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Liberalisation, TRIPS And Technological Behaviour Of Firms In Indian Pharmaceutical Industry

Anita Kumari*

Abstract: This paper has attempted to identify the factors determining technology imports for firms in the Indian Pharmaceutical industry, the most-vibrant knowledge based industry. The study is based on firm level data from 1995, the year when liberalisation actually trickled down to the pharmaceutical industry. The study found that firms capability has been very important for motivating technology imports to take advantage of liberalisation policies and face challenges under TRIPS. It is revealed that firms larger in size tend to import more technology. Also older firms have been found to be importing more technology. Profits is not found to be significant determinant of technology imports. Firms with foreign equity participation have been found to have more technology imports as compared to their domestic counterpart. A complementary relationship has been found between technology imports and research and development expenditure.

Field of Research : Economics

1. Introduction

The Indian pharmaceutical industry has been largely affected by various options and strategies available in Indian Patent Act 1970 and various Drug Price Control Orders and significant changes in Drug policy and Price controls under the economic reforms of 1991. The Indian Patent Act 1970 did not allow product patents on medicines but process patents were allowed. Thus, domestic firms were able to introduce MNC-patented products by making some minor changes in the manufacturing process. This act also restricted import of finished formulations and imposed high tariff rates. The policies prior to 1990s involved elaborate use of industrial licensing and restrictions on technology imports. In lieu of the economic reforms initiated by the Government of India in July 1991, the Drug policy was further modified in September 1994. The significant changes have taken place in Pharmaceutical industry since then. Industrial licensing for the manufacture of all drugs and pharmaceuticals has been abolished with some exceptions, technology imports have been uncontrolled with automatic approval for foreign technology agreements in the case of almost all drugs. Foreign investment has also been liberalized; it had been allowed initially up to 51 percent, it was raised to 74 percent in March 2000 and to 100 per cent in December 2001. Later on Price control

* **Dr. Anita Kumari, Sir Ratan Tata Fellow, Institute of Economic Growth, University of Delhi Enclave, Delhi-110007, India, E Mail: anita@iegindia.org; anita_ieg@yahoo.co.in**

has also been substantially diluted. Thus liberalisation of Indian economy had driven the need for new technology and new products. As a result new technology was imported. Also some firms invested in R&D to add their own value to the existing products. Further, India has also signed an agreement on TRIPS (Trade-Related Aspects of Intellectual Property Rights) under WTO on April 15, 1994. As part of this agreement, India has implemented product patent with effect from January 2005. Thus on account of liberalisation of the Indian economy and on account of new obligations undertaken by India under the TRIPS agreement, the adoption of new technology has become essential for overall long-term macroeconomic growth and in particular to growth of pharmaceutical industry.

Studies for technology imports in India have been done for the period before 1990's. But no systematic study seems to have been done on the impact of liberalization on technology imports in the pharmaceutical industry in India. This is particularly important as under the 1970 Indian Patent Act, The Indian pharmaceutical sector grew by legally reverse–engineering internationally patented drugs. But, with the globalisation of world economy and new obligations under the WTO agreements, the technological capability of Indian firms will determine the success of Indian industry in general and the pharmaceutical industry in particular. This requires a change in the policies for making pharmaceutical industry internationally competitive and promoting accelerated growth of the pharmaceutical industry. Against this backdrop, this paper makes an attempt to identify the factors important for technology imports in the Indian pharmaceutical industry in the post-reform period and to draw policy implications for firms in the Indian pharmaceutical industry in Post-TRIPS regime. The paper is organized as: section 2 gives a brief review of the literature. Section 3 discusses the hypotheses of determinants of technological imports. Section 4 specifies the methodology for analyzing determinants of technology imports. Section 5 discusses the findings. Section 6 presents the conclusion of the study

2. Literature Review

According to literature, propensity to seek import of foreign technology than to internal transfer via a merger, joint venture or partnership with a foreign firm is related to the firms perception of cost, risk and benefit of the desired technology (Caves 1982, Robinson 1988 and Kumar 1990), opportunity and appropriability conditions faced by firms (Basant, 1997) and technological capabilities of firms (Lall, 1992). Thus studies dealing with the determinants of technology imports have argued that firms technology imports are determined by the environment in which the firm operates along with various industrial and firm characteristics. This section shall briefly review the literature, for India as well as other countries, on determinants of technology imports.

