a number of years the South Korean government has continued to play an active role in promoting indigenous technological development through a number of initiatives. In 1967 the Ministry of Science and Technology (MOST) was established to act as a central agency for policymaking, planning, coordination and promotion of science and technology. Although there has tended to be a territorial conflict between MOST and the South Korean Ministry of Trade and Industry, MOST is in charge of funding and providing direct guidance to many of the government-supported research institutes. The South Korean Institute of Science and Technology (KIST) established a year earlier than MOST has been set up as the first modern multi-disciplinary research organisation in South Korea, undertaking contract research with industry.”

Chen and Sewell also found that Taiwan went through the same developments that South Korea had. Like the role played by MOST in South Korea, the National Science Council (NSC) in Taiwan acted as a central agency of science and technology formulation, coordination and implementation at the national level. However, as observed by Chen and Sewell (1996), despite the broad similarities in policy “South Korea seems to have been relatively more successful than Taiwan in mobilising the private sector to invest in R&D, a factor which can be partly attributed to its more concentrated economic power but also to its relatively more generous levels of government subsidy.”

However, for the low-income developing countries there are not many studies similar to the ones on NICs. From the limited information available a portrayal shall be given of technology capability building in two selected low-income developing countries (Nepal and Bangladesh) and in some Sub-Saharan African countries.

Nepal. Research undertaken by Chitrakar (1994, 1999) and Shakya (1999) enables us to get a good understanding of some of the relevant aspects of TCB, including the state of S&T infrastructure and level of R&D expenditure. While Chitrakar’s original studies related to FDI, he subsequently studied closely the S&T infrastructure and its effectiveness in technological capability building. A number of important findings emerge from Chitrakar’s studies:

* There is no local R&D in FDI, although they are found to have contributed in investment and employment growth and also have demonstration of spillover effects.
* S&T infrastructure is fragmented.
* Hardly any private R&D, although in recent years one or two NGOs are carrying out R&D.
* Existing R&D activities, particularly at the university-level, are more orientated towards fundamental research.
* A high percentage of the R&D fund (70-80%) is spent on salaries and wages. (The exception is an NGO, Lever, which spends 65% on R&D)

Indira Shakya’s research is in the form of an industry case study, thus enabling one to have a clearer idea of areas not covered by Chitrakar’s studies. She finds that R&D is almost non-existent and the S&T infrastructure needs rapid development and suitable coordination. However, by focusing on a particular sector, micro hydro, she has been able to see the technological development by examining the technology manufacturers and users. Thus viewed, she finds that the sector has some glimmer of hope. Balaju Yatra Shala (BYS), a pioneering engineering firm, started to promote the technology in collaboration with non-profit making foreign organisations. Some of the skilled hands left BYS to start their own firms and in the recent past there were in total nine industrial units producing turbines and other necessary equipment (the number of units is now eight); working with the users of this particular technology they have improved the efficiency of the turbines based on in-house experimentation, in effect R&D. However, there...
is a serious lack of coordination in the research that is being undertaken and little collaboration with the Government Research Organisations and Universities. Credit given by the Agricultural Development Bank of Nepal, ADB/N, at a subsidised interest rate for electricity generation has helped the expansion of the micro-hydro units thus helping the local manufacturers of turbines, but the credit policy is not well-formulated and has operated in an ad-hoc basis. Since this type of small turbine is not made in many countries the local demand has been met by the local producers but it is believed that countries like China and India can produce these turbines at a much lower cost.

**Bangladesh.** I have been involved with some technology studies at the industry level in Bangladesh. Another recent study worth mentioning is that by Mahmood et al, which was produced in 1991 in the form of a Task Force Report submitted to the Planning Adviser of the Government of Bangladesh. As in Nepal, Bangladesh's S&T infrastructure is fragmented with strong emphasis on pure fundamental research. The amount spent on R&D is negligible and there is hardly any R&D activity undertaken by the private sector, including the FDI sector.

Our own study on fertiliser manufacturing was found to be particularly revealing in terms of technology capability building (Huq & Islam 1992). In spite of investing heavily in the manufacture of fertiliser (mainly urea and a small percentage of TSP) during a period of four decades, Bangladesh has little to demonstrate in terms of TCB. This is a result of heavy dependence on suppliers credit and little government direction.

