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CHANGING DIMENSIONS OF TECHNOLOGICAL
DEPENDENCE IN INDIA

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In the Indian context, attempts had been made in the past to demonstrate 'new' dependence on foreign technology due to unequal bargaining. Given sufficient time for internalised learning for acquisition and development of technology, did India gain more strength over time? viewed in the performance perspective, capability, though is a unitary concept reflects itself in the structure and growth of the country's industrial sector. However, a variety of diverse elements comprising of technological capability of the nations - eg. stock of skilled manpower, R & D institutions, number of patents registered etc. can be identified and changes in these over time can be observed in the process of industrial growth. But in a situation in which industrialisation was triggered off with imported technology like that of India, a study of national technological capability should indicate the degree of autonomy that the national entities have in making technological decisions and implementing it without external interference. In relation to foreign collaboration in India, it is therefore interesting to study as to whether the learning involved lead to unbundling of technology package thereby reducing the cost of foreign technology. As seen in table I, when long term trend in foreign collaboration is considered there is an increasing tendency to take technology divorced from equity control. If the package of assets transferred along with equity is considered more externally controlled and the inflow of only technology divorced from ownership capital a less externally controlled type of asset transfer into India, can this be interpreted as increasing bargaining strength of India? Theoretically, the above trend tend to suggest that Indian Industry possess a measure of infrastructure and technical capability required for choosing better methods of transfer and bargaining in the direction of

unpackaging the technology transfer and thereby reducing the extent of foreign control and hence technological dependence !

We may strike a note of caution in this respect, for, it has also been observed by management experts that the most dramatic of the new strategies adopted by MNCs in recent years had been an explicit policy shift from management control facilities to the sale of technology and management services as a direct means of return on corporate asset.^{1/} May be, but in the case of other developing countries which also pursued a similar import-substitution strategy, however, this trend is not that marked as it is in India^{2/} and hence such pronouncements cannot be taken too far. We are therefore left with the feeling that this reverse trend might have been due to the ability of Indian bourgeoisie to articulate state apparatus to its advantage whose strength is comparatively better rooted than other developing countries like Brazil where the growth of 'capitalism' needs a much closer integration and therefore more capability in the sense of acquiring technology divorced from capital compared to other developing countries. Reading from the secular trend of foreign collaboration, this type of feelings may be far too stretching from scanty evidence. More analysis is therefore necessary to assert about the changing dimensions of technological dependence in India.

Increasing Technological Capability, Some hypothesis

Let us therefore dwell upon the more meaningful aspects of learning process and its accumulation over time in India. The utilisation of domestic innovations

1/ See Baranson J. Technology and Multinationals, Lexington Books, 1980

2/ In this context see UNIDO " International Forms of Technology Transfers, Industry 2000, New perspectives, December 1979.



Table I

Number of collaborations approved between the
period 1948-81

Years	Total number of cases approved	Cases including financial collaboration	Financial collaborations as % to total collaborations approved
1948 - 55	254		
56	82		
57	81		
58	103		
59	150		
60	380		
61	403	165	41.0
62	293	124	41.0
63	298	115	39.0
64	403	123	31.0
65	241	71	31.0
66	202	49	24.0
67	182	62	34.0
68	131	30	23.0
69	134	29	22.0
70	183	32	17.0
71	245	46	19.0
72	257	36	14.0
73	265	34	13.0
74	352	55	16.0
75	277	40	14.0
76	282	39	14.0
77	267	27	10.0
78	307	44	14.0
79	267	32	12.0
80	526	76	14.0
81	388	56	14.0

Source: Journal of Industry and Trade Various Issues.

being abysmally low, ^{1/} import of foreign technology is increasingly relied upon. Therefore, the degree of dependence will have to be examined by ascertaining whether in the process of acquiring foreign technology lead to more learning through negotiating for better technology and learning to use more of domestic elements in technology by generating from imported technology? The generation of technological elements within the country (within the enterprise through R & D and utilising innovations of national laboratories) reflect a measure of technological capability. Did this technological capability measured up in accumulated experience and expertise over time lead to better terms and conditions in collaboration agreements and thereby reduce the cost of imported technology? The changes in the cost of imported technology can therefore be considered an approximate proxy for the qualitative change in the technology dependence 'status' of India. As a result of learning process implicit in technology import, if the payments for technology shows a declining trend, it can be considered a measure of more capability. The limitations of this measure should be pointed out; for, the payments for technology (royalty and technical fees) being only the registered or direct cost does not reflect the true cost. It is necessary to take into account the clandestine practices of licensors such as transfer pricing and the controls exercised via restrictive terms and conditions in foreign collaboration agreements etc. Such implicit forms of control can not always be measured due to data limitations, alternatively we had to rely on recorded payments only.

