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TECHNOLOGY IMPORTS AND LOCAL RESEARCH AND DEVELOPMENT IN INDIAN MANUFACTURING

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I. INTRODUCTION

THE technological level of a country is argued to be a function of indigenous research and development (R & D), technology imports, and relation between the two [2]. The relation between the imported and domestic technologies is often a complex one. The import of technologies may either substitute or complement (or a combination of both) local R & D. The nature of this relation is of overwhelming importance for the formulation of appropriate science and technology policies. The empirical evidence on the nature of relationship, however, has been mixed. Blumenthal's exercise for six countries, namely, Australia, France, West Germany, Italy, Japan, and Sweden, leads to no firm conclusion. For three of the six countries, that is, Australia, Japan, and France, there is evidence of complementarity between imported technology and local R & D while for the remaining three countries there is no significant relationship between the two. In an Indian case study in a roughly similar context, Katrak [15] finds imports of technology to be stimulating adaptive R & D. The magnitude of the effect, however, appears to be "rather limited" and weaker for the complex technologies.

The potential determinants of the nature of relationship between imported technologies and local R & D include factors such as the nature of R & D, the degree of risk aversion of private firms, role played by the government in supporting high-risk projects, relative expenditure on basic as opposed to applied research, availability of foreign technology and government policy towards it, the institutional framework for adaptation of technology, and the industry structure [2]. The mode of technology may also be an important factor in determining the nature of the relationship. For instance, the influence of technology import under licensing (purely technical collaboration) by locally owned-and-controlled firm on local R & D may be quite different from that of import through the package of foreign direct investment (FDI) where the technology supplier owns (partly or wholly) and controls the local enterprise. The difference is expected because

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the local enterprise in the latter case becomes an integral part of a multinational enterprise (MNE). Investment decisions in the case of MNEs including on R & D are taken in consonance with the corporate strategy responsive to global opportunities.[1] The influence of the mode of technology import, however, has not been controlled as yet in the literature while analyzing its relationship with local R & D.

The present paper examines the influence of technology imports on levels of company financed or in-house R & D spending in forty-three Indian manufacturing industries. While doing so, distinction between the two parallel modes of disembodied technology acquisition, that is, FDI and licensing, is made in view of their possibly differential influence on local R & D activity. Plan of the paper is as follows. Section II briefly reviews the existing literature relevant to influence of technology inflows particularly through FDI on local R & D. It also compares the R & D intensity of foreign-controlled and local firms in forty-three Indian manufacturing industries. Section III empirically analyzes the determinants of the levels of in-house R & D expenditure to separate the influence of technology imports. Finally, Section IV concludes the paper.

II. INFLUENCE OF TECHNOLOGY IMPORTS ON LOCAL R & D

Literature on influence of technology imports on local R & D activity per se is scarce. Mostly it relates to MNE's propensity to concentrate the global R & D activity at the headquarters and the comparative performance of foreign-controlled firms (usually subsidiaries of MNEs) and their local counterparts in terms of R & D spending. Since MNEs are the major source of technology in the world accounting for about 80 to 90 per cent of total technology traded [36] and a sizeable proportion of technology transfer even in the case of India taking place through FDI (i.e., in foreign-controlled firms) it would not be out of place to review some of those studies here.

R & D activity is the source of proprietary technology considered to be one of the most important monopolistic advantages enjoyed by MNEs. It is only logical, therefore, to expect MNEs concentrating their R & D activity near their headquarters [38]. The U.S. Tariff Commission [37] confirmed that U.S. MNEs do concentrate most of their R & D in the United States. Creamer [6] on the basis of a survey of over 900 U.S. MNEs having overseas R & D found that though there was evidence of a tendency to locate larger part of R & D activity abroad, over 90 per cent of the total R & D activity was undertaken in the United States only.[2] Furthermore, the overseas R & D was carried out primarily in the highly industrialized countries (with two-thirds of total overseas R & D activity done by U.S. MNEs being taking place in three countries, viz., Canada, the United Kingdom, and West Germany). Only a "negligible share" of the overseas R & D found its way to the developing countries. Therefore, the affiliates (or subsidiaries)

[1] See [12] for empirical evidence.