However, two recent studies, one on readymade garments (RMG) manufacturing by Bhattacharya (2000) and the other on leather manufacturing by myself (Huq 2000), provide some new insights. Although, in the case of RMG, the producers enjoy some assured market under the Multi-Fibre Agreement, introduced in 1971, in general they have to compete in the world markets. However, an important factor in the development of these two industries is the push by the government. Both of these sectors have been regarded as 'thrust sectors' and the government is encouraging these industries to meet export targets by providing the investors with various incentives. It has been found that these incentives have played an important role in transforming the growth and structure of the sectors (Huq 2000). The above two sectors alone are accounting for over 80% of Bangladesh's exports with the RMG industry bringing over three-quarters of the total export earning of the country. However, TCB is still very shaky. There is still hardly any investment into R&D. The main growth push factor for RMG is the cheap wage rate but because of extreme competition the charges offered by the buyers for cutting and making (C&M) have fallen drastically. In the case of leather manufacturing there are serious environmental considerations which are being ignored at the moment creating serious long-run cost impacts for the country.

**Sub-Saharan Africa (SSA).** Information on R&D in SSA countries is scarcely available. However, a recent study by James (1995) provides some relevant information about indigenous technology capability based on selected public sector projects, as may be seen from Table 2.

**Table 2. Certain Characteristics of Indigenous Technological Capability in Various Sub-Saharan African Countries (Information Mainly Based on Selected Public Sector Projects)**

<table>
<thead>
<tr>
<th>Country (GNP per capita in US $)</th>
<th>Local Production Capability</th>
<th>Search for Tech Alternatives</th>
<th>Reliance on Domestic Capital Goods</th>
<th>Local Design Capability</th>
<th>Local Innovation Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghana (370)</td>
<td>Yes*</td>
<td>Non-Existent</td>
<td>Non-Existent</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Ivory Coast (690)</td>
<td>Yes*</td>
<td>Non-Existent</td>
<td>Non-Existent</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Kenya (330)</td>
<td>Yes**</td>
<td>Non-Existent</td>
<td>Non-Existent</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Nigeria (260)</td>
<td>Yes*</td>
<td>Non-Existent</td>
<td>Non-Existent</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Tanzania (210)</td>
<td>Yes*</td>
<td>Non-Existent</td>
<td>Non-Existent</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Zimbabwe (750)</td>
<td>Yes***</td>
<td>Intensive</td>
<td>Substantial</td>
<td>Some</td>
<td>Some</td>
</tr>
</tbody>
</table>

Notes:  
* Refers to simple consumer goods, mainly for local production.  
** Refers to consumer goods but of high quality, some of which are exported.  
*** Both consumer goods and capital goods.  

Sources: Based on the findings reported in James (1995). GNP per capita figures refer to 1997 and are taken from the World Bank (1999).
Even in countries such as Ghana, the Ivory Coast, Nigeria and Tanzania, production capability is confined to simple consumer goods mainly for the local market, while in Kenya the capability is further developed as the consumer goods produced are of higher quality some of which are exported. It is only in Zimbabwe that there is production capability in consumer goods and capital goods; technology is selected based on intensive search from various alternatives; local design and innovation capabilities; and that there is substantial reliance on the domestic capital goods sector. So far as capabilities in terms of design and innovation are concerned they are either nil or non-existent in most of the selected SSA countries, except Zimbabwe. As mentioned earlier, expenditure on R&D hardly features in these countries.

Should Low-income Developing Countries have a Technology Policy?

The question whether low-income countries should have a technology policy is relevant in the sense that the liberalisation strategy appears to be successful in attacking rent-seeking which was rampant in the import substituting industrialisation (ISI) phase of development. The liberalisation strategy has also been found helpful in forcing investors to be competitive.

However, a distinction needs to be made between trade policy and technological policy. The liberalisation strategy which has now become almost the conventional wisdom in most countries is a policy prescription more in the context of trade policy. In the case of technological capability building market failures will remain a permanent feature in many areas, including human capital development and R&D with two obvious features:

(a) The market rate of return will be lower than the social rate of return, causing underproduction; and

(b) There is likely to be a lack of co-ordination between various agents participating in the activities.

It is, therefore, not difficult to answer the question posed above: the state will need to be involved in technological capability building. The point of Intellectual Property Rights (IPR) is perhaps worth mentioning at this point. The main justification of providing IPR to a person or an organisation is that it is not possible to depend on a free-market to reap the benefit. The industrialised countries, led by the USA, strongly argue for the enforcement of intellectual property rights. In other words, the argument is not for free-trade but rather the opposite, to honour the monopoly rights of the patent holder. It is argued that if IPR is not enforced a market failure exists. If we free the market there is no incentive for R&D so the patent-holder has the right to impose restrictions on the transfer.

Thus, the above argument recognises that market failures are pervading in the area of technology development that even the US government, which strongly advocates free enterprise, is forcefully arguing for the implementation of IPR. If the liberal standpoint of non-intervention by the government is extended to technology capability building, an obvious contradiction arises between enforcing IPR and not intervening for improving the S&T infrastructure and R&D growth.

