

The Process of Import and Development
of Technology and its Implications
for Government Policy - the Case of
Indian Manufacturing Industry

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1. Introduction

While technological self-reliance has been an important constituent of India's industrial policy ^{1/} and development of local technological capabilities has been supported through institutional and financial support, a large proportion of the Indian industry's technological needs continue to be met by import of technology.

Since the early post-independence years, the Indian government has regulated technology imports through a variety of policy instruments. Although the policy has gone through many important changes in emphasis during this period, its regulatory nature has continued to the present day. In the fifties and the early sixties, the policy was relatively liberal, and its scope was limited. The mid-sixties saw the beginning of a policy which was more selective and discriminatory against technology imports. This was partly in response to a scarcity of foreign exchange and partly because ^{it was} considered necessary to protect the indigenous technological efforts. ^{2/} The industries were categorized according to the role foreign technology and foreign capital were expected to play in their development and the terms and conditions on which technology could be imported were regulated. Important among these were those which regulated technology payments, the duration of a collaboration agreement and those related to the use of technology by the Indian firm. The royalty payments were restricted to 5% or less of the production value and in most cases only 3% or less were permitted. The duration of the collaboration, which until the early sixties was often 10 years, was brought down to 5 years

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The collaboration agreements were also examined to ensure that they did not prevent Indian technology importers from modifying the imported technology, from undertaking R & D activities, from sub-licensing the technology to other Indian firms, and from exporting the products manufactured under licence.^{3/}

The regulatory aspects of the technology policy, by and large, have been effectively implemented and, as a result, the nature of foreign collaborations in Indian industry has considerably changed after the mid-sixties. At the same time it has become increasingly clear that the policy's success in promoting technological development in Indian industry has been limited. In fact, according to some, it is these policies which are largely responsible for the technological obsolescence of Indian industry.^{4/} A policy of allowing liberal import of technology and capital is increasingly suggested as a necessary condition for increasing technological competence and efficiency of the Indian industry and a definite shift in the policy in this direction is already evident.

Although the technology policy and its effect on technology development and industrial growth have attracted considerable attention in the recent years, the problem has not been studied sufficiently to generate information and analysis on which the policy, and changes in it, could be based. This paper is an attempt in this direction. It uses fresh empirical evidence to examine the nature of technology import activities of Indian firms and discusses the implications of these findings for the Indian technology policy. The paper is based on analysis of (a) information on foreign collaborations approved during 1977 and the first half of 1983. This information, made available by the Ministry of Finance and the India

Investment Centre, has been computerised by the NCAER; (b) information collected through questionnaires and interviews from 211 technology importing firms; (c) discussions with government officials involved with the formulation and implementation of these policies.

2. Choice of Collaborator

The technology import policies in developing countries (including India) are mainly based on an understanding of the technology importers as passive partners in the technology transfer process. According to this understanding, the technology suppliers are the main and active actors in the act of technology transfer to developing countries. It is they, who, in order to protect or capture markets in developing countries and to increase returns on R & D expenditure, look for markets for their technology in developing countries. The developing country firms, according to this view, are passive partners who have to choose from the technologies offered to them by the technology suppliers. Not surprisingly, these policies are aimed at ensuring that both the amount and the nature of technology being 'pushed' by technology suppliers are controlled.

We find that this picture of technology transfer is essentially incorrect. In the collaborations studied by us, a very large proportion of agreements (more than 90%) were initiated by the Indian firms (see Table 1). It was the Indian firms who, either due to absence of local source of technology or due to unwillingness to use technology developed locally took recourse to technology imports. In fact many of the larger Indian firms studied by us were found to be continuously involved in a search for potential technology suppliers.

Table - 1

<u>Initiative for Collaboration</u>	
	<u>No. of Cases</u>
1. Indian firms	217 (93)
2. Foreign firms	11 (5)
3. Others	5 (2)
	<hr/>
TOTAL	233 (100)
	<hr/>

Note : Total No. of cases : 279

Not available : 46

Figures in parenthesis indicate percentages.

Source : NCAER data.

That the Indian firms are most often the initiators of a collaboration is also supported by findings of some recent European studies.^{5/} In view of our findings it is clear that the Indian firms are not passive actors in the process of technology transfer, as has been hitherto believed. They are actively engaged in a search for and selection of technologies required by them.

The fact that in most cases Indian firms initiate the process of foreign collaboration also suggests that they are likely to make a choice from a number of alternative sources. To be able to do so, these firms will need to consider and approach more than one potential technology suppliers and the possibility of the choice can be expected to increase with the number of firms approached.

Table 2No. of Foreign Firms Approached by Indian Firms for
Technology Purchase

<u>No. of Firms Approached</u>	<u>No. of Collaborations</u>
1. One firm	28 (30)
2. Two-three Firms	31 (34)
3. More than three firms	33 (36)
TOTAL	<u>92 (100)</u>

Note : Total No. of cases : 279

Not available : 187

Figures in brackets indicate percentages.

Source: NCAER Data.

We find that in one third of the collaborations studied by us, only one foreign collaborator was approached by the Indian firms (See Table 2). In some of these cases it is likely that only one foreign firm controlled the technology. Our interviews with the Indian firms, however, suggest that it is very rarely that Indian firms have imported technology which is held by only one foreign firm and we believe that in most cases only one technology supplier was considered, alternative suppliers were available. This is also confirmed by a recent study of Indo-UK Collaborations which found that the technologies imported by the Indian firms could have been obtained from

a number of sources.^{6/} The explanation of why many firms did not approach more than one technology supplier perhaps lies in the facts that :

- (a) In a number of these cases the Indian technology importers had previous business dealings with the technology supplier. While most often the Indian firm was an importer of technology supplier's products, in some cases the Indian firm had previously imported technology from the collaborator. Satisfied with its past relationship with the foreign firm, it usually approached only the latter for the technology and often succeeded in arriving at an agreement for the technology collaboration.
- (b) The larger Indian firms often need to approach only one technology supplier. In our sample, while almost half of the large firms approached only one foreign firm for a collaborator, most of the smaller firms approached more than one foreign firms (see Table 3).