[2] Mansfield et al. [22] in an independent and more recent survey also reached a similar figure.

of MNEs, particularly in the developing countries, are expected to spend little on R&D. However, it is not clear how the R&D intensity of MNE affiliates would compare with that of their local counterparts. A few studies have addressed themselves to this aspect. Ragachand [25] finds evidence that the local-controlled firms were more R&D intensive than their foreign-controlled counterparts in Canada. Several other industry specific studies like Subrahmanian [34] for Indian chemical industry; UNCTAD [35] for Indian capital goods industry; and Evans [8], Gordon and Fowler [11], and Kumar and Chenoy [19] for pharmaceutical industry in Brazil, Canada, and India respectively, have also reached similar conclusions. Rugman [28] finds some support for the hypothesis that innovations occur in the home country of MNE rather than in the country of its subsidiaries (Canada in this case). However, Lall [20] while trying to explain firm-level R&D expenditure in Indian engineering industry found the foreign ownership to be having no significant influence.

A. *R&D Intensity of Foreign and Local Firms in Indian Manufacturing*

To compare the R&D intensity of foreign-controlled and local firms in forty-three Indian manufacturing industries considered here, we computed the ratio of reported R&D expenditures (in company annual reports) to net sales of all the sample companies in the industry for the two groups of firms from financial statistics of 1,334 medium and large nongovernmental public limited companies for the year 1980–81, compiled by the Reserve Bank of India (see next section for more details). The ratios presented in Table I reveal a relatively poorer performance of foreign firms in this regard. Of the forty-three industries, only thirty-six industries report any significant R&D expenditure. In twenty-six of these thirty-six industries, local firms spend a higher proportion of sales on R&D than do their foreign-controlled counterparts. In ten industries the R&D intensity of foreign firms is higher. The weighted average of R&D expenditure to sales ratio for local firms is also higher than for their local counterparts. The statistical significance of the difference between the R&D intensity of foreign and local firms is evaluated in terms of Wilcoxon's signed-rank test. The null hypothesis that there is no difference is rejected at 5 per cent level of confidence (two tailed). One problem with the conclusions drawn from simple comparisons of R&D intensity, however, is that they do not control for other factors influencing the R&D intensity. Caves et al. have attempted a systematic analysis of determinants of industry R&D intensity in Canada finding that "high foreign subsidiary share indeed lowers R&D intensity in Canadian industry" [4, p. 193]. Similar evidence has been found by Palda and Pazderka [23] in an attempt to analyze the determinants of international variation in R&D intensity in pharmaceutical industry. Gannicott [9] in the case of Australian manufacturing industries finds the influence of foreign share to be not significantly different from zero. In the case of high technology industries, however, foreign share appears to have a significant favorable influence on local R&D.

The empirical evidence for different countries, therefore, generally suggests an adverse influence of FDI on local R&D intensity of industry through lower

TABLE I

R & D Intensity of Foreign and Local Firms in Indian Industries (Medium and Large Public Limited Companies), 1980–81