Deolalikar and Evenson (1989) have carried out an econometric analysis of the decision to purchase technology in Indian industry for the period before 1970s. They argued that these decisions are jointly determined by characteristics of Indian Industries, Indian prices and the supply of purchasable foreign technology. They found out that industrial structure, firm size, and public and private ownership influence technology purchase. Kumar (1990) study considered data on 49 three digit Indian manufacturing industries for late 1970s. He considered advertisement intensity, skill intensity, capital intensity,

total capital employed, research intensity, imports and effective rate of protection in explaining total royalty paid as a ratio of sales. He found research intensity and capital intensity as the only significant determinants. Katrak (1991) explained the probability of importing technology in case of Indian manufacturing. He considered size of the firm, age of the firm and R&D expenditure as possible determinants. Using a probit model, he found all the three variables as significant determinants. Basant (1997) explored the technology strategies of large enterprises in Indian chemical industry and argued that firms technology strategy is influenced by the technology regime in which it operates. They defined technology regime to be consisting of a combination of variables capturing industrial structure, nature of technological knowledge and the policy environment. Using logit model, he explored the impact of firm size, capital and material imports, foreign equity participation and foreign/domestic technology spillover on foreign technology purchase. The study used firm level data for large firms in chemical industry for 1974-84. The study found that size of firm, capital import and foreign participation as significantly increasing the probability of licensing foreign technology. Siddharthan and Krishna (1994) also analysed for Indian manufacturing the determinants of technology imports. They estimated a Tobit model using data on firms in different industries. The variables considered were: advertisement intensity, foreign equity participation, capital output ratio, import of capital goods, components and other materials including raw materials, profit margins, research and development intensity relative size, skill intensity and export intensity. They found relative size and foreign equity participation as the only two significant determinants in case of drugs and pharmaceutical industry for the period 1987-90. Evenson and Joseph (1997) however used industry level data. Using probit analysis, they considered variables profits, market concentration, firm size, market share, exports, imports, patents and foreign control for explaining the decision of firm for acquiring technology. They also included industry dummies in the function.

Studies for other countries included Wilson (1977) for Fortune 1000 firms, Braga and Willmore (1991) for Brazilian firms and Giannitsis (1991) for Greek firms. Wilson (1977) has tested the influence of firms technological environment on licensing. He used firm level data for 350 firms in Fortune 1000 for royalty payments in 1971. He considered spending on license purchases as function of both the firms operating profits and environmental variables representing the opportunity for new product discoveries, the complexity of product configuration options and the concentration level of the firms industry. Braga and Willmore (1991) for a sample of Brazilian firms considered a dummy variable approach for firms importing technology and firms not importing technology. They used a logit model and considered size of firm, diversification of output, operating profit of the firm, dummy for exports and state control and foreign control, effective protection as possible determinants. They found size, foreign control and exports to have a positive whereas profit and protection to have a negative relationship with technology imports. Giannitsis (1991) in case of Greek manufacturing explained decision to import technology with the help of size of the firm, nature of industry and foreign participation of the firm. He used ordinary least squares technique and found foreign participation and size of the firm as significant determinants.

Studies for technology imports in India have been done for the period before 1990's. This study, on the other hand, analyses factors determining technology imports in the

Indian pharmaceutical industry after liberalisation to draw policy implications for firms in the Indian pharmaceutical industry in Post-TRIPS regime.

3. Determinants of Technology Imports: The Hypotheses

According to the literature, a firm technology imports are determined by the environment in which the firm operates; industrial characteristics: industrial and market structure, firm characteristics: size, scale of production, technological knowledge, technology absorptive capabilities, international orientation and profits and policy environment. Since this study relates to firms in only one industry subject to overall same industrial and market structure and policy environment, we shall focus only on firm characteristics and the hypotheses related to this has been discussed below.