Remittance behaviour of Indian Private Sector

We have collected information on the remittance behaviour of Indian companies in the Private sector. This however does not give us a total picture of

1/ See for details Prabir Mitra "Utilisation of Indigenous Technology, Organisational and Policy Constraints" Economic and Political Weekly, Review of Management, November 29, 1981.



direct cost of foreign technology to India due to the absence of time series information on the direct cost incidence of foreign technology intake into public sector enterprises.

The data pertaining to Private sector enterprises available from the recorded official estimates give year-wise estimates on five elements of cost due to the intake of foreign capital and technology. They are profit, dividend, interest, royalty and technical fees. Except for profit and interest, information is available for other variables from 60-61 to 79-80. Of these five elements, the two mentioned above i.e. royalty and technical fees are the only two relevant variables necessary for our analysis. However, since data are available, we thought of seeing the total remittance pattern of private sector to start with and later to isolate the technology variable. The year-wise details of total remittance is seen in table II. When value added in the organised manufacturing sector registered an average annual growth rate of 12.37 percent during the period (60-61 to 78-79) total remittance increased by 18.23 percent, at a faster pace. See table IV. This is when the collaborations contracted declined marginally by - 0.37 percent between 1960 to 80. The remittance due to technology collaboration compared to total remittance had grown still at a slower pace by 8.37. But when the two components of technology remittances are broken up, the technical fees component is seen to have highest growth and strangely enough, lowest growth among all components is registered by royalty rate. Therefore, as postulated earlier there is no a priori evidence of a fall in the payments due to increasing technological capability via learning process. At the most one can say from the behaviour of macro aggregate that the payments for technology lagged behind the overall payments for foreign investment.

Table II

Remittances Abroad by Indian Private
Sector Companies according to elements

(Rs. crores at current prices)

Year	Profit	Dividend	Interest	Royalty	Techni- cal fees	Royalty + Technical fees	Total Remi- ttance 2+3+4+5+6	Value added in manu- facturi- ng sector
1	2	3	4	5	6	7	8	9
1960-61	-	11.38		9.06	3.07	12.13	23.48	864.00
61-62	-	14.14		8.83	2.13	10.96	25.11	987.90
62-63	-	18.35		8.09	2.38	10.47	28.82	1115.61
63-64	-	16.11		9.50	3.18	12.68	28.79	1295.25
64-65	-	20.30		3.26	3.20	6.46	26.76	1503.51
65-66	13.50	19.40		2.95	6.98	9.93	42.83	1700.40
66-67	14.47	28.77		5.13	10.43	15.56	58.80	1831.72
67-68	15.95	32.70		4.32	14.68	19.00	67.65	1964.02
68-69	12.96	30.25		4.78	17.97	22.80	65.96	2096.34
69-70	12.72	31.41	9.28	5.80	13.05	18.85	72.26	2478.00
70-71	19.11	43.48	12.80	5.23	20.63	25.86	95.26	2890.00
71-72	9.94	33.87	12.13	5.86	13.90	18.96	80.70	3123.52
72-73	15.54	39.08	15.60	7.33	11.33	18.66	88.88	3611.26
73-74	21.31	37.51	16.27	6.21	14.08	20.29	95.98	4099.00
74-75	7.10	18.46	36.70	8.46	12.56	21.02	83.37	5492.04
75-76	20.36	24.84	24.65	10.49	25.66	36.15	106.00	5769.00
76-77	19.39	48.47	25.11	15.88	37.80	53.68	146.65	6596.00
77-78	10.13	68.01	22.70	19.50	28.19	47.64	148.71	7199.00
78-79	4.80	54.40	11.40	11.30	24.63	35.93	111.06	8529.00
79-80	2.50	50.90		12.00	27.64	39.64	132.68	

Source: Lok Sabha and Rajyasabha debates various issues. Value added figures ASI various issues.