This, we feel, is due to the ease with which large Indian firms can attract foreign collaborators. We find that the technology leaders in developed countries prefer the large Indian firms. As the larger Indian firms also prefer to collaborate with the technology leaders, they often only approach the technology leaders. In most cases, due to the mutual preference, their first approach results in a collaboration and they do not need to approach other suppliers.

Table - 3Indian Firms' Size (Turnover) and Number of Foreign Firms Approached

Number of Firms Approached	Size (Turnover Rs.)			Total
	More than 5 million	5 - 100 million	More than 100 million	
1	0	1 (6)	9 (41)	10
2 - 3	2 (50)	10 (59)	8 (36)	20
More than 3	2 (50)	6 (35)	5 (23)	13
TOTAL	4 (100)	17 (100)	22 (100)	43

Note : Total No. of cases : 279

Not available : 236

Figures in parenthesis indicate percentages.

Source : ICASER Data.

On the other hand, approaches from smaller Indian firms are often either ignored by the foreign firms or the technology price is considered to be too high by the smaller Indian firms. In either case, they are compelled to approach a number of potential suppliers before they are able to find one who is willing to collaborate at a price which these firms can afford to pay. Often these are small foreign firms who are entering the technology licensing business for the first time and feel more confident in dealing with the small Indian firms.

If the number of suppliers approached for technology by an Indian firm is taken as an indicator of the extent of choice exercised by Indian firms, it seems that the incidence of choice has increased in the recent years. In more than half (53%) of the collaborations undertaken before 1970, only one technology supplier was approached by the Indian firms. This has come down to only 25% in the post-1970 period. In other words, while only in 30% of the collaborations a choice was made before 1970, the choice was made in 75% of the post 1970 collaborations (see Table 4).

Table 4

Foreign Firms Approached Before and After 1970

	<u>1 Firm</u>	<u>2-3 Firms</u>	<u>More than 3 firms</u>	<u>Total</u>
Before 1970	8 (62)	3 (23)	2 (15)	13 (100)
After 1970	16 (25)	26 (40)	23 (35)	65 (100)
TOTAL	24	29	25	78

Note : Total No. of cases : 279

Not available : 201

Figures in parenthesis indicate percentages.

Source : ICAR Data.

The success of a collaboration very largely depends on the correct choice of the collaborator and the technology. As we have seen, in a large number of cases Indian firms have exercised some kind of choice and there are indications that the incidence of choice has increased in the recent years. What is this choice based on?

Our study shows that technological considerations play the most important role in the Indian firm's choice of a collaborator. We find that in almost half of the collaborations studied by us superior technology of the collaborator was considered to be the most important reason for the selection of the collaborator. This was followed by the prestige of the foreign collaborator in the international and the Indian market. In 20% of the cases prestige was considered to be the most important factor. Interestingly, only a small proportion of firms considered financial considerations the most important factor. (See Table 5).

Table 5

Reasons for the Choice of Collaborator

	<u>No. of Cases</u>
1. Superior Technology	112 (45)
2. Financial	30 (12)
3. Prestige	49 (20)
4. Others	57 (23)
TOTAL	<u>248 (100)</u>

Note : Total Cases : 272

Not Available : 31

Figures in parenthesis indicate percentages.

Source : ICMA Data.

Our interviews show that, on the whole, Indian firms prefer to import most advanced technology and in many cases they claim to have done so. In fact, none of the firms reported having imported technology which was even more advanced than the one used by their collaborators. In one case, for example, a firm reported that the technology imported by it for its sodium cyanide plant was more advanced than the one used by its collaborator and that the quality of sodium cyanide produced in the Indian plant was considered by the foreign collaborator to be superior to their own product. In another case, an Indian manufacturer of electrical control gears was negotiating an agreement with a U.S. multinational to import control gear technology which has not yet been introduced even in the U.S. market.

We also found that in many cases Indian firms terminated their negotiations after realizing that the foreign firm was not interested in transferring their latest technology. In the circumstances some approached other suppliers, while others decided to use their in-house skills to develop the necessary technological inputs. In one case, for example, an agreement was terminated by the Indian firm when they realized that their East German collaborators were not prepared to transfer their advanced technology for producing horizontal boring machines. As the technology in this area was fast changing, the Indian firm did not want to be stuck with obsolete technology.

Very few firms in our sample reported having technology which they felt was obsolete at the time of the collaboration. Often these firms had no manufacturing experience prior to their collaboration and were not aware of the vintage of the technology being transferred to them. The commercial performance of such firms has usually been poor. For example, a firm with

no previous manufacturing experience, imported technology to produce acrylic sheets from a Japanese manufacturer in the mid-seventies. Soon after the production began, the Indian firm realised that the process transferred to it by the Japanese firm was of 1945 vintage. It was inefficient and costly and required major modifications. As a result of the inefficient production technology the firm has been continuously making losses and is likely to be soon taken over.

Although the vintage of the technology is considered to be the main technological criterion applied by most Indian firms, some have not hesitated to import relatively old technology if it suits their special needs. The need to use simpler techniques, smaller production scales and batch processes as opposed to continuous process, have influenced firms to import technologies which at the time of the collaboration were not the most advanced.

It is interesting to note that an Indian firm is not always able to exercise a choice though it may be competent to do so. The firm may be forced to import a technology which it does not consider most suitable. For example, a large machine manufacturer studied by us had imported technology to produce very sophisticated sugar centrifugal machinery from a U.K. firm. The Indian firm felt that this machine was too sophisticated and expensive for the Indian market, but the U.K. firm had insisted on the transfer of this technology as a pre-condition for transferring another technology which the Indian firm had very much wanted. The machine has electronic/

pneumatic controls which are imported. Out of a total cost of 4-1/4 lakh rupees, the imported panels of the machine alone cost rupees 2 lakhs. It is very difficult to market this machine as a competitor has recently introduced a simpler machine in the market for half the price.