3.1. Technology Imports and Growth of Firm.

The growth of firm indicates increase in the demand. The increase in demand for the firm increases the returns from acquisition of new technology which allows for introduction of new products and processes. It is hypothesized that firms with larger growth have greater incentives to import technology.

3.2. Technology Imports and Firm Size

Firms propensity to import technology depends on firms size as large size improves the probability of being technologically active. Size of the firm is also taken as resource variable which enables firms to cope with risk taking and competitiveness in the market. (Braga and Willmore 1991, Giannitsis 1991, Katrak 1991, Lall 1992, Siddharthan and Krishna 1994 and Basant 1997).

3.3. Technology Imports and Export Orientation

Exports serve as an additional source of demand. Thus exports by increasing the size of the market increases the returns to technology acquisition. Also exports motivate firms to import technology to be competitive in the international market. Thus it is expected that firms with foreign orientation will be importing more technology. (Pugel 1978, Zimmerman 1987, Braga and Willmore 1991 and Siddharthan and Krishna 1994).

3.4. Technology Imports and Profitability

In the literature, there has been mixed argument on the impact of profits on technology imports. Some authors have argued that low profits puts pressure on firms to be innovative in order to become more competitive. (Horowitz, 1961 and Braga and Willmore, 1991). On the other hand some authors have argued that firms with higher profits may have higher imports of technology as liquidity in the form of higher profits is necessary for expenditure on technology imports (Siddharthan and Krishna, 1994). It may be hypothesized that firms with higher profits may be in a better position to import technology given the cost of technology imports.

3.5. Technology Imports and Foreign Participation

Foreign equity participation facilitates transfer of technology. Literature suggests that firms with foreign equity spend more on foreign technology because firms with foreign equity participation do not develop indigenous R&D efforts because of having access to the technology developed by their foreign partners. However, technology strategy of firms may be different in different industries. For pharmaceutical industry, which had only process patent, the parent company may transfer only part of their process technology through licenses and at the same time undertake R&D to change the process. It is hypothesized that firms with foreign participation have higher technology imports than those without foreign participation. (Braga and Willmore 1991, Giannitsis 1991, Siddharthan and Krishna 1994, Caves 1982 and Basant 1997).

3.6. Technology Imports and R&D

Firms import technology to obtain basic design and know how. But to improve and adapt the imported technology to local conditions requires research and development expenditure and then the relationship between technology imports and R&D expenditure may be complementary. But research and development expenditure may be required to introduce new products and in such cases there will be substitution relationship. Thus relationship between technology imports and research and development may be different for different industries depending upon the requirement of firms. In pharmaceutical industry, because of existence of process patent, reverse engineering is required to change the process which in turn requires expenditure on research and development. Hence, in pharmaceutical industry, a complementary relationship is expected between technology imports and research and development expenditure. A number of studies have examined the relationship between technology imports and R&D expenditure; Siddharthan and Krishna,1994 and Basant, 1997 and Katrak, 1991).

3.7. Technology Imports and Age of Firm

Older firms are well-established firms and have better risk taking capacity as compared to new firms. Since their other products are well established, therefore they can take risk of introducing new products or processes. Also, the older firms have accumulated knowledge in operating know-how and experience that helps in the changes in the production process. Thus considering age as a proxy for accumulated experience, technological learning and risk taking capacity, it is hypothesized that older firms will import more technology as compared to new firms. (Siddharthan and Krishna,1994 and Katrak, 1991).

4. Methodology

4.1. Specification of the Model

Based on both theoretical and empirical literature discussed above, the function for explaining technology imports in the Indian Pharmaceutical industry is specified as:

MTS=F [GS, EXS, LS, GPS, FE, RDS, AGE]

To account for changes in the policy from year to year, a set of year dummies have also been included in the equation to be estimated. MTS is technology imports intensity, GS is growth of firm, EXS is export intensity, LS is size of firm, GPS is profitability of firm, FE is foreign equity participation, RDS is research and development intensity, Age is age of firm. A firm may or may not import technology. Hence there will be two types of firms; one importing technology and other not importing technology. Therefore, in the former case, dependent variable will take actual technology import intensity whereas in the latter case, dependent variable will take value zero. A Tobit model is employed to estimate the above function as simple OLS will produce biased estimates in such cases where dependent variable takes on the value zero for a large number of cases. The model has been estimated after correcting for heteroskedasticity using the Huber - white estimators. Eviews, the statistical package, has been used for estimation.

