

Export behaviour and Innovation-A tobit analysis

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Abstract— For any firm, knowledge acquisition happens in either of the two ways. One being internal Innovation and the other one being knowledge transfer which happens as a result of International activities like Exports and imports. This paper studies the relationship between these two methods of knowledge acquisition. Indian Chemical industry in itself is unique because it consists of different sub sectors which behave differently. The R&D intensity determinants of the sub sectors of Chemical industry are studied in this paper based on two sets of independent variables namely Firm specific characteristics and market concentration. Censored Tobit regression was employed. It was found that both in Chemical as well as Pharma industries, the Export orientation of the firm positively contributes to the R&D intensity of the firm.

Keywords— *Research and Development expenditure; Export; Chemical industry; Pharmaceutical industry; Tobit analysis*

I. INTRODUCTION

Chemical Industry in India is gaining lot of importance in the recent years mainly because of its growth, diverse subsectors and commercial products which come under the umbrella of Chemical Industry. The industry has changed over time to meet the dynamic demands of an emerging economy. Not only exports but also the domestic demand grew, helping the industry to develop. A strong support from the Government's side was also extended by sanctioning 100% FDI in the sector and giving special emphasis to R&D [13]. The Indian Chemical industry has different sub sectors which include Petrochemicals, Chemicals and Chemical Products, Drugs & Pharmaceuticals and Rubber & Plastics sector. The R&D intensity remains different for various sub sectors across the industry. The sub sectors have exhibited different threshold limits for R&D expenditure with the Pharmaceutical sector on the higher end and the Fertilizer sector on the lower end of the scale [11]. The Pharmaceutical industry is highly research oriented and innovative firms spend on an average of about 15% of sales turn over in internal Innovation [9]. However, the Research & Development intensity of the Indian Pharmaceutical firms remained less than 2 percent till 2000[10]. A lot of innovation and research is happening not only in drug development but also in the area of drug delivery systems [20]. The orientation of the entire Pharma industry towards Research had made this study inevitable. The R and D intensity of the Chemical industry over the years were obtained

from CMIE Prowess database and is shown in Fig. 1 which shows that there has been an increase in the R&D intensity over a period of years. Of the subsectors mentioned above the Organic chemicals and Drugs& Pharmaceuticals are the two top exports of India accounting to about 12.1 billion USD and 11.7 billion USD in 2014 respectively [12]. In an industry where innovation and Exports contribute to the growth of the economy, it becomes critical to understand and analyze the factors which determine the R&D expenditure of a firm. Other studies which have focused on Export performance is [19]. This study focuses on the impact of Export intensity on the internal innovation expenses of the firm and the results show that a positive relationship exists between them.

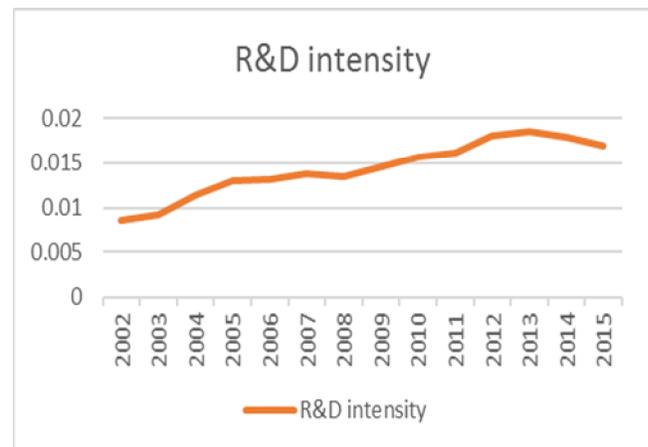


Fig 1. Chemical Industry R&D intensity: Indian scenario

II. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

A. Factors affecting firm's Research & Development intensity

The factors affecting the Research and Development decision of the firm depends on two main factors namely firm characteristics and the market structure.

B. Firm specific characteristics

1) *Export intensity and Capital intensity*: Studies like [4] and [5] argues that the innovation activity of a firm largely depends on firm specific characteristics like cash flow and

export orientation of the firm. Several empirical studies like [15] and [16] has found that there exists a positive correlation between a firm's Export activity and its Research & Development activity. They also suggest that competition in the International markets are fiercer than in the domestic market. Thus the hypothesis (alternate) tested in our study are the following.

