Technological Efforts and Export Behavior of IT firms in India

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Abstract:

This paper attempts to examine the role of technological efforts in determining the export behavior of firms belonging to the IT industry in India. Technological efforts considered in the study are investments on in-house research and development; import of capital goods; imports of designs, drawings and formulae against royalty payments; and intra-firm transfer of technology through foreign equity participation. Export behavior is considered in terms of decision to export and export intensity of exporter. The results confirm that efforts on import of technology, via both arms length and intra-firm modes, positively determine the export behavior of the firms in the IT industry. Firm size and skilled workforce are also important in explaining exports in this industry.

Keywords: Technological Strategies, Competitiveness, Exports, Information Technology, Developing Countries, India

JEL Code: F14, L1, L63, L86.

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1. Introduction

In the past few years, India has been witnessing substantial growth in the economy, largely driven by the export oriented information technology (IT) industry. The IT industry is also providing employment opportunities to a large number of people in India (Arora and Athreye, 2002). However, Indian IT sector is now facing increasing competition from countries such as China and Philippines. Thus, in the long run, this export led growth would be sustainable only if the industry keeps pace with the rapid technological changes taking place in the world IT sector.

In literature, the role of technological efforts in determining competitiveness of firms is well established. Inter-country difference in technological capabilities is an important determinant of the direction of trade (Posner, 1961; Vernon, 1966; Krugman, 1979). The evolutionary theorists (Nelson and Winter, 1982; Dosi, Pavitt and Soete, 1992) assert that these differences emanate at the level of the firm itself, which eventually accumulates into inter-country differences in capabilities. Some of the recent empirical evidences based on the evolutionary theoretical approach (Patibandla and Petersen, 2002; Siddharthan and Nollen, 2004; Bhaduri and Ray, 2004; Narayanan, 2008) too suggest that continuous technological up gradation in the firm is important for keeping the IT industry in India competitive.

This paper attempts to examine the effect of technological efforts on export behavior of firms based on a more recent sample from the IT industry in India. The technological efforts are in the form of in-house research and development, import of capital goods, imports of design, drawings and formulae against royalty payments, and intra-firm transfer of technology through foreign equity participation. Unlike earlier studies on export competitiveness of IT sector in India (Kumar and Siddharthan, 1994; Bhaduri and Ray, 2004; Siddharthan and Nollen, 2004; Narayanan, 2008), the present study will follow a methodology suggested by Wakelin (1998), Sterlacchini (1999), and Basile (2001) to deal with the censored data sample. Thus, in this study we define export behavior of the firms in two forms, namely, the probability to export, and the export intensity of the exporter firm. Using the likelihood ratio test as suggested by Wakelin (1998) and others, we compare the Tobit model to the Double Specification model (Probit +

Truncation) and find that the Double Specification model is more appropriate and robust for the present study.

The Prowess database provided by Center for Monitoring Indian Economy is the source for the balanced panel data. The sample period considered is from 2000 to 2005, a period of economic growth in India. For the purpose of the study, we have extracted firm level data for 155 companies of Information Technology industry incorporated before the year 2000. The sample contains data on 19 hardware, 127 software, and 9 service firms.

The following section gives an overview of the IT industry in India. Section 3 looks into the potential determinants of exports as given in the literature. Section 4 describes the sample, methodology, and the model. Section 5 carries out the empirical analysis and the last section deals with the summary and conclusions of the study.

2. IT Industry in India

The IT industry started in India in 1960s. Initially International Business Machines (IBM) and ICL (International Computers Limited) were the two giants in Indian IT industry. The Indian government at that time wanted to achieve self-sufficiency in various industries including computers and electronics. The government put forth policies, such as participation of Indian nationals in ownership and control of foreign computer subsidiaries and use of domestically procured inputs to the maximum extent with foreign units fulfilling only complex and large technical needs. This resulted in IBM leaving India and ICL splitting its operations into a manufacturing unit having 40% Indian ownership and a sales unit with no Indian involvement.

In 1975, Burroughs (US) entered into joint venture with Tata Consultancy Services (TCS) to export software and printers. By the end of the same year, the government gave monopoly power to newly established Computer Maintenance Corporation (CMC) to maintain all foreign computer systems. By late 1970s, Indian firms, such as Hindustan Computers Limited (HCL), DCM Data products and Operations Research Group (ORG) that designed and assembled systems, and International Data Machines (IDM) that marketed and serviced Microsystems, entered the IT industry. However, over the years, due to the protective policies of Indian

government and lack of competition, the IT industry in India became technologically backward in comparison to the world.