To summarise, it is clear that except a few cases where market and technological considerations require otherwise, the Indian firms prefer to import the most advance technology they can obtain. Also, in most cases they claim to have imported such technologies. Only rarely we came across instances where the Indian firm felt that the technology imported by them was obsolete or too sophisticated at the time of the collaboration and who were unhappy about it.

3. Content of Technology Imports

In the fifties and sixties, technology transfer to India largely took place in the form of turn-key projects. As a result of government policies and the increased competence of Indian industry this began to change in the late sixties. Today, in most cases the technology is unpackaged before its import.

The transfer of drawings and designs is most commonly included in technology import by Indian firms. In 30% of the collaborations studied by us, transfer of drawings and designs were included in the collaboration agreements (See Table 6). The extent of the information provided in these drawings and designs, however, varies enormously and their number can range from a few hundred to many thousands.

Table 6
Content of Technology Imports

Contents of Technology Imports	Yes	No	Total	Ranking
a. Licence to use know-how	143(51.3)	136(48.7)	279(100)	3
b. Patent rights	47(34.8)	182(65.2)	279(100)	4
c. Drawings and designs	223(80.0)	56(20.0)	279(100)	1
d. Supply of plant/equipment	88(31.5)	191(68.5)	279(100)	5
e. Supply of raw materials/spares	66(23.7)	213(76.3)	279(100)	7
f. Commissioning of the plant	56(20.0)	223(80.0)	279(100)	9
g. Operational Guarantees	55(19.7)	224(80.3)	279(100)	10
h. Quality control	74(26.5)	205(73.5)	279(100)	6
i. Setting up of R&D facilities	41(14.7)	238(85.3)	279(100)	11
j. Training of personnel	181(64.9)	98(35.1)	279(100)	2
k. Equity participation	58(20.8)	221(79.2)	279(100)	8

Note: Figures in brackets indicate percentage

Source: NCAER data.

In one-third of the collaborations in our sample equipment and plant were supplied by the foreign collaborators. It appears that in recent years plant and machinery has been increasingly procured locally. While before 1970 about 44% of the technology agreements included supply of plant and machinery, in the post-1970 period this proportion has come down to only 29% (See table 7).

We have no detail information on the nature of the equipment imported but our discussions with the firms suggest that these are limited to specialised equipment, supplied usually by the technology suppliers or their associates. Also, we find that, when possible, Indian firms prefer to shop around for equipment in order to bring down the cost of the project.

Table 7

Change in the Content of Technology Imports

	Before 1970		After 1970		Total	
	Number	Total	Number	Total		
Licensing	34	(63)	54	98	(62)	157
Patents	25	(46)	54	62	(39)	157
Plant supply	24	(44)	54	45	(29)	157
Raw material supply	18	(33)	54	38	(24)	157
Plant Commissioning	11	(20)	54	40	(25)	157

Note: Total cases 279 Not available 69

Figures in parenthesis indicate percentages

Source: NCAER data.

That the use of local equipment has become more common in the recent years is also indicated when imported component of different technology agreements of the same firm are compared. Typically, while the first collaboration (usually in the early sixties) of these firms included supply of a turn-key plant, the collaborations in the later years included little or no import of equipment. The foreign collaborator in many of these cases merely supplied the drawings, and the equipment were fabricated in India on the basis of these.

4. Technology Payments

The control on payments for technology imports is perhaps the single most important and certainly one of the most successfully implemented elements of India's technology policy. This policy, which is aimed at preventing the technology suppliers charging "excessive" prices for the technology, regulates both the lump-sum payments and the royalty rates. The latter, which can be more easily regulated, are, in most cases, fixed at 5% or less of the value of the production. Only in exceptional cases, where the ownership of the technology is restricted and access to it is difficult or where substantial exports are expected, a higher rate of royalty is permitted.

Since the mid-sixties, when these regulations were first introduced, the payments have been effectively controlled. Only in less than 1% of the agreements approved during 1977 and 1983, the royalty rate has been fixed at a rate higher than 5%. Within the 5% limit the tendency, however, is to fix the royalty rates close to the limits: in almost two-third of the agreements the royalty rates are above 3% (See Table 8).

Table 8Distribution of Collaborations According to Rate of Royalty (1977-83)

<u>Royalty</u>	<u>Number of Collaborations</u>	
1. 1 - 3%	568	(38.93)
2. 3.1 - 5%	879	(60.25)
3. Greater than 5%	12	(0.82)
4. Total	1459	(100.00)

Note : Figures in parenthesis indicate percentages.

Source : ICAER Data.

The low royalty rates, however, do not necessarily indicate that technology payments by Indian firms have come down after the mid-sixties. It is probable that in order to compensate for losses due to low royalties, the technology supplier will tend to take part of/or all the payment as lump-sum. Our data suggests that the proportion of cases involving lump-sum payments has indeed increased from 20-30% in the early fifties to 93% in the 1980s. The substitution of royalties by lump-sum payment has continued in the late seventies and the eighties. While the proportion of collaborations with only royalty payments has decreased from 21% in 1977-79 to 17% in 1980- the proportion of collaborations with lump-sum only has increased in the corresponding period from 35% to 39% (See Table 9).

Table 9

<u>Year</u>	<u>Royalty only</u>	<u>Lump-sum only</u>	<u>Royalty and Lump-sum</u>	<u>Total</u>
1977-79	169 (21)	264 (35)	350 (44)	803 (100)
1980-83	260 (17)	593 (39)	576 (44)	1531 (100)
Total	429	877	1028	2334

Note : Figures in parenthesis indicate percentages.

Source : NCAER Data.

Notwithstanding the tendency of technology exporters to substitute lump-sum payments for royalties (and thereby receive higher payments), we find that total technology payments by Indian firms continue to be rather low. Although the royalty rates permitted by India are comparable to those prevalent in many other developing countries,* the actual royalty payments from India are small. In our sample, only in 1/3 of the cases these payments exceeded 1 lakh rupees (ten thousand US Dollars) in 1981-82 (See Table 11).