H1: The Export intensity impacts the R&D intensity of the firm

H2: The capital intensity impacts the Research & Development intensity of the firm

H3: The Profit intensity impacts the Research and Development intensity of the firm

2) *Firm Size*: The empirical studies on the firm size affecting the Research & Development decision of the firm is inconclusive. Many studies like [1], [2] and [3] showed that a positive relationship existed between the firm size and the innovation activity of the firm. This relationship was explained with the reasoning that those firms which have large sales will be able to spread their Research and Development costs. A counter argument [14] states that as the size of the firm increases the efficiency in Research & Development decreases due to loss of managerial controls and also leads to attenuation of incentives given to individual scientists and engineers. These studies explain how the relationship between larger firms and innovation differ compared to relationship between smaller firms and innovation. The hypothesis (alternate) thus tested in this study is as given below

H4: Firm size impacts the Research & Development intensity of the firm

3) *Firm Age*: Studying the relationship between the age of the firm and its Research & Development expenditure, [17] suggests that a high degree of persistence in investing in Research and Development is observed among mature firms whereas relatively young firms have low degree of persistence. This explains the path dependent nature of the firms. The hypothesis(alternate) tested in the study is

H5: Age of the firm impacts its Research and Development intensity

C. Market Concentration

The hypothesis studied by [6] contented that a higher market power favors innovation. Study [7] rejects the Schumpeterian hypothesis to find a nonlinear 'U' shaped relationship between market concentration and Research & Development. Our study tests the hypothesis(alternate) that

H6: Firm's market share impacts its R and D intensity

III. DATA SOURCE AND RESEARCH METHODOLOGY

A. Data Description

The sample consists of 587 firms from three different subsectors of Chemical industry which are Chemicals and Chemical products, Drugs & Pharmaceuticals and Rubber and Plastic products. The classification of the industries was done

based on the National Industrial Classification(NIC) code. The data from CMIE- Prowess was used. The definitions of the variables under study is given below

TABLE I. VARIABLE DEFINITION

Variable	Definition
Firm age	Age of the firm since inception
Firm size	Natural log of Sales
Capital intensity	Natural log of Net Fixed Asset to Sales
Profit intensity	Proportion of Profit After Tax to Sales
Export intensity	Total Exports to Sales ratio
R and D intensity	Proportion of R&D Expenditure to Sales
Market share	Ratio of firm's Sales to subsector's total Sales
Import Dummy	=1 for Import of raw materials = 0 otherwise
Industry Dummies	Two dummies to account for subsectors
H-index	Sum of the squares of the market share of all firms in the subsector

B. Methodology

To find out the determinants of R&D intensity of a firm, Tobit regression Model is considered. Since the data also includes firms which do not have Research & Development Expenditure, a truncated model, Tobit regression will best fit the data. Stata 13.0 was used for the analysis.

The following is the general model used for the study. The model supposes that there is a latent or unobservable variable, Y_i^*

$$Y_i = Y_i^* \text{ if } Y_i^* > 0 \quad (1)$$

$$Y_i = 0 \text{ if } Y_i^* \leq 0$$

$$Y_i^* = \beta_0 + \beta_1 X_i + u_i \quad (2)$$

Where Y_i^* is the latent dependent variable, X_i $i=1$ to n independent variables and u_i is the error term. Other studies which have used Censored tobit regression are [19]. Thus the Model 1 in our study involves dummies for Chemical subsector and interaction of the dummy. The is as follows Model 1 is as follows

$$RDIntensity = \beta_0 + \beta_1 Age + \beta_2 Insize + \beta_3 Insize^2 + \beta_4 capins + \beta_5 PATint + \beta_6 Expint + \beta_7 DIMP + \beta_8 MShare + \beta_9 Hindex + \beta_{10} DChem + \beta_{11} DCExp + u_i \quad (3)$$

The Model 2 employed in our study makes use of dummy and its interaction to study the Drugs & Pharmaceutical subsector. The Model 2 is as follows

$$RDIntensity = \beta_0 + \beta_1 Age + \beta_2 Insize + \beta_3 Insize^2 + \beta_4 capins + \beta_5 PATint + \beta_6 Expint + \beta_7 DIMP + \beta_8 MShare + \beta_9 Hindex + \beta_{10} DPharma + \beta_{11} DPExp + u_i \quad (4)$$

Where Age=Age of the firm, Insize=natural log of sales, Insize2=natural log of sales², capins=capital intensity, Expint=Export intensity, MShare=Market share of the firm, Hindex=Herfindahl index, DChem= Dummy for Chemical industry, DPharma= Dummy for Pharmaceutical industry, DCExp= Chemical Dummy interaction with Export intensity, DPExp= Pharmaceutical Dummy interaction with Export intensity.