During 1980s, with the aim of modernizing the Indian IT industry, the government brought out policies to promote exports of software and computer peripherals. It also permitted import of mainframes and supercomputer. In 1984, Department of Electronics (DOE) announced new computer policy to help manufacturing of latest technology computers at international comparable prices. Imports of both components and know-how were liberalized at low duties to support domestic hardware manufacturers (Parthasarathy, 2005). In the year 1986, DOE announced Software Export Development and Training Policy. Soon, the import duty level was reduced to 60%, which was subsequently cut to 25% in 1992. Income tax exemption of 100% was announced on profits from software export. Due to lenient regulations in late 1980s, production shot up by 100% while prices fell to 50% and slowly computers became affordable.

As the value of internet was recognized, lot of encouragement in the form of tax incentives, infrastructure, free licensing to ISPs (internet standard protocol), permission to lay cables or setting up gateways, etc were given to the industry. Software Technology Parks were set up in the 1990s to provide duty free imports of capital goods, high-speed data communication links and tax holidays for 10 years. In the year 2000, the IT Act was enacted. This Act underscores the legal infrastructure for e-commerce and e-governance in India (see Basu and Jones, 2005 for details).

The IT industry in India can be broadly divided into IT enabled services and e-businesses, software products, and hardware. The IT software and services have a large export market with a small domestic component as well. The IT enabled service industries like call centers, back offices, etc. have also shot up from the small beginning in early 90s with American Express, British Airways and GE. A major bottleneck in many cities like Bangalore, Mumbai, and Hyderabad is lack of infrastructure. Furthermore, generally, the trained workforces have to be retrained by the companies to keep up with the advances in the industry.

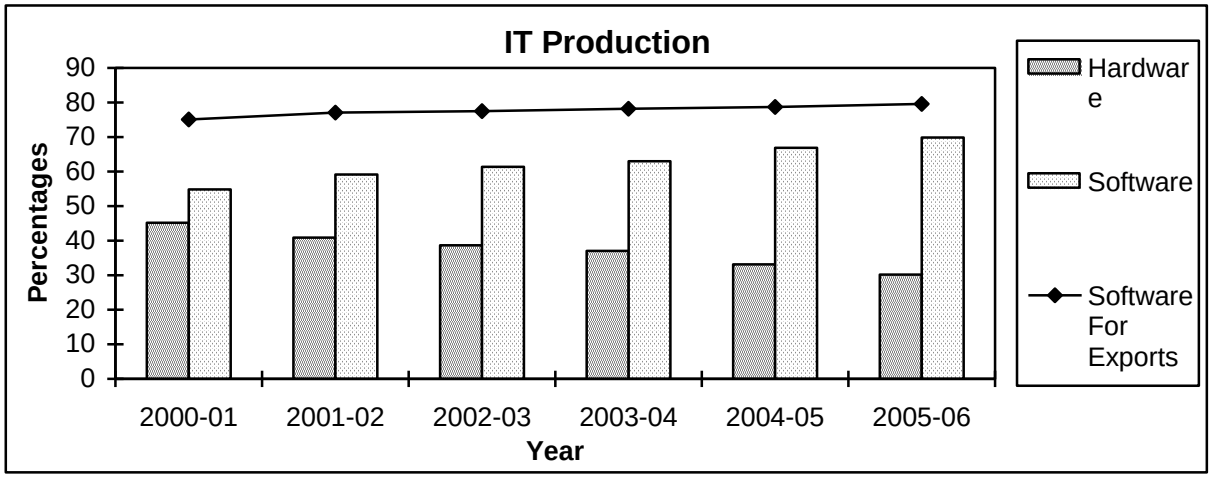
Table 1 shows the value of production in India for various constituents of hardware and software during 2000-01 to 2005-06. Figure 1 depicts the hardware and software production (in percentages) in graphical form. As is clear from Table 1, consumer electronics, and equipments and components form the major portion of hardware production. In India, higher value of software is produced as compared to hardware. The share of software production in the total IT production has been continuously increasing over the past few years (see Figure 1). Of the total software produced more than 75 percent has been for export market. The share of export-oriented software in total software production is also increasing gradually over the past few years.