Table 10

<u>Lump-sum Payments (Rupees)</u>	<u>No. of Cases</u>
1. Less than 50,000	6 (7)
2. 50,000 - 0.1 million	49 (53)
3. More than 0.1 million	27 (35)
	84 (100)

Note : Total cases : 279

Not available : 195

(Figures in parenthesis indicate percentage.)

Source : NCAER Data.

* For example, in most Latin American countries the royalty ceilings are fixed at 5%. For many industries the royalty ceiling is even lower (e.g. for auto mobile industry in Argentina royalty rates exceeding 2% are not permitted).

Table 11Royalty Payments (1961-62) (Rupees)

	<u>No. of cases</u>
i. Less than 50,000	6 (14)
ii. Upto 0.1 million	22 (50)
iii. More than 0.1 million	16 (36)
	<hr/>
	44 (100)
	<hr/>

Note : Total No. of cases : 279

Not available : 235

Figures in parenthesis indicate percentages.

Source : NCAER Data.

The small scale of plants and the low capacity utilization are mainly responsible for the low royalty payments by the Indian firms. The payments are further reduced by the fact that production usually begins only in the second or the third year of the collaboration and the technology supplier receives royalty only for 2-3 years.

Convinced that the government's restrictions are largely responsible for low technology payments by the Indian firms, some authors believe that in many instances the latter are unable to import sophisticated technology from more innovative firms, and often import second rate technologies. They suggest that a liberalization of the policy of restricting payments will ensure that the Indian firms import more efficient and modern technology. If argument, it seems, assured that if permitted to pay more, Indian firms would by and large, like to import more advanced and sophisticated technologies.

First of all, it is interesting to note that most of the firms studied by us claim to have selected and imported technologies of fairly recent vintage. This is also supported by the technology suppliers, most of whom report having transferred technologies which have been developed and commercialized in the recent years.

Furthermore, we have come across relatively few cases where a supplier refused to collaborate with an Indian firm ^{because} ~~it~~ it considered the technology payments to be insufficient. Most Indian firms felt that they have been able to attract collaborators within the government limits on technology payments. They also felt that due to the current recession in the developed countries, the technology suppliers were prepared to transfer technology at relatively low price. Many instances, where foreign firms were now willing to supply technology on terms and conditions which were unacceptable to them earlier, were cited by them. The experience of a majority of Indian firms suggest that low technology payments have not restricted the flow of technology to India.

How can we explain the fact that the Indian firms are able to purchase recent vintage technologies at prices which are lower than those prevalent internationally? While part of the reason could be the attraction of a potentially large Indian market in which many foreign firms like to maintain a presence even if the short-term returns ^{are} low, the main reason is perhaps that the technology suppliers usually adjust their technological package to suit the Indian prices. The price of a technology is generally considered to depend on its vintage. This understanding of the technology price underestimates the importance of the size of the technological package being supplied. We feel that the technology price tends to depend more on the

nature and the size of the package transferred and less on the vintage of the technology. In other words, technologies of similar vintages but differing in the size of the packages would differ in their price. The Indian experience suggests that the payments made by the Indian firms for their technology purchases are low because the technology packages imported by them are often small and not because the technology is old. Our discussion with Indian firms show that in most instances the technology transferred to India, while it belongs to recent vintage, involves the transfer of a limited range of technological elements. The range of products/process covered by the collaboration and the transfer of skills, particularly those related to the development (as opposed to operation) of technology are almost always considerably less compared to what the technology suppliers possesses and, in most cases, is willing to supply.

As a result, while the Indian firms do import technologies which were recently developed and also get sufficient skills to operate and often adapt them, they rarely acquire the skills and wk experience required for understanding the basic knowledge and the process of technical change involved in the technology. While this enables these firms to carry out a profitable operation, it rarely prepares them to undertake innovative activities.^{10/}

Why do Indian firms choose to import smaller technological packages? Is it because of the government limits on payments which restrict the Indian firms access to larger technological packages or is it because the Indian firms themselves prefer to import smaller (and cheaper) technology packages?

Our study suggests that in most cases it is the Indian firms who prefer to import low cost, small technology packages, and it is this, rather than the government restrictions, which is largely responsible for the low technology payments by the Indian firms. In fact, in many instances the government restrictions have been used by these firms to bargain for a low

price for their technology (16% of the firms in our sample reported having used government policy to bargain for a better price).^{11/} Considering the little effect these controls seem to have on technical payments, it is not surprising that only 15% of the firms studied by us felt that a modification in the payment policy was necessary.

The finding has serious implications for the policy. A liberal approach to technology payments, as has been suggested in recent years, may be a necessary condition for import of larger technological packages, but it certainly is not a sufficient condition. Unless the Indian firms themselves consider it necessary to import larger and more comprehensive technology packages, and can afford to pay higher prices for these, a liberal policy will not be very effective.

It may be argued that the recent trend of technology imports do not support this view. The 1980s have seen an increase in the number of collaborations involving large payments, and this, it can be argued, has been possible because of the liberal technology import policy. Our figures, however, show that it is only in a few, but well publicised instances, where technology payments have been larger than those in the past. In a very large majority of collaborations the technology payments, inspite of a liberal policy, have seen little change. For example, if we exclude the cases in which the lump-sum payments are more than one crore rupees, the lump-sum payments during the late seventies and the early eighties have seen very little increase. While the average lump-sum payments of 615 collaborations during 1977-79 was 16.3 lakhs rupees, during 1980-83 it had increased to 17.46 lakhs rupees.^{12/}

Thus, we see that while it is true that a liberal policy, among other factors, has led to an increase in the number of collaborations with large payments, most Indian firms have continued to import small technological packages at a low price. It is clearly necessary that unless the Indian firms perceive the need for more comprehensive technological packages, the quality of technology import will remain essentially unchanged.