4.2. The Data and Measurement of Variables.

The above model has been estimated by using the data on companies from Capital line data set brought out by Capital Market Publishers India Pvt. Ltd. Since the economic reforms initiated by the Government of India in July 1991, trickled down to the Pharmaceutical Industry only in 1994 with the modification of Drug Policy in September 1994, the model has been estimated for the period 1995 to 2004 to analyse the determinants of technology imports for pharmaceutical industry. The sample consists of 1149 observations belonging to pharmaceutical industry. The measurement of different variables used in the analysis are mentioned below:

MTS = Technology imports intensity measured as ratio of total payments for royalty and technical fees made abroad to sales.
GS = Growth of firm measured as growth of sale of firm.
EXS = Export intensity measured as ratio of exports to sales.
LS = Size of firm measured as logarithm of sale of firm.
GPS = Profitability of firm measured as ratio of gross profits to sales.
FE = Foreign equity participation measured as dummy variable taking value 1 for firms with 25% or more foreign equity and 0 otherwise.
RDS = Research and development intensity measured as ratio of research and development expenditure to sales.
AGE = Age of firm measured as ratio of accumulated depreciation to fixed assets.

5. Findings

Table 1 presents the mean and standard deviation of key variables for firms importing technology and firms not importing technology. It is observed that average of technology import intensity has been 0.6 per cent of sales over the period 1995 to 2004. Average annual rate of growth of sales has been 30 per cent for firms importing technology

Table 1: Average of Variables for Firms in Indian Pharmaceutical Industry from 1995 to 2004 (In Percentage)

	Firms Importing Technology	**Firms Not Importing Technology**
GS	30.0 (125.6)	26.5 (90.2)
EXS	19.2 (26.4)	16.0 (22.3)
GPS	13.4 (9.2)	7.6 (33.2)
RDS	1.6 (3.0)	0.6 (1.9)
MTS	0.6 (0.8)	0
No. of Observations	189	960

Note: Figures in parentheses gives standard deviation.

whereas it has been 26.5 per cent for firms not importing technology. Export intensity has also been higher for firms importing technology being 19.2 percent on an average as compared to that for firms not importing technology being 16 per cent on an average. There has also been substantial difference in profitability for firms importing technology and firms not importing technology, average profitability being 13.4 per cent and 7.6 per cent respectively. Interestingly, for technology importing firms research intensity has also been higher being 1.6 per cent as compared to that for firms not importing technology being 0.6 per cent only.

Table 2 gives the estimates of Tobit model for factors determining technology imports. The estimation results have been provided with robust standard errors, Z-Statistics. These standard errors are Huber-white estimates of standard errors and are robust to the problem of non-normality and heteroskedasticity in the residual variance. From the results it can be seen that growth of sale has been insignificant determinant in technology imports in the Indian Pharmaceutical industry. Export intensity has also been found to be insignificant. However, size of the firm has been found to be positive and highly significant in affecting technology imports. Thus larger firms have been importing more technology as compared to smaller firms in the pharmaceutical industry. Basant (1997) for the period 1974-84 in the case of Indian chemical industry has also