Industry Code	Industry	No. of Companies		R & D Expenditure as % of Sales	
		Total	Foreign	Foreign-Controlled Firms	Local Firms
332	Processed foods	31	9	0.168	0.084
341	Cigarettes	6	2		
350	Cotton textiles	238	3		0.023
360	Other textile products	14	1		
370	Brewaries & distillaries	19	1		0.006
380	Leather & products	3	1		
420	Aluminium	3	2	0.027	
430	Other non-Fe.-base metals	8	4	0.028	0.009
441	Auto. vehicles	13	3	0.605	0.019
442	Auto. components	32	12		0.134
443	Other transport equip.	14	2		0.481
445	Electric cables	15	3		0.164
446	Dry cells	7	4	0.003	0.055
447	Electric lamps	7	2		
448	Electric machinery	86	26	0.052	0.115
449	Machine tools	12	3	0.001	0.003
450	Textile machinery	13	2	1.103	0.127
451	Non-electric machinery	126	52	0.042	0.402
452	Steel tube & pipes	14	4	0.043	
453	Steel wire & rodes	13	2		
454	Steel forgings	29	2		0.031
455	Foundries & engineering workshops	43	4	0.334	0.005
456	Metal products	40	12	0.020	0.083
461	Fertilizers	13	3		0.011
462	Dyes & dyestuffs	10	3		0.218
463	Manmade fibres	13	3	0.049	0.169
464	Plastic raw materials	12	5	0.097	0.168
465	Basic indus. chems.	43	13	0.201	0.653
466	Medicines & pharm.	52	24	0.025	0.604
467	Paints & varnishes	15	5	0.009	0.186
468	Toiletaries & other chemical products	47	20	0.143	0.080
521	Cement	15	2	0.182	0.055
522	Asbestos & A. cement	4	2		
531	Str. clay products	19	1		0.061
541	Tyres & tubes	6	3		0.140
542	Other rubber products	14	2		0.066
551	Paper	25	1		0.023
552	Products of paper & board	16	1		0.064
553	Wood products	15	1		0.186
561	Glass containers	6	1		0.026
562	Other glass products	6	3		0.125
580	Plastic products	15	2		0.001
630	Industrial & medical gases	11	1		
	Total manufacturing industries	1,334	262	0.078	0.100

Source: Derived as explained in the text.

Note: Blanks indicate that no R & D expenditure was reported by the sample firms.

spending on R&D by foreign-controlled firms. Or, that FDI mode of technology imports substitutes the local R&D activity. The nature of influence of technology imports through licensing (or purely technical collaboration agreements) which has become a more popular mode in India's case since the late sixties because of the government policy, however, is not yet clear. But there are reasons to expect the motivation to undertake R&D of a local firm importing technology under licensing to be different than that in case of a foreign-controlled firm. Though the foreign collaborators often restrict any changes in the original specifications/designs supplied through regulatory clauses inserted in the collaboration agreements,[3] the propensity to adhere to these restrictions may be less in case of a locally controlled firm than in the case of a firm controlled by the foreign collaborator himself. Secondly, unlike the affiliate of an MNE the unaffiliated licensee does not enjoy the continued and captive access to the research laboratories of the technology supplier. Finally, the technical collaboration agreements are of a finite duration like five to ten years while relationship between local and foreign party in the case of FDI is lifelong (unless the foreign collaborator divests his share holdings). Due to restrictions placed on renewals of the technical collaborations by the government, the local licensees may be anxious to absorb the technology before the expiry of the foreign collaboration agreements. The same anxiety may not be found in the case of foreign-controlled firms. The keenness to absorb the technology during the period of collaboration appears to have encouraged the local licensees to set up in-house R&D units [7, p. 85]. For all these reasons the propensity of local firms entering into purely technical collaborations to undertake R&D may be different from that of foreign-controlled firms. The Reserve Bank of India's survey indicates that the proportion of companies having R&D set up was much higher among those with technical collaboration arrangements than in the case of those with financial participation [26, p. 132].

III. DETERMINANTS OF IN-HOUSE R&D ACTIVITY: EMPIRICAL ANALYSIS

A. *Hypotheses*

To separate the influence of the two modes of technology imports on industrial R&D intensity, the determinants of its variation across forty-three industries will be analyzed through a regression equation. The extent of FDI and licensing will be posited as explanatory variables along with other hypothetical determinants of R&D intensity, namely, market structure, technological and product market factors, and cash flow.[4]

1. *Technology imports*

As argued above, the influence of technology imports on local in-house R&D activity may be dependent upon the mode of import. In view of the continued

[3] See [16] for a review of literature.
[4] See [14] for a review of literature.

captive access of MNE affiliates to the group's centralized research laboratories and in light of the empirical evidence summarized above, the influence of FDI mode of technology imports on local R&D appears to be dominated by substitution. On the other hand, there are reasons for expecting a greater propensity to undertake in-house R&D among the unaffiliated licensees because of lack of captive access to laboratories abroad, need for adaptation, and anxiety to absorb the technology during the life of the agreement. Hence, the influence of technology licensing on local R&D could be dominated by complementarity. Therefore, two variables—one proxying the significance of FDI (*FS*), and the other, of licensing (*LCG*)—will be included among the determinants of in-house R&D intensity to examine their influence.