5. Collaboration Duration

Technological collaborations, in most cases, are for a limited duration during which a technology supplier is expected to complete the transfer of production and related knowhow. While the duration is important for the technology importers as they can expect to receive technological inputs only during this period, for the technology supplier its significance lies in the fact that he usually receives payments only during this period.

Until the early 1960s, collaborations for 10 years or more were common. However, since the mid-sixties, the government policy has restricted the agreements, in most instances, to a duration of 5 years. Only rarely agreements for longer duration are permitted. A reduction in the collaboration period was considered necessary both for foreign exchange savings and for reducing the technological dependence of Indian firms on technology supplier, and it was hoped that a shorter collaboration would induce the Indian firms to increase their efforts to absorb and adopt the imported technology.

As a result of this policy, a very large majority of the collaborations approved in the 1970s and the 1980s are for a duration of 5 years or less. Our figures show that the proportion of 5 years agreement increased from 16% in 1965 to about 50% in 1966 and to 66% in late seventies.^{13/} Also the proportion of agreements with outright purchase of technology and no royalty payment increased from 13% in 1951-67 to 27% in 1977-80.

While it is likely that, in the short term, the policy of limiting collaboration duration has reduced technology payments and technology dependence of Indian firms, in the long run its effect has perhaps not been beneficial. There are many reasons for considering this possibility. First of all, it can be argued that the policy has restricted Indian firms'

access to foreign technology. As the value of royalty payments depends on the duration of the collaboration, the technology supplier may find sale of certain technologies, through short-duration collaborations, unprofitable. Also, some of them could be reluctant to transfer their technologies if their involvement in the use and the control of the technology is limited only to a short duration.

In addition to its effect on the supply of technology, the rigid approach to the duration could also limit the benefits of a collaboration to the Indian firms. It ignores the important consideration that, depending upon the technological competence of the Indian firms and the complexity of the technology, the period necessary for technology absorption by Indian firms would vary considerably. The five years duration could be too short for many firms to absorb the variety of techniques/skills, and to begin production of the complete range of products included in the agreement. Obviously, in these instances, the Indian firms' benefits from a collaboration would be considerably less than what would have been possible in a longer collaboration. Many of these firms would either renew their agreement or enter into a new collaboration, and this would clearly increase the financial and other costs of the technology import.

However, it needs to be stressed here that merely a long term agreement with a provision for continuous exchange of information does not necessarily lead to the use of the information thus exchanged. A lot depends on the technological activities of the Indian recipient to make use of it. We are not in a position to guess the extent to which information passed over to the Indian firms after the initial stages of the agreement has been used. Our impression, based on the experience of a

few firms who discussed this issue, is that this information is often not used. One firm, who was very clear about this, felt that an Indian firm needs to develop its production technology to a level where it feels the need for fresh technical input and reaches a stage where it can make use of the more advanced know-how. Simply acquiring improvements, without developing the capacity to absorb and utilise them is not beneficial.

The long term agreement are also crucial for Indian firms who collaborate to strengthen their designing capabilities for the manufacture of custom built industrial products such as furnaces. As these firms cater to a wide range of customers, requiring products with different characteristics, they often need the assistance of their collaborators to solve more difficult/new design problems. Many of the firms who feel that 5-year duration is not enough are firms of this nature. On the other hand ^{there are} technologies where once a plant is set up, and the production process stabilised, the need for assistance from the foreign collaborator is considerably reduced. Firms operating such technologies are by and large happy with the 5-year duration.

a. Technology Imports and Exports

One of the important concerns of the India's technology import policy has been the restrictions imposed by the technology suppliers on exports of the products manufactured under collaboration. The agreements with export restriction clauses are discouraged and restrictions (mostly permitting exports only to neighbouring countries and restricting exports to areas where the licensee has another licence or production arrangements) are allowed only when complete freedom to export is not acceptable to the

technology supplier. Faced with the need to expand exports this concern is understandable. Our research, however, shows that the role of these restrictions (and their absence) on exports is over emphasised, as they do not affect the export performance as much as is usually suggested.

Before discussing their implications, it is important to note that these restrictions are indeed very common. In the collaborations for which information is available with us, almost half were found to have export restrictions (See table 12). The restrictions vary in their scope; while some specified the countries and regions where exports were allowed or banned, other simply mentioned that exports are not allowed to countries where the foreign collaborator has subsidiaries, licences and other business associates. Restrictions limiting exports to India's neighbours are found to be the most common.

Table 12

<u>Export Restrictions on Indian Firms</u>	<u>No. of collaborations</u>
(i) Yes	95 (48)
(ii) No	135 (52)
(iii) Total	230 (100)

Note: Total Cases: 279.

Not available 79

Figures in parenthesis indicate percentages

Source: NCAER Data.

The high incidence of the export restrictions may lead one to believe that they play an important role in limiting India's exports of manufactures. This, however, is incorrect. Our interviews suggest that the presence of export restrictions are usually irrelevant to the actual export performance of the Indian firms.

Most of the firms we studied were non-exporters and did not foresee exporting in the future. Although many of them had restrictions on export, none of them considered these as serious impediment to exports. Either the firm found domestic market more attractive than the export or their products were inferior, expensive, and could not compete in the international market. For example, a firm producing toulina reported that although there were no restrictions on their exports, they could not compete in the international market as their cost of production was more than twice of the world's major producers. While the domestic price of toulina is Rs.7200 per ton, the international price is Rs.3,000. With this kind of price difference, Indian firm has no intention of even trying to explore the possibility of exporting.

Government's insistence that the Indian firms should be free to export is likely to have affected both the supply of technology and its quality, without significantly increasing the possibility of exports.^{14/} This is specially true in instances when buy-back arrangements are insisted upon by the government. Instances are not uncommon where the foreign collaborator, though interested in importing from the Indian firm, was not willing to accept contractual obligations to do so.^{15/} Furthermore, it is also likely that those technology suppliers who agree to transfer technology with little or no export restrictions could charge a higher price to compensate for the risk of losing part of their market to the Indian firm. This

obviously will increase the cost of technology import without increasing export possibilities.