Learning Effect : Evidence examined

May be this way of looking at the remittance behaviour has obvious limitation due to the fact that we were looking at the trends of absolute magnitudes only. What is relevant and meaningful is to see the relative movement of remittances.^{1/} Moreover, studies in the past underlined the need to look into that portion of value added due to the intake of foreign technology and not the total value added in the manufacturing sector. If the actual royalty payments are declining as a proportion of manufacturing output resulting from more or less similar imported technologies, it would be possible to say that the payments have been effectively reduced.^{2/}

Due to data limitations we could not pursue the above methods. Alternatively, we have related the total remittance as well as various elements in the payments with the value added arising from organised manufacturing sector. A caveat is to be added regarding value added figures. Since it is not counted in basic border prices, there may be substantial elements of margins that can be charged in domestic prices in view of the high level of protection.

However, it is interesting to observe that over time total remittances (representing foreign investment, royalty and technical fees representing - technology transfer) when related to value added did register a negative growth over time. See table IV and graph showing the behavioural trends in the outgo over time. As is shown in the graph the fall in total remittances is steeper since 70s, though between 75-77 there had been a tendency to increase, but this tendency was short lived. Royalty payments started stabilising around 65-66 and since then the gap between the growth of value added and royalty payments had been widening. The behaviour of technology payments (Royalty plus technical fees) though erratic have been downward sloping except during some short intervals.

^{1/} Relative to output, value added prices etc.

^{2/} See Daniel Chudnovsky "Regulating Technology Imports in some Developing countries" UNCTAD, 1978 (Himeo)

Table III

Major Elements of outgo relative to value added

(Rs. crores)

Years	Total outgo	Value added	<u>Total outgo %</u> <u>Value added</u>	<u>Royalty%</u> <u>Value added</u>	<u>Royalty + Technical fees %</u> <u>Value added</u>
1	2	3	4	5	6
1960-61	23.48	864.00	2.71	1.05	1.40
61-62	25.11	987.90	2.54	0.89	1.11
62-63	28.82	1115.61	2.58	0.73	0.94
63-64	28.79	128.45	1.98	0.66	0.88
64-65	26.76	1503.51	1.78	0.22	0.43
65-66	42.83	1700.40	2.51	0.17	0.58
66-67	58.80	1831.72	3.21	0.28	0.85
67-68	67.65	1964.02	3.42	0.22	0.97
68-69	65.06	2096.34	3.14	0.23	1.09
69-70	92.26	2478.00	2.91	0.23	0.76
70-71	95.26	2890.00	3.29	0.18	0.89
71-72	80.70	3123.52	2.58	0.19	0.63
72-73	88.38	3611.26	2.46	0.20	0.52
73-74	95.98	4099.00	2.34	0.15	0.49
74-75	83.37	5492.04	1.52	0.15	0.38
75-76	106.00	5769.00	1.84	0.18	0.63
76-77	146.65	6596.00	2.22	0.24	0.81
77-78	148.65	7199.00	2.06	0.27	0.66
78-79	111.06	8529.00	1.30	0.13	0.42