2. *Market structure*

Schumpeter [31] had argued that oligopolistic market structures, rather than perfectly competitive ones, are conducive for innovations to take place because a competitive firm will not have surpluses to invest on a high-risk activity like R&D. The subsequent literature has posited a positive functional relationship between the degree of oligopoly and R&D intensity though Schumpeter's theory did not necessarily imply it. This hypothesis could muster only a weak empirical support so far.[5] Nevertheless, we shall include the degree of oligopoly as one of the determinants of R&D intensity expecting a positive relationship. It will be proxied through as usual, four-firm concentration ratio (*CR*4).

3. *Technological opportunity*

Scherer [29] found that about half of the total inter-industry variation in innovative activity in the U.S. manufacturing industries could be explained in terms of "dynamic supply conditions" dependent upon broad advances of science and technological knowledge popularly referred to as technological opportunity or environment. Subsequent studies like Phillips [24], Scherer [30], Rosenberg [27], Wilson [39], Shrieves [32] also found the technological opportunities to be important determinant of the R&D intensity. The direct measurement of the technological opportunity is, however, difficult. The previous studies have tried to capture its influence by separating the industries offering extraordinarily richer technological opportunities like chemicals, engineering from the rest through dummy variables. We shall also include dummy variables distinguishing the engineering (*DENGG*) and chemical (*DCHEM*) industries from the rest. In addition to these, two continuous variables proxying capital and skill intensity (*COR* and *SKIL* respectively) of the industry will be included to examine whether richer technological opportunities exist in capital- and skill-intensive industries. It can be expected that industries characterized by high skill and capital intensities, particularly the latter, offer scope for process improvements and hence encourage spending on R&D. We shall expect a positive relationship between each of these proxies and R&D intensity.

[5] See [14] [33] for a review of literature.

4. *Product market factors*

Firms spend on R&D to promote introduction of new products and improvements of the existing products with the aim of gaining an edge over their competitors. Therefore, the tendency to undertake R&D can be expected to be higher in industries where products are differentiable. Findings of Phillips [24] and Comanor [5] suggest that levels of R&D spending tend to be greater in industries which manufacture differentiable product than in those producing homogenous products. Here again dummy variables distinguishing groups of industries on the basis of product characteristics have been used to capture these influences. We shall also employ two dummy variables, one separating consumer goods industries from the rest (*DCON*); the other separating consumer convenience goods (*DCCON*). In addition industry's advertisement intensity (*ADS*), a continuous variable, will be used to proxy product differentiability and a positive association will be expected between the two.

5. *Cash flow*

Spending on R&D activity may also be influenced by the profitability of the industry because it is unlikely that a risky and uncertain activity like R&D would be financed by borrowed funds [14]. Another reason to expect profitability to be a positive influence is that only a profitable company can benefit from the tax incentives provided by the government of India to encourage in-house R&D.[6] Therefore, we shall expect a positive association between the profit margin (*PCM*) and R&D intensity.

In sum the in-house R&D intensity (*RDS*) has been postulated to be determined by the variables included in the following equation:

$$\begin{aligned} RDS = & a + b1\, FS + b2\, LCG + b3\, CR4 + b4\, DENGG + b5\, DCHEM \\ & + b6\, COR + b7\, SKIL + b8\, DCON + b9\, DCCON + b10\, ADS \\ & + b11\, PCM, \end{aligned} \qquad (1)$$

where a and bs are the coefficients. The expected signs of all bs, except in the case of $b1$, are positive.

B. *Data and Measurements of Variables*

Most of the variables employed have been derived from an unpublished data base made available by the Reserve Bank of India. This data base includes financial statistics in respect of 1,720 select nongovernment, non-financial public limited companies for the years 1976–77 to 1980–81. The sample companies accounted for 86 per cent paid-up capital of all public limited companies in the private sector in 1979–80. Out of these 1,720 companies, 1,334 were in the manufacturing sector. The present study confined to these manufacturing companies. Each one of these companies had been classified into a three-digit industry on the basis of the manufacturing activity accounting for at least one-half its turnover.