In fact, given the very low level of R&D in most low-income developing countries they will have to abandon the hope of technology capability building if they decide to take the liberalisation stand. However, if introducing market failure into technological capability building one should not ignore the point that government failure has been strongly associated with industrial policy in most developing countries.

One, therefore, needs to focus on promoting the involvement of the private sector in technological capability building. The experience of South Korea is particularly revealing within this context. While the government has helped in building the training and skill base and in providing some S&T institutions (e.g. MOST and KIST), R&D development in the private sector has been strongly pushed. The Government of South Korea took the responsibility of promoting indigenous technological development by establishing the necessary S&T infrastructure, providing its own fund for R&D and at the same time strongly encouraging private firms to undertake R&D (Chen & Sewell 1996).

The development of the capital goods sector is another related issue. On its own the sector is not developing since past state participation in production has not been found to be successful. Bangladesh's experience in this regard is simply striking (Huq et al. 1993). The pertinent question that needs to be answered with regard to TCB is how the private sector can be encouraged to promote the sector rapidly.

It may even be necessary to extend the private sector involvement much wider. Chen and Sewell (1996) mention that South Korean firms increased their presence overseas (particularly in the US) through a programme of acquisition, providing them with direct access to highly qualified scientists and engineers, advanced technologies and major markets. Perhaps for the LIDCs this will, for the time being, remain a dream.

In closing this section, it should be mentioned that the suggested approach proposed in this paper, fortunately, does not completely clash with World Bank's recent thinking on the issue. In the latest World Development Report (1998/99), the World Bank suggests that action to improve information failures in developing
Concluding Remarks

Technological capability building is a conscious process of development. The externalities and the degree of market imperfections involved in technology development are so high that, left to market forces, there is hardly any prospect of development in this regard. This is particularly so in developing countries which are not able to strictly enforce IPRs. Such a situation, however, does not necessarily imply direct public production of R&D. Indeed, given the experience of government failures of implementing trade policy for efficient resource allocation in LIDCs, the direct role played by the government needs to be carefully considered.

Thus viewed, there are four major policy implications which can be listed as emerging from the paper:

1. On Production in a Competitive Environment: A competitive production environment is expected to push the manufacturers to take measures for technological capability building, otherwise they will find it difficult to maintain their competitive advantage; especially with regard to developing countries who are dealing with borrowed technology. The liberalisation approach should, therefore, prove helpful for TCB through the increase and expansion of trade outlets. The example of the South Korean firms increasing their presence overseas (particularly in the US) through a programme of acquisition provides them with direct access to highly qualified scientists and engineers, advanced technologies and major markets. (Chen & Sewell 1996) However, for the LIDCs such a programme of increasing overseas presence will, obviously, prove demanding.

2. On Human Capital Development: It is recognised all over the world that for the development of human capital it will not be possible to depend entirely on the private sector. This is a merit good and does not truly reflect the social rate of return. However, there are opportunities for private sector participation since it will ultimately increase both the quantity and quality of trained manpower in the scientific, engineering and technology sectors and in management.

3. On Increasing R&D Expenditure: Even given the low level of income, R&D expenditure is much lower in LIDCs. There is, therefore, hardly any prospect of increasing R&D if left to market forces. There is also hardly any prospect of R&D if the developing country concerned depends on FDI. Any policy for increasing R&D should not imply that the growth should necessarily be in the public sector. In an age where the private sector is being promoted actively, they should be encouraged to participate in R&D. Indeed, the private participation in R&D will be of great help as it will be directly market-orientated. However, as this type of R&D may often lack a long-term prospect, the government will be required to co-ordinate the direction of research taking its distribution and content into consideration in the interests of the economy as a whole.

4. Need for Central Coordination: Given the fragmentary nature of research activities now being undertaken in most LIDCs, a central coordination is of urgent necessity. In the case of Japan, MITI has been found to carry out such a coordinating role besides remaining active in carrying out R&D programmes (Tamura & Urata 1990). In South Korea, MOST played the role of planning, co-ordination and promoting S&T by making the old institutions active and adding, as required, new S&T institutions. It is doubtful if a private sector agency can be given the responsibility of playing the coordinating role. One has to question, therefore, whether the state agency can stand up to the challenge.

In conclusion, it should be mentioned that in the face of market failure while state participation is needed to correct the underproduction in the required R&D, it does not follow that the state will necessarily have to engage itself in production. Indeed, active private sector participation emerges from the experience of studies carried out not only in Japan but also in South Korea and Taiwan. It is also apparent that the S&T infrastructure needs to be significantly strengthened by coordinating the activities of the existing institutions and also by adding, as required, some new ones according to the planning and promotion programmes. The main objective is to make the production sectors remain competitive by acquiring various abilities - to select, assimilate, design, maintain, innovate and even create new technologies - to introduce processes and products into the competitive markets.

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