If forced to permit the Indian firms to export, the collaborator could also be tempted to withhold crucial aspects of the technology to prevent the Indian firms from becoming competitive in the international market. As the low technological level of the Indian firms is one of the main factor responsible for the poor export performance, an incomplete transfer of technology would obviously further undermine their export potential. The policy, in these circumstances, would not only fail to encourage exports during the period of the collaboration, but, by restricting the flow of information from the collaborator, would also undermine the technological competence and future exports of the Indian firms. It would be more fruitful if the collaboration is primarily considered as a way of building technological competence of the Indian firms and policies which could in any way limit the technological benefits of a collaboration should be avoided. Once the technology is mastered, the firms would have a greater export potential. Our discussions with firms also indicates that once they are competent to export, they themselves are unwilling to accept these restrictions; some, in fact, would only collaborate if no export restrictions are imposed.

As the policy has not been very successful in encouraging exports, but on the other hand, is likely to have had a negative influence on the Indian firm's technology competence and future exports, a more flexible attitude towards export restrictions is necessary. We believe that a more

removal of restrictions would not lead to increased export - sufficient technological capability is a far more important condition for that. Policies which help in maximising the flow of technology and information through a collaboration, even if it means accepting export restrictions for a limited period (which, in any case, would not make much difference to the actual export performance of most of the firms) will be more successful in promoting exports in the long run.

7. Research and Development

One of the important criticisms of technology imports by developing countries relates to their possible effect on the development of indigenous technological capabilities. It is argued that technology imports discourage developing country firms from undertaking R&D to develop their own technologies. This, it is further argued, leads to a situation where technology importers become perpetually dependent on foreign technology. While it is true that technology imports may inhibit innovative R&D in the importing firm, they could, in many cases, initiate limited research activities necessary for the absorption and adaptation of the imported technology. A technology importer requires certain amount of minimum skills for successfully exploiting the imported know-how in production. The skills related to design evaluation and interpretation (to examine the possibilities of import substitution, plant operation and maintenance and quality control) are usually necessary for a successful transfer. Furthermore, in many

cases imported technology requires changes and adjustments to suit the needs of the Indian firm. These changes may be necessary due to the need to reduce the production scale, to simplify the production process or to modify the product characteristics to suit the Indian market. The R&D activities to develop the necessary knowledge, skills and experience within the importing firm are necessary as the foreign firms commonly do not assist the Indian firms in the modification and adaptation of the imported technology.^{16/} The extent of the adaptive R&D can be expected to increase with the complexity of the technology imported.^{17/}

Until the early 1970s most research activities in India were confined to government owned laboratories and institutes and very little research took place within the industry. The government research was expected to generate technologies to meet a large part of the technological needs of the Indian industry. Contribution of these activities, however, has been rather small.^{18/} It is now generally agreed that the policy of supporting research activities outside manufacturing firms, though successful in creating a large scientific infrastructure, has not been equally successful in providing technological impetus to the industry.

As a result of the realisation that the research undertaken at the government laboratories is not sufficiently geared to the needs of the industry and that research by the latter needs to be strengthened for technology development, policies which support research by industry were initiated in the 1970s. Essentially, these policies provide a number of incentives (mostly fiscal) to encourage the Indian firms to undertake R&D and use locally developed technology. As a direct result of these incentives, the number of firms reporting research activities has seen a considerable increase in the last decade. The number of firms with R&D activities and

registered with the Department of Science and Technology has increased from 484 at the end of 1977 to about 700 by 1983.^{19/} The total R&D expenditure by industrial firms as estimated by DST has also seen a sharp increase in the recent years. It increased from about Rs.34 crores in 1976-77 to Rs.285.6 crores in 1982-83. This would suggest that the policy has been successful in inducing a large number of firms to undertake R&D activities.^{20/} While this may be true, it must be pointed out that these figures do not, in any way, reflect_{on} the nature and the quality of R&D activities by these firms. Our evidence suggests that the effect of these incentives on the nature and the quality of R&D has been marginal. We also find that a number of technologically dynamic firms with large R&D establishments are not registered with the Department of Science and Technology for the incentives. Our feeling is that, while these incentives may encourage firms to set up R&D department and to even take up preliminary research activities, they are rarely responsible for making a firm technologically dynamic.

In their present form the incentives have some serious limitations. The most obvious of these is that they tempt firms to show expenses incurred on other activities as R&D expenditure and to generally inflate their R&D expenditure figures. Even more important is the fact that the incentives are based on R&D expenditure and not on achievements of R&D activities. This could often lead to non-utilisation of resources (especially equipment) or to their diversion into more profitable (non R&D) activities.

Interestingly, we find that most Indian technology imparting firms undertake some amount of R&D. More than three fourths of the firms in our sample claim that they are engaged in research and development activities. Also, in terms of R&D expenditure, some of the firms were found to be quite

research intensive. Some spent upto 3% of their turn-over on R&D and employ as many as 50 scientists in R&D departments*. This, however, is not common. Most firms spend less than 1% of their turnover, and typically employ less than 10 researchers.

These figures, however, can be misleading as they do not necessarily indicate the total technological activities taking place in a firm. We found that while in some of the firms with R&D facilities, most of the R&D staff was engaged in routine quality control and customer services and no serious development activity was being carried out, in others, who did not even have a separate R&D department, technological developments had taken place at the shop floor. In these cases the production staff was continuously involved with monitoring and improving the performance of the technology. In view of this, we feel that statistics related to R&D (such as R&D expenditure and number of R&D personnel) in the Indian corporate sector do not correctly indicate the extent of technological activity in the industry.

What is the nature of their research activities? Our study suggests that R&D activities of these firms are most commonly aimed at adaptation of imported technology; about one-third of the firms engaged in R&D reported adaptation as their main R&D activity (See table 13). In fact, it appears that in a number of firms the R&D began due to the need to adapt and assimilate the imported technology.

*Only one firm was found to spend 5% of its turn-over on R&D.