[6] See [18] for an overview of various incentives extended by the government of India to encourage in-house R & D activity.

In all there were sixty-two industry classes. However, certain refinement of the industry classification was found to be necessary which yielded fifty-four industries.[7] The sample for the present study included forty-three of these fifty-four industries with 1,143 companies, leaving aside the single company industries, miscellaneous industries and those without representation of foreign-controlled enterprises. A company was considered to be "foreign controlled" if 25 per cent or more of its equity capital was held abroad, in tune with the Reserve Bank of India's definition of a "foreign-controlled rupee company." Industry aggregates were generated by adding up respective values for all the companies included in the industry group (in the sample). Measurements of the variables are indicated below. Unless otherwise indicated all the variables have been derived from the above data base.

Dependent variable:

1. *RDS* (research and development intensity): total research and development expenditure reported by sample firms as per cent of total (sample) industry sales, averaged over 1978–79 to 1980–81.

Independent variables:

1. *FS* (foreign share): share of foreign-controlled enterprises (those with 25 per cent or more foreign equity) in total industry sales, averaged over three years, 1978–79 to 1980–81.
2. *LCG* (licensing of technology): royalty, technical and other professional fees remitted abroad as percentage of industry sales, averaged over three years, 1978–79 to 1980–81.[8]
3. *CR*4 (four-firm concentration ratio): share of top four firms in total industry sales, averaged over three years 1978–79 to 1980–81.
4. *DENGG* (engineering industry dummy): a dummy variable taking value one if the industry is one of the engineering sectors and zero otherwise.
5. *DCHEM* (chemical industry dummy): a dummy variable taking value one if the industry is one of the chemical sectors and zero otherwise.
6. *COR* (capital intensity): total capital employed to net sales ratio, averaged over 1978–79 to 1980–81.
7. *SKIL* (skill intensity): proportion of non-production workers in total work force in 1978–79. Source: calculated from the Government of India, Ministry of Planning, Department of Statistics, Central Statistical Organisation, *Annual Survey of Industries, 1978–79: Census Sector Summary Results,* 2 vols. (New Delhi, 1982).
8. *DCON* (consumer goods dummy): a dummy variable taking value one if industry is producing consumer goods and zero otherwise.
9. *DCCON* (consumer convenience goods dummy): a dummy variable taking value one if industry is producing consumer convenience goods and zero otherwise.

[7] More specific details are available in [18, Appendix I].

[8] Sometimes companies with FDI also remit royalty or technical fees. However, the insignificant correlation between *FS* and *LCG* ($r=0.0797$) reassures their independence.

10. *ADS* (advertisement intensity): advertisement expenditure as per cent of total industry sales, averaged over 1978–79 to 1980–81.
11. *PCM* (profit margin): pretax profits as per cent of total industry sales, averaged over 1978–79 to 1980–81.

Since *RDS* is a proportion with its values ranging between zero and hundred, it is necessary to ensure that its predicted values are constrained from becoming negative. This is done by logarithmic transformation. All the independent variables are also expressed in logarithms, which necessitated adding small positive values to the observations having zero or negative values.

C. *Results*

Table II presents the estimated version of equation (1) for forty-three Indian manufacturing industries. It is apparent that the explanatory variables considered here are able to explain over half of the total variation in the R&D intensity. The overall equation is also significant in terms of *F*-test at 1 per cent level. Results pertaining to different factors are discussed below.