found that firms become technologically dynamic with increase in their size. Siddharthan and Krishna (1994) for the period 1987-90 in the case of Indian drugs and pharmaceutical industry have found relative size as significant in determining technology imports. Profitability on the other hand has been found to be insignificant determinant of technology imports. Siddharthan and Krishna (1994) have also found profits as insignificant in the Drugs and Pharmaceutical industry for the period 1987-90. The impact of foreign equity participation has come out to be positive and highly significant in import of technology. Thus firms with foreign equity participation seem to have larger imports of technology as compared to firms without foreign equity participation. Research and Development expenditure has come out to be positive and significant. Thus there seems to be complementary relationship between technology imports and R&D expenditure in the pharmaceutical industry. Basant (1997) and Siddharthan and Krishna (1994) have found an insignificant relationship between the technology imports and R&D expenditure for chemicals and drugs and pharmaceutical industry for the period before 1990s. This shows signing of an agreement on TRIPS (Trade- Related Aspects of Intellectual Property Rights) by India and liberalisation of economic policies have motivated the firms for transition for changed industrial environment. Age of firm has also turned out to be positive and significant. However, Siddharthan and Krishna (1994) have found age as insignificant in determining technology imports in drugs and Pharmaceutical industry for the period 1987-90. Thus an insignificant coefficient for the period before 1990 and a positive and highly significant coefficient in the period after the signing of TRIPS agreement and modifications in Drug policy in 1994 may indicate that in the anticipation of product patent approaching, firms started transforming themselves for changed industrial environment. And older firms were in a better position to start aligning themselves in accordance with product patent regime because of better risk taking capacity and accumulated experience in operating know-how for bringing changes in the production process. All the year dummies have been found to be insignificant.

Table 2: Tobit Estimates of Technology Imports in Indian Pharmaceutical Industry

Variables	Coefficient	Z-Statistic
C	-0.027558***	-6.506120
GS	0.000442	0.972140
EXS	0.000529	0.197721
LS	0.002988***	6.797253
GPS	0.004113	1.018542
FE	0.008505***	4.068626
RDS	0.049127***	2.639567
AGE	0.000106**	2.500739
Y96	0.001189	0.440728
Y97	7.34E-05	0.025584
Y98	0.002215	0.801015
Y99	0.001771	0.690467
Y00	0.001074	0.404411
Y01	-0.000720	-0.286446
Y02	-0.001269	-0.464342
Y03	-0.003164	-1.074433
Y04	-0.003759	-1.452782
Log likelihood	330.4344	
Observations	1149	
Observations with technology imports	189	
Observations without technology imports	960	

Note: ** significant at 5%, *** significant at 1 %.

6. Conclusions

The study analysed the impact of liberalisation policies on technology imports in Indian Pharmaceutical Industry. The study is based on capital line data on companies from 1995, the year when economic reforms actually trickled down to the pharmaceutical industry. The Tobit model has been used to identify the factors determining technology imports in the Indian pharmaceutical industry. It has been found on the basis of estimated function that among factors determining technology imports, it is size of firm and not growth of firm or export orientation which has been significantly determining technology imports in the pharmaceutical industry. Thus large firms, because of availability of huge resources and risk taking capacity inherent with new product development have been found to be in a better position to take advantage of liberalisation policies for import of technology. Profit has been found to be insignificant determinant to seek technology imports to avail the opportunities created by

liberalisation and face the challenges under TRIPS. Firms with foreign equity participation have been found to have more technology imports as compared to their domestic counterpart. Because of lack of product patent and risk of copycat by domestic firms, firms usually preferred intra-firm technology transfer. A complementary relationship has been found between foreign technology acquisition and research and development intensity. Older firms have been found to go for more technology imports as compared to newer firms because of availability of resources and accumulated knowledge needed in distribution and marketing of introduction of new products. Also these firms have a broad range of products, therefore these firms are able to have better risk taking capacity in terms of benefits and costs involved in the introduction of new chemical entities (NCE).

Thus in the TRIPS regime, when technology component is going to be the driving force in the growth of Indian industry in general and pharmaceutical industry in particular with the introduction of product patent from 2005, Indian pharmaceutical industry will not be able to take the advantage of the reverse engineering. Therefore to be competitive, firms have to seek technology imports for producing new products. Research and development efforts should be further increased for adaptation of imported technology to Indian conditions. Smaller firms should also take advantage of new technology by growing larger through mergers, acquisitions or partnership with either larger domestic firms or foreign firm. Firms may also create their own resources through borrowing or equity financing.

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