Table 1: Value of IT industry Production during 2000-01 to 2005-06 periods (Rupees in Crore) (with Percentage Share of Total IT production for *Subtotal (Hardware)* and *Subtotal (Software)*, Percentage Share of Total Software Production for *Software for Exports in parenthesis*)

Item	Sub-Item	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Hardware	Consumer Electronics	11950	12700	13800	15200	16800	18500
	Industrial Electronics	4000	4500	5550	6100	8300	9300
	Computers	3400	3550	4250	6800	8800	10500
	Equipments and Components	11750	12000	13900	15700	16600	17700
	Subtotal (Hardware)	31100 (45.17)	32750 (40.87)	37500 (38.66)	43800 (37.03)	50500 (33.13)	56000 (30.16)
Software	Software for Exports	28350 (75.10)	36500 (77.05)	46100 (77.48)	58240 (78.18)	80180 (78.67)	103200 (79.59)
	Domestic Software	9400	10874	13400	16250	21740	26460
	Subtotal (Software)	37750 (54.83)	47374 (59.13)	59500 (61.34)	74490 (62.97)	101920 (66.87)	129660 (69.84)
Total IT Production		68850	80124	97000	118290	152420	185660

Source: Adapted from Department of Information Technology, Government of India website: http://www.mit.gov.in/dbid/eproduction.asp accessed in June 2007.

Figure 1: IT Production (based on data in Table 1)



3. Literature Review on Potential Determinants of Exports

The literature on international trade recognizes the role of technological factors in trade. The proponents of technology gap (Posner, 1961) and product cycle approach to trade (Vernon, 1966) emphasize the importance technological capability differences in determining the direction of trade. Further, they propose that a country would continue to have a comparative advantage in production and export of a particular product if it incessantly improvises the product through technological efforts. The empirical evidences (Hufbauer, 1966; Pavitt and Soete, 1980; Fagerberg, 1987; Fagerberg, 1988) based on these theories confirm that technological differences are important in determining trade. The new trade theories too acknowledge the importance of technology factor in determining trade by incorporating innovative activities within imperfect competition models of trade and growth (Grossman and Helpman, 1991). However, the proponents of evolutionary theoretical approach (Nelson and Winter, 1982; Dosi, Pavitt and Soete, 1992) are the ones who assert that the differences in competitiveness at macro-level emanate at micro or firm level due to acquisition of differential technological capabilities by the firms over time.

In the context of developing countries, several empirical studies have incorporated technological variables at micro level to test the importance of technological efforts in determining competitiveness of the firms. Some such studies that have dealt with competitiveness in the IT sector in India are Patibandla and Petersen (2002), Siddharthan and Nollen, (2004), Bhaduri and

Ray (2004), Narayanan (2008). However, these studies have intrinsically assumed commonality between the determinants of decision to export and export intensity of the exporters.

In-house R&D is the most commonly used technological explanatory variable in studies on firm competitiveness. In-house R&D can be aimed at either improving the existing process of production or developing a new product. The empirical evidences show differing effects of R&D on export competitiveness. Aggarwal (2001) for medium-high technology industry in India, Basile (2001) for Italian manufacturing industry, and Ozcelik and Taymaz (2004) for Turkish manufacturing industry find a positive relationship between R&D and exports. In case of Chinese manufacturing industry, Zhao and Zou (2002) also find a positive relationship between R&D and probability to export. However, in their study, R&D activities do not favorably affect the export intensity of the exporters. In case of Indian high technology industries, Kumar and Siddharthan (1994) do not find R&D to be important in determining the export competitiveness. However, in a recent study on Electronics/Electrical industry of India, Bhaduri and Ray (2004) find large firms with high amounts of R&D investments to favorable affect export intensities.

In several studies, foreign equity participation is considered as a mode of intra-firm transfer of superior technological and managerial knowledge. Most of the studies on export competitiveness find foreign equity participation to have a favorable influence on exports (Kumar and Siddharthan, 1994; Aggarwal, 2001; Wignaraja, 2002; Bhaduri and Ray, 2004; Ozcelik and Taymaz, 2004; Siddharthan and Nollen, 2004; Narayanan, 2008). In particular, Patibandla and Petersen (2002) find the role of transnational corporations (TNCs), especially the tacit knowledge transfer, to be important in the competitive evolution of the software segment in India.

Firms can acquire foreign technology in disembodied form by importing designs, drawings, and blueprints against royalty payments. They can then produce products of export quality based on these imported designs, drawings, and blueprints. Kumar and Siddharthan (1994) in case of Indian high technology industry, Sterlacchini (1999) in case of non-R&D performing small firms of Italian supplier dominated industries, and Siddharthan and Nollen (2004) in case of MNE affiliates of Indian IT industry find the effect of disembodied technology imports to be positive on export competitiveness.

Modern machines and equipments from abroad can help in improving the services and products offered by the firms. These technology imports in embodied form enable the firm to produce higher quality products that are at par with the world standards. The firms can also use reverse engineering technique to learn from the imported capital goods. Empirical evidences such as Sterlacchini (1999) for non-R&D performing small firms in Italy, and Basile (2001) for manufacturing firms in Italy have reported positive effects of import of capital goods on exports. However, studies on Indian manufacturing industries including IT (Siddharthan and Nollen, 2004; Narayanan, 2008) did not find import of capital goods to have favorable effect on exports.