1. *Technology imports*

The variables proxying the two modes of technology imports, that is, *FS* and *LCG,* appear to be influencing the in-house R&D intensity significantly but with different signs. *FS* is significant with negative sign while *LCG* with positive. The findings pertaining to *FS* are, therefore, in tune with those of Caves et al. [4] and Palda and Pazderka [23] that foreign ownership has a depressing effect on the levels of local R&D spending. This may be owing to the reported tendency of MNEs to centralize R&D activities near their headquarters. The foreign subsidiaries in India appear to be fulfilling their R&D requirements from their parent firms instead of undertaking it themselves. Thus substitution dominates the influence of technology import through FDI on local R&D. However, the same is not the case with technology transfer through licensing. Implications of a significant positive coefficient of *LCG* are that technology import under licensing stimulates local R&D spending. This may be due to the following reasons. It is possible that the licensees do not get technologies perfectly suited to local conditions and hence they need to undertake R&D for their adaptation. The unaffiliated licensees may have greater tendency to absorb, assimilate, and master the imported technologies. Or they might be undertaking R&D simply to keep pace with modernization while those importing technology through FDI may have continuous access to parent company's R&D. Thus Blumenthal's argument of possible complementarity between imported and indigenous technologies [2] seems to be applicable only to the technology licensing and not to FDI in India's case.

2. *Market structure*

The market structure variable *CR*4 attains a modest level (10 per cent) of significance with negative sign. The neo-Schumpeterian expectation of a positive

TABLE II
REGRESSION EQUATION EXPLAINING VARIATON IN *RDS*

Independent Variable	Estimated Coefficient
1. *FS*	−0.99137[a] (2.757)
2. *LCG*	0.3458[a] (2.607)
3. *CR4*	−1.4463[c] (1.810)
4. *DENGG*	0.6942 (0.861)
5. *DCHEM*	2.0803[c] (1.908)
6. *COR*	−1.4393[a] (3.065)
7. *SKIL*	0.6102 (0.482)
8. *DCON*	−2.2960[b] (2.109)
9. *DCCON*	1.1037 (0.984)
10. *ADS*	0.6291[a] (2.348)
11. *PCM*	−0.0480 (0.243)
12. *CONSTANT*	−6.3541
R^2	0.5007
F	4.829
N	43

Notes: 1. Figures in parentheses are *t*-values.
2. Superscripts indicate levels of significance as follows: a: 99 per cent; b: 95 per cent; and c: 90 per cent (two-tailed test).

relationship between the seller concentration and R&D activity is, therefore, contradicted for Indian industry. However, it is not for the first time that this hypothesis is refuted. Studies by Mansfield [22] for the United States, Adams [1] for France and the United States, Globerman [10] for Canada, and Subrahmanian [34] for Indian chemical industry also did not find support for it. Scherer [29] [30] could find only a weak support; and Comanor [5], Phillips [24], and Shrieves [32] found the influence of market structure on innovation to be dependent upon other factors such as product differentiation and technological opportunity. An explanation of the inverse relationship in India's case can be offered in terms of the role of the entry barriers. Comanor has argued that in the presence of entry barriers concentration does not encourage innovation. Findings of Scherer [30] also support this argument. In India's case in addition to the usual structural barriers like product differentiation, scale economies, capital requirements, etc., entry to the industry (particularly to the large-scale sector) is heavily deterred by the government policy factors. The industrial licensing policy (with the complement of the Monopolies and Restrictive Trade Practices Act, 1969 and Foreign Exchange Regulation Act, 1973) regulates the entry of new firms to any industry.[9] The competition from abroad is shielded by tariffs and non-tariff barriers and exchange controls. The government policy barriers seem to be much more potent in blocking the entry than the structural ones. In the absence of threat from potential competition the high concentration might discourage R&D activity instead of encouraging it. The Indian car industry provides an illustration to this point. It is evident that the Indian passenger car industry which until recently enjoyed a very high level of concentration (with two firms producing almost entire output) did not undertake R&D in any significant proportion and kept producing models based on designs of the fifties vintage inspite of rapid improvements in both the production technology and the product in the Western World. The obvious reason for this had been in the lack of competition both from inside and outside. Only now, after the government decided to break the barrier and let a joint venture between a public sector enterprise and an MNE enter the industry, the existing firms were trying to modernize their products. Katrak [15] also explained the less than proportionate influence of firm size on R&D expenditure in terms of lack of competitive pressures.