I illustrative graph showing the trends in the outgo

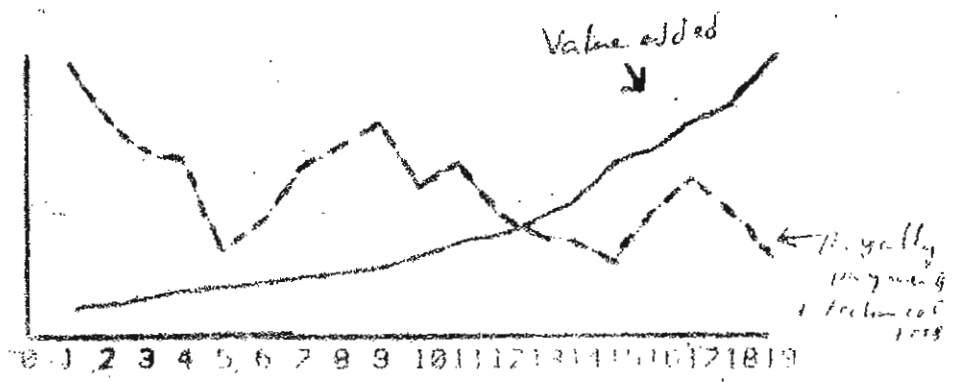
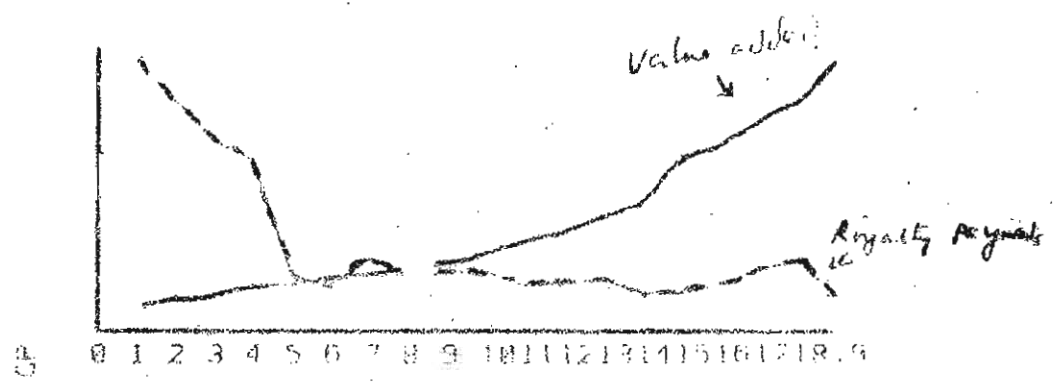
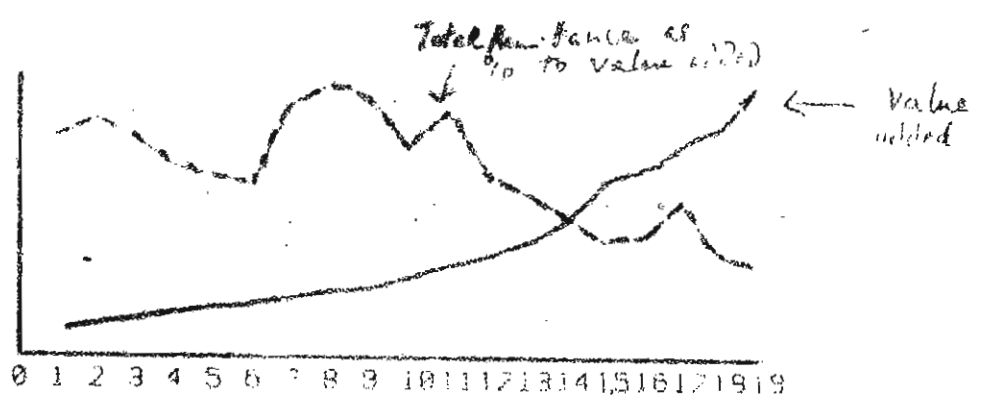


Table IV

Growth rate of various Elements in
the Remittance Basket

	1960-61 to 78-79	1960-61 to 70-71	1970-71 to 78-79
1. Average annual (Compound) Growth rate of			
a) Value added	12.37	-	-
b) Total Remittance	18.23	-	-
c) Technical fees	13.63	-	-
d) Royalty	4.22	-	-
e) Royalty and technical fees	8.37	-	-
2. Total Remittances as % to value added	- 2.13	3.14	- 8.85
3. Royalty + technical fees at % to value added	- 3.83	- 2.23	- 2.67
4. Royalty as % to value added	- 8.40	- 17.86	0.49