Table 13

Nature of R&D

	Nature of R&D	Number of cases	Total
1.	Adeptation	101 (66)	157
2.	Quality control	77 (31)	157
3.	Customer services	49 (31)	157
4.	Basic Research	32 (20)	157

Note: The total number of firms : 211

Total Number of firms with R&D = 157

Figures in parenthesis indicate percentages.

Source: NCTDI data.

Technology importers are incorporating changes in the imported technology, mainly in order to adapt the technology, to reduce production costs and to meet government requirements of import substitution. However, although these changes are often crucial for the survival and growth of these firms, they seldom involve major technological efforts. Very rarely the technological changes have been aimed at, or led to, significant technology developments. Also, in most cases, the technological activity was short-lived. In the beginning of a collaboration, when designs were to be interpreted for equipment manufacture, a plant to be set up and commissioned and production to be streamlined, the extent

of learning was usually high. However, soon the learning process slowed down and technological activities became limited to routine production. The technological gap between the technology supplier and the technology recipient, which in many cases had been significantly reduced at the time of the collaboration, became large within a few years of the collaboration.

The technological progress of Indian firms have not been slow in comparison only with their collaborators. Often firms in other countries, who imported technology at about the same time as the Indian firms, have seen far greater technological development than the latter. For example, a large Indian heavy machinery manufacturer imported technology at about the same time as a Japanese firm in the late 1960s. At the time of its collaboration the Indian firm was at the forefront of the international technological level in this field. However, it has remained technologically stagnant since then and requires new technical collaboration, to update its technology. On the other hand, the Japanese firm, who began with the same technological level as the Indian firm has emerged as one of the three largest manufacturers of these machines in the world. Interestingly, the Indian firm has recently collaborated with the Japanese firm to update its technology.

In only two cases we found that the Indian technology importer had undertaken major product development. While in one case, competition was the immediate reason for the product development, it is difficult to identify a single reason in the second case. A number of factors, it seems, were responsible for the successful product development by this firm. Both the firms

are in the engineering sector. While one is a large, multiproduct public sector firm, the other is a small, single product, private firm. In both cases the products developed are based on the imported technology, and the products were developed in the face of competition, both from domestic manufacturers and imports.

One of the cases involves development of CNC machines. The manufacturer is a producer of machine tools for engineering industry and is a major manufacturer of milling machines. In the recent years the firm has faced stiff competition from small firms in the field of traditional, simpler machine tools. As a result, they have decided to move into the manufacture of more complex and specialised machinery and are undertaking a large modernisation drive. One of the major products selected for manufacture is CNC milling machine. As the firm has long experience in the manufacturing of conventional milling machines, they are converting this machine into a CNC machine. These efforts, being made in collaboration with an Indian electronic consultant, involve redesigning of the existing milling machine to accommodate new components and controls.

In the other case, the product involved is a new range of printing machinery. The Indian firm began manufacturing printing machinery in the mid 1970s in collaboration with a British firm. According to the firm, the nature and extent of technological support provided by the foreign collaborator was not sufficient to undertake manufacturing. The drawings and designs were incomplete and the Indian firm had to develop in-house capabilities to produce

quality machines. These in-house facilities were further increased, independent of the foreign collaborator, to modify and improve the machine. Soon after the expiry of their collaboration, the Indian firm was able to introduce a faster machine (35,000 impressions/hour machine as opposed to 25,000 impressions/hour machine which was produced under collaboration). Although their collaborators were interested in a renewal of the agreement, the Indian firm refused as the foreign firm was still making 25,000 impressions/hour machines. Clearly the Indian firm did not think it needed the assistance of their collaborator any longer. Their confidence was soon proved right as they were able to develop a multicolour machine, which, according to them was of comparable quality to the imports. They are also very competitive. Their multicolour machine costs about $7\frac{1}{2}$ lakhs while the imported machine costs 56 lakhs.

The need to develop in-house capabilities to use the imported technology was clearly the initial step in developing the technological skills in this case. However, why this firm continued its technology development further and did not stop once it had achieved production on the basis of the imported technology (a stage where most Indian technology importers seemed to have stopped) is difficult to answer. According to the firm, the main force behind its technological activities had been a desire to "teach a lesson to their collaborator by showing them that we can do better than them". However, this desire, even if very strong, is not a sufficient condition for major technological developments.

that
Perhaps the fact/the help from the foreign collaborator was particularly insufficient, forced the Indian firm to learn about technology more than most Indian firms have to do and also enabled them to further develop it. Once they had learned the designing techniques and characteristics of the materials to be used, further modifications in the design were relatively easier. However, as mentioned earlier, we do not have enough information about similar successful developments to make a useful generalisation.

It is clear that import of technology has, in many cases, led to R&D activities and has increased importing firm's technological capabilities. This, however, does not mean that R&D in India is only carried out along with technology import or that imported technology is a necessary condition for growth of R&D activities by Indian firms. In fact, we find that in many cases, R&D has been undertaken not only in the absence of imported technology but because technology could not be imported. In many of these cases the firms were now happy that they were not able to import technology as a result of which they were able to undertake successful development activity within the firm. Some of them felt that they had developed sufficient technological capabilities to render any further collaboration unnecessary. In a typical example, a transformer producing firm had negotiated an agreement with a Dutch firm, who later backed out due to differences over lump-sum payments. The Indian firm decided to develop the range of transformers it had planned

to produce in collaboration with the Dutch firm. The efforts were successful and now the firm does not see any need for further collaboration.

In another example, an Indian chemical manufacturer wanted to produce aluminium chloride, a raw material for the firm's production of wet dyes. The firm searched for a collaborator and found the price too high (about 10 million rupees). They decided to develop the production technology and were successful in undertaking production at a cost of 1.5 million rupees.