One of the important assumptions to run regression is that the variance of the error term remains constant across observations, failing which the problem of heteroscedasticity might exist in the data. In order to overcome the problem of heteroscedasticity in the data, White's correction method was employed and the parameters in the table II are adjusted for heteroscedasticity.

IV. ESTIMATION

A. Censored Tobit Estimation

The Model 1, as given above is estimated using Tobit regression. The results for the estimation are tabulated in Table II. Further the subsectors interact estimates are also done using Tobit regression as described in Model 2 above. The results for Model 2 is also given in table II

TABLE II. TOBIT REGRESSION

Independent Variable	Coefficients	
	Model 1 (Chemical)	Model 2 (Pharma)
Age	0.0001*	0.0001**
lnsize	0.0381***	0.0372***
lnsize2	-0.0019**	-0.0019**
PATint	0.0030**	0.0030**
capins	0.0007	0.0007
Expint	0.0439***	0.0189***
DIMP	0.0080	0.0079
MShare	0.4667**	0.4385*
Hindex	-11.2308***	-5.1551***
DChem	-0.0174***	-
DPharma	-	0.0088**
DCExp	-0.0231**	-
DPExp	-	0.0336**
cons_	0.1674	-0.0375

***p<0.01, ** p<0.05, *p<0.10

1) Model 1

As seen from table II, the age of the firm positively impacts the Research & Development intensity of the firm at 10% level of significance as stated in study [18]. From Model 1, the firm size has a nonlinear relationship with R and D intensity. And this relationship is stated at 1% level of significance. From table II, the positive coefficient of firm size shows that the size of the smaller firms has a positive impact on Research & Development intensity as stated in studies [1], [2] and [3] while the firm size of the larger firms has a negative impact on its R and D intensity. Also from the table II, Export intensity has a positive effect on the Research and Development intensity of the firm at 1% level of significance. This is consistent with the studies [16] and [16]. Model 1 also shows that the Market share of the firm positively affects the Research and Development intensity favoring Schumpeterian hypothesis [7]. Also as the market concentration has a negative impact on the Research &

Development intensity at 1% level of significance. From Model 1, the age of the firm does not play a significant role in determining the R&D intensity of the firm. This is contrary to the study [17] and therefore the null hypothesis H4 can be rejected. As seen from the table II, Model 1 shows that the Research & Development intensity of the firms in Chemical subsector is less by 0.0174 when compared to those in other subsectors. From Model 1, the firms which export and belong to the Chemicals subsector has 0.0231 less R&D intensity at 10% level of significance.

2) Model 2

From table II, the results of Model 2 shows that the Pharmaceutical firms have 0.0088 higher Research and Development intensity than other subsector firms at 5% level of significance. Also seen as in table II, firms which export and are a part of Drugs & Pharmaceutical subsector have 0.0336 higher Research & Development intensity when compared to other firms at 5% level of significance. The other results are similar to that of Model 1 as seen in table II.

V. CONCLUSION

Indian Chemical industry which contributes significantly to the GDP, is mainly export driven. Not only exports but also due to increasing domestic demand, the need for spending on Research & Development and developing new chemicals are on the rise. In order to study the relationship between Exports and innovation, this study used Censored Tobit Regression. The results show that a positive relationship exists between Export intensity and a firm's inclination to innovation. The Research & Development intensity of the Chemical subsector is lower when compared to that of other subsectors whereas for Drugs & Pharmaceuticals subsector, the Research and Development intensity seems to be higher than other industries. In accordance with firm size the results support the hypothesis that the firm size has a positive effect on the innovation decisions of a firm to a certain extent after which it shows a negative effect. Other firm specific characteristics like Age and Profit intensity have a positive impact on the Research & Development intensity of the firm. In addition, the market concentration negatively impacts the Innovation inclination of the firm. The study also aims to study the impact of Export intensity of Chemicals subsector and Drugs & Pharma subsector specifically on Research & Development intensity.

VII. LIMITATIONS

The current study has lot of limitations which provides scope for further research. The data is collected for the FY 2015. Further study can be done by extending it to panel data and the results of determinants of R&D intensity can be compared. The study can also be extended to other sectors where Research and Development expenditure and Exports play a key role in driving the growth of the sector.

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