It is also interesting to observe from table IV that highest negative growth had been marked in the case of royalty remittance between the period 60-61 to 78-79 followed by technology remittance (royalty plus technical fees) and lastly by total remittances in line with our thinking earlier regarding the increasing technological capability in India linked to royalty payments. We examined the trend in the outflows in the light of postulations of researchers on the subject such as there are time periods of foreign investment into critical and liberal approaches, for example, although the number of collaborations have been increasing over time, a generally critical approach towards foreign investment, was characteristic of the period between 1947-56. Then on the general tightness was slowly giving way to a period of relaxation till 1965; since '65 a period of renewed monitoring and regulation towards new foreign investment was seen and this period lasted till 1979. However, since 1979, due to the emphasis on export led growth, led to a relative liberalisation of capital and technology import. When payments were examined in that light however, we could not gather much evidence on it rather, we found difference in the outflows since 70-71. In fact, till 70-71 total remittance had grown by 3.14 whereas, on the technology account and in particular on royalty account negative growth had been highest during this period. Though subsequently, royalty remittance only did register a positive growth but, of late, the gap has been widening.

Overall, it can be suggested that there is evidence to show that we are paying relatively less for our technology intake over time. This phenomenon is more striking when compared to other developing countries where payments for foreign technology is of a higher magnitude.^{2/} The feeling that it is due to

1/ See Michal Kidron "Foreign Investment in India" Oxford, 1965, K.K.Subrahmanian 'Import of Capital And Technology' Peoples Publishing House, 1972.

2/ To illustrate when the payments for technology as a percentage of total manufacturing output were studied for a few developing countries such as Argentina, Brazil, Mexico, Columbia and India it was found that India's payments had been the lowest of all. See Daniel Chudnovsky "Regulating Technology Imports in some developing countries" op.cit.

the intake of relatively outdated technology in the international market though may carry some weight needs substantiation, which is beyond the scope of this paper. It is also observed in this context that relatively larger proportion of technology payments have been in the form of outright payments when attempts were made at regulating royalty rates and duration of payments etc. which may not always be reflected in the recorded official payments.^{2/} There is also a greater possibility of retaining profits for expansion and diversification, to that extent, total outflow, in particular dividend may be less in the short-run. Given these limitations, we also thought it important to recognise that compulsive instruments must have exerted some environmental pressures for assimilation of imported technology. Selective approach to import of technology under a licensing procedure i.e. some kind of screening, technical evaluation and registering procedure etc. there must have resulted in an environment of search for self-reliance. However, studies in the past revealed that the time lag involved in adaptation and assimilation was long due to foreign control which prevented further technological break throughs.^{3/} Notwithstanding the real costs in terms of opportunities foregone for better assimilation, it is plausible to argue that though the core technology is imported, many of the elements of peripheral technology, inter-alia, detailed engineering is generated and done locally. A recent investigation in the three major sectors of capital goods industry revealed that though foreign controlled joint ventures and subsidiaries imported more packaged forms of technology, of 43 collaborations contracted only 25 per cent of sample firms agreements involved services

2/ See K.K.Subramanian "Collaboration agreements and their Impact on assimilation, diffusion of knowlwe and outgo of resources" paper presented at SSRC/ICSSR workshop on Science and Technology policy, University of Manchester, June 1983.

3/ See P.Mohanam Pillai "Technology Transfer, adaptation and assimilation. "Economic and Political Weekly (Review of Management) Vol.XIV, No.41, No.24, 1979

of foreign collaborators for detailed design and engineering^{4/} (See table V)

Therefore, the intermediate stage of learning by doing and detailed engineering for productionising imported designs to lowerscale and replicate it by design engineering to specific needs might have imparted capability in consultancy and engineering services and production of capital goods. Though very weak in science based industries, instances of capacity to innovate in the fields of standard modern technology is evident though there is no conscious efforts to upgrade imported technology or to get going on making their own design capability.^{1/} In short, the capacity to open up elements in imported technology bundle and replace it by domestically generated element coupled with the learning by negotiating must have contributed in reducing the technology payments in India.

Learning Effect and Stimulation through Research and Development

The resources devoted for Research and Development activities stimulated the generation of technology elements replacing foreign technology imports. Thus conceptually, the growth of R & D - shall lead to a decline in the payments for foreign technology. Therefore, the former represents an appropriate proxy variable for the qualitative change occurred in the learning process. Hence, we have fitted the following regression equation

R is royalty repatriated as percentage to value added.