3. *Technological opportunity*

Of the four variables tried to capture technological opportunity, only *DCHEM* and *COR* turned out to be significant.[10] The former has a positive sign, as expected. Thus the chemical industries, as observed, among others, by Scherer [29] [30], Comanor [5], Shrieves [32] are endowed with richer technological opportunities than the rest. The engineering industries in India, however, do not spend on R&D in a measure significantly different than in other industries. The capital intensity, *COR,* is significant with negative sign. It would tend to suggest that capital-intensive industries do not offer technological opportunities. However, this finding may be on account of the tendency of Indian industry to neglect R&D for process improvements. There is some evidence that whatever little R&D is undertaken in India usually involves product improvements, substitution of raw materials, etc. [26] [7]. Therefore, this finding needs to be generalized with caution. *SKIL* is insignificant implying that skill intensity of operations, at least in India, does not particularly result in higher outlays on R&D.

4. *Product market factors*

Of the three variables employed to capture influence of product market factors, two, *ADS* and *DCON,* attain significance and the third one (*DCCON*) remains

[9] For details of industrial policy see [13].

[10] Another dummy variable distinguishing electrical engineering industries was also tried. It, however, did not turn out to be significant. Hence it is not reported.

insignificant. *ADS* is significant at 1 per cent level with positive sign. The advertisement intensity proxies the differentiability of the product because industries producing homogenous product would hardly advertise. Therefore, this result suggests that industries producing differentiable products spend significantly larger sums per unit of sales on R&D than the rest. This is in tune with the findings of, among others, Comanor [5], Rosenberg [27], Wilson [39], and Shrieves [32]. *DCON*'s negative sign indicates that consumer goods industries (after controlling for influence of product differentiation) spend lower on R&D per unit of sales than producer or intermediate goods industries.

5. *Cash flow*

The profit margin variable (*PCM*) turns out to be insignificant with negative sign implying that R&D spending is independent of industry's profitability. However, it is possible, as Kamien and Schwartz have concluded, that profitability is a threshold factor "necessary in some degree for R&D activity but with no direct functional relation with innovative activity" [14, p. 98].

IV. CONCLUSIONS

The present paper has examined the nature of influence of two alternative modes of technology imports on local levels of in-house R&D spending. Our search through the existing literature indicated that influence of FDI mode of technology import may be dominated by substitution. Though no clear-cut indication was available regarding the influence of licensing mode of technology import, there were reasons to expect it to be different, possibly dominated by complementarity.

The empirical exercise included regressing industry R&D intensity on significance of FDI and licensing while controlling for its other hypothetical determinants across forty-three Indian manufacturing industries. The findings of the regression analysis revealed that nature of influence of the two modes of technology imports on R&D intensity was quite different. FDI had a negative association with R&D intensity implying that, other things being same, industries dominated by foreign-controlled firms spent lower on R&D per unit of income than the rest. The substitution dominated the influence of FDI on local R&D in tune with the existing literature. On the contrary the licensing was found to be having positive association with R&D intensity implying a complementarity dominated relationship between this mode of technology imports and local level of R&D spending.

Among the other determinants of R&D intensity, the extent of seller concentration in India was found to be inversely related to the local R&D, possibly because of the presence of public policy factors eliminating the threat of potential entry to industries. The chemical industries as a group were found to be spending higher proportion of their income on R&D compared to others. While the industries characterized by high capital intensities revealed a tendency to avoid R&D activity, those with high levels of product differentiation tended to spend a higher proportion. Profit margins failed to explain R&D intensity significantly.

These findings have important implications for technology policies aiming at the promotion of technological self-reliance through stepping up the in-house R & D activity. They indicate that those local firms which imported technology under licensing (or purely technical collaboration) ceteris paribus do seem to complement it by R & D activity while those importing it through FDI do not. Therefore, policies seeking technological self-reliance ought to encourage technology imports in unpackaged form, that is, under licensing rather than through package of FDI. Secondly, those instruments of public policy which restrict the entry of new firms to any industry giving the existing firms persistent monopoly power discourage the firms from undertaking R & D activity and hence are counterproductive. An assessment of those policy instruments is, therefore, due from this angle.

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