The imported technology's contribution to in-house R&D activities largely depends on the existing technological capabilities of the technology importers. Some of the most successful collaborators in our sample, especially in terms of technological learning, were those where the Indian firms were familiar and experienced (at the time of the collaboration) in the use of related technologies and were also engaged in research activities. They were often able to make the best use of what they received from their collaborators. This is especially true of agreements involving a continuous transfer of improvements by the foreign collaborator. While the technologically competent firms were aware of the various developments being carried out by their foreign collaborators, and were able to ask for them, the less capable firms had to completely depend on the foreign collaborators for the information and the transfer of new developments. This suggests that to be effective, the past experience and technological competence of the firm need to be closely related to the technology to be imported.

8. Conclusions

The paper has attempted to provide an insight into the nature of foreign collaborations in Indian industry. It shows that in a number of important aspects, the process of technology imports differs from what has been suggested in the past. Importantly, the paper highlights the fact that in most countries foreign collaborations are the result of a large demand for technological inputs in Indian industry which is reflected in an active and often continuous search for foreign collaborators.

The active involvement of Indian firms in technology imports suggests that a policy directed at the Indian firms, rather than at the technology exporters, will be more successful in influencing both the nature and the terms and conditions of technology imports.

Another important conclusion relates to the effect of government policy on the quality of technology imparted by Indian firms. The findings of our research show that restrictions on amount of payments do not seem to have limited the supply of technology for Indian firms. In most cases, the firms claim to have acquired recent vintage technology inspite of financial limits imposed by the Indian government. The import of recent vintage technology at comparatively low price has been possible as the technological package is limited in scope. In most cases it involves transfer of knowledge of manufacturing operation for a specific product/process range and does not include knowledge and skills necessary for technology improvement and technology development. The technology suppliers find the cost of such transfers relatively small (both in terms of actual transfer cost such as preparation of drawings, designs and training and potential threat of competition from the recipient firm, and is willing to transfer the technology at a low price.

Why do Indian firms prefer to import technology packages which do not provide them skills required to become technologically dynamic and independent. There are two possible explanations:

- (a) Although the Indian firms prefer more comprehensive technology imports and are willing to pay for them, the government limits on technology payments prevent them from doing so.
- (b) The Indian firms do not consider the import of more comprehensive technology packages necessary to operate in the Indian market. They are merely interested in importing skills directly related to, and essential for, the establishment of successful production facilities.

Our research suggests that in most cases the second reason has largely been responsible for the import of limited technology packages. The Indian firms are mainly interested in importing a technological package which will enable them to begin production in the shortest time with the least technical obstacles. They are rarely interested in importing (and using) technology packages in order to become technologically dynamic and innovative. In view of the limited purpose of the technology imports, most firms prefer small technology packages as they cost less. Higher payments for more comprehensive packages are considered unnecessary.

Unless the Indian firms themselves feel the need to import more comprehensive packages (and are willing to pay more for them), a liberal government policy permitting higher payments may not be very effective. On the other hand, if the nature of the Indian market changes in order to force these firms to become technologically dynamic, we can expect an increase in the import of more comprehensive technology packages.

The market's influence is equally, or perhaps more, important on the nature of R&D activities of the Indian firms. As we have seen, adaptive and cost reduction R&D activities are very common and, many times, very successful. Examples of serious innovative R&D are rare. While the nature of the competition in the Indian market induces these firms to reduce their production costs (through R&D), it actually discourages innovative R&D.

The Indian market, for most products, as described by Detail ^{21/} is characterised by a few dominant large firms and a large number of small firms. The large firms, who begin manufacturing with imported technology, are usually the first to enter the market. They are, however, soon followed by a number of small firms. The latter, with little or no overheads, produce cheaper but inferior products and put strong pressure on the large firms to reduce their costs. The market, in most cases, is very sensitive to the price and the competition is mainly price oriented. As a result, the large firms though sometimes technologically competent and resourceful to undertake innovative R&D, concentrate their R&D efforts on reducing production costs. As the option of reducing costs by increasing scales is usually not available (due to the government's licensing policies), the possibilities of cost reduction are seriously limited and are soon exhausted. These firms, when unable to cope with the increasing pressure from the small firms, decide to move on to, let us say, a higher technological orbit to produce more sophisticated products. However, because their R&D has remained limited in the past to adaptive and cost reduction activities, they are unable to make the "Technological Jump" independently and resort to technology imports.

Therefore,
We feel that the nature of the competition in the Indian market (not necessarily the amount of competition, is largely responsible for the technological stagnation of the Indian industry. It is responsible for diverting Indian firms R&D (when it is undertaken) away from innovative activities and for making them import small and limited technology packages. Furthermore, we would like to emphasise that the technological activities of Indian firms are far more sensitive to the policies pertaining to the nature of the market and the industrial structure compared to those policies which are explicitly aimed at promoting technology development. While acknowledging their significance, we feel that the latter can only be successful if an industrial environment conducive to innovative activities is simultaneously created. On the other hand, modifications in the technology policy alone (such as a liberal technology import policy, greater R&D incentives), without necessary changes in the industrial policy, would fail to introduce the necessary technological dynamism into the Indian industry.

Notes

1. See India (1983)
2. See NCAER (1971; 56)
3. Similar measures were taken by a number of LDCs in the 1960s and 1970s. See UNIDO (1977).
4. For example see Lall (1982)
5. See Hoffmann Lutz et al (1984)
6. See Bell RM and Scott-Kemmis. D (1984:5)
7. The date for the early 1950s is taken from NCAER (1971; 57)
8. See UNCTAD (1980; 14)
9. See Lall (1982; 23)
10. For details see Alam (1985a)
11. This, incidently, refutes the commonly held belief that the Indian firms do not bargain with the technology suppliers. For example see NCST (1973; 550)
12. For details see Alam (1985 b; 7)
13. See Desai (1982 a; 11)
14. See Lall (1980; 327)
15. For a discussion of the disadvantages of buy -back arrangements see Guleti I.S. and Bansal S.K. (1980)
16. See Balasubramanyan VN (1980; 63)
17. See Katrek Homi (1984; 16)
18. See Desai (1980; 91) and Alam (1984)
19. For statistical source see DST (1977, 1984)
20. See Lall (1982; 18)
21. See Desai (1982b).

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