RD is the resources devoted for R & D as a percentage to gross National

4/ See P.Mohanan Pillai, Y.K. Alagh, K.K. Subramanian, 'Technology issues in capital goods sector: A study of leading machinery producers in India' (UNCTAD), 99/56 1983.

1/ See M.R.Bhagavan "Technological Innovations in Indian Industry" Seminar, No.2, Feb. 1981.

Product. The estimated equation is as follows:

$$R = 1.0186 - 1.7460 RD$$

$$(-2.8519)$$

$$R^2 = 0.3675$$

The results indicate that one percent increase in the expenditure on R & D to GNP leads to a decline of 1.74% of royalty to value added. Although the t value (given in bracket) of the co-efficient is significant at one percent level, The multiple co-relation co-efficient exhibited a value of only 0.3675, this implies that a major portion of the variance in royalty payments is still unexplained by the variable considered here. May be other factors like regulatory framework for technology transfer, development of capital goods industry etc. have had equal influence in reducing payments for technology from India.

Conclusions and Policy Implications

The analysis above indicated that there is evidence of more technological capability due to learning by doing and learning by negotiating which represents changing dimensions of technological dependence in Indian industries compared to earlier acute dependence where the import/technology was of a 'black box' type. Institutional modalities for regulation of technology transfer, building up of technology capability, in particular capital goods industries etc. under a protected regime did help in learning and its positive impact felt though this learning could not be capitalised into a sort of innovative thrust. This is mainly because increasing technological capacity has been at the cost of technological autonomy. Though technology transfer increases the capacity for directing technological change, autonomy implies greater selectivity in and closer control of externally acquired technology in the absence of which it will not produce the desired effect.

The feeling in some corners that controls retarded technological capability

Table V

Elements of Technology Transferred under Licensing (Collaboration) Agreements of the Sample firms (in numbers)

Elements	Machine Tools				Equipment for process industries				Electrical Equipment				Total for complex capital goods			
	I				II				III				(I + II + III)			
	DT	FT	FC	TOTAL	DT	FT	FC	TOTAL	DT	FT	FC	TOTAL	DT	FT	FC	TOTAL
A. No. of firms	2	1	2	5	3	1	-	4	1	1	2	4	6	3	4	13
B. No. of collaboration	8	2	4	14	8	3	-	11	10	2	6	18	26	7	10	43
C. Elements of Technology																
1. Design (basic)	8	2	4	14	8	3	-	11	10	2	6	18	23	7	10	40
2. Designing methodology	5	2	4	11	5	3	-	8	9	2	6	17	19	7	10	36
3. Detailed Design	2	1	2	5	1	1	-	2	1	-	2	3	5	2	4	11
4. Technical assistance	6	1	4	11	1	-	-	1	5	1	4	10	12	2	8	22
5. Patents	5	1	3	9	3	2	-	5	6	2	5	13	14	5	8	27
6. Trade Mark	-	-	1	1	-	-	-	-	1	-	-	1	-	-	2	2
7. Personal Training	6	1	2	9	3	2	-	5	8	2	5	15	17	5	7	29
8. Others	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	32	8	20	60	21	11	-	32	40	9	28	77	90	28	49	167
Average number of elements in each collaboration	4	4	5	4	2	4	-	3	4	4	5	4	3	4	5	4

DT - Domestic firms with ongoing foreign collaboration

FT - Financial cum technical collaboration (foreign minority joint venture)

FC - Foreign controlled joint ventures (including Indian subsidiaries of foreign companies)

Source: Technology Issues in the capital goods sector: A case study of leading machinery producers in India UNCTAD/TT/55

and thereby technical change is not borne out by hard facts. Controls in fact stimulated more learning. As mentioned earlier, unlike many other developing countries like Brazil, Mexico etc., technological elements generated in India over time created conditions capable of assuming a relatively more autonomous role in technology matters and this partly reflects the changing bargaining strength of Indian bourgeoisie. The question why they did not consolidate it is again an issue and explanations have to be sought in the political economy emerging bourgeoisie rather than in static concepts like control mechanisms etc. It is these type of static considerations that prompt many of our economists to plead for more liberalisation.

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