In studies on competitiveness, a frequently used non-technology variable is size of the firm. The argument in favor of better export performance of large sized firms is availability of resources for investments. In addition, the firm is able to reap benefits of economies of scale by increasing its size of operation. Large size also gives risk bearing capacity and advantages with respect to brand loyalties and price-setting power (Krugman, 1979). However, empirical evidences on the effect of size on exports have been inconclusive (see Aggarwal, 2001; Basile, 2001; Zhao and Zou, 2002; Siddharthan and Nollen, 2004; Narayanan, 2008).

Age of the firm determines a firm's learning curve and thus the capabilities that the firm has accumulated over time. It also determines the cost of capital for a firm. However, in India, as part of the liberalization process, the software and services firms were given many incentives to become export-oriented. Therefore, many of them established in the late 1980s and afterwards are exporting from their very inception. In other words, younger firms might be more export oriented in the Indian IT industry. The findings of Bhaduri and Ray (2004) support this view for Indian Electronics/Electrical industry where younger firms are more export oriented than the older ones.

Export is a risky activity requiring substantial investments on client search and marketing of the firms' products. Furthermore, since it is difficult to obtain venture capital finance for new product development in India, software firms frequently use services exports to get funds to

invest on new product development (Arora et al, 2001). Thus, firm profits become an important source of finance for new product developers in IT industry.

To deal with international clients, especially from countries that are technology forerunners such as United States and United Kingdom, the Indian firms require a high level of skills. The technological and managerial capabilities of the employees of the firm determines the efficiency of the firm to handle and complete large projects from the overseas clients. In addition, since attrition is a major problem in the IT industry in India (Arora et al, 2001), only a firm providing high salary packages to its skilled workforce or a firm employing a large number of semi-skilled workers is likely to be able to maintain the skill level of the workforce in firm.

To summarize, technological efforts such as in-house R&D, import of technology, and intra-firm transfers are believed to be important in determining export competitiveness of the firms. Other firm characteristics such as size of the firm, age of the firm, profitability, and skill content are also considered to be significant factors in determining exports.

4. Sample, Methodology, and the Model

As noted earlier, this study uses a balanced panel data obtained from the Prowess database provided by Center for Monitoring Indian Economy. The sample period considered is from 2000 to 2005. The sample consists of 155 IT firms-19 hardware, 127 software, and 9 services firms.

The data set contains both exporters and non-exporters. For such a sample, where the dependent variable takes a zero value on many observations, models that use maximum likelihood estimation technique are considered to be more appropriate than ordinary least square (OLS) estimation technique (Greene, 2002; Gujarati, 2003; Siddharthan and Nollen, 2004; Narayanan, 2008).

In India, Tobit model is one such econometric model that has been used for censored data (see Kumar and Siddharthan, 1994; Bhaduri and Ray, 2004; Siddharthan and Nollen, 2004; and Narayanan, 2008). The advantage of using Tobit model instead of a Probit model is that information on the continuous values of explained variable are not lost in Tobit models, whereas

after converting the variable into binary form (as is the case in Probit model) valuable information is lost. Statistically, a general Tobit model can be expressed as:

$$Y_i^* = \alpha_0 + \alpha_1 X_{1i} + ... + \alpha_n X_{ni} + u_i,$$

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

$$= 0 \quad \text{if } Y_i^* \leq 0, \qquad \text{-----(1)}$$

where subscript i stands for the particular observation, Y_i^* is the unobserved regressand or the latent variable (also called as index variable), Y_i is the actual observed variable, and X_{1i} to X_{ni} are the n regressors.

However, in their respective studies on Italian manufacturing industry, Wakelin (1998), Sterlacchini (1999), and Basile (2001) note that Tobit technique intrinsically assumes the explanatory variables to have same effect on the decision to export and on the export intensity. This assumption may not always be a correct. In other words, the effect of the explanatory variables on decision to export may differ from that on export intensity for exporters. Therefore, the three authors in their studies consider a Double Specification model where the effect of the explanatory variables on decision to export is first analyzed for the complete sample using Probit technique, followed by a truncation model fitted to analyze the effect of the explanatory variables on the export intensity of the exporters. This Double Specification model thus nests the Tobit model as a special case

A general Probit model can be specified as:

$$Y_i^* = \alpha_0 + \alpha_1 X_{1i} + ... + \alpha_n X_{ni} + u_i,$$

$$DY_i = 1 \quad \text{if } Y_i^* > 0,$$

$$= 0 \quad \text{if } Y_i^* \leq 0 \qquad \text{-----(2)}$$

where subscript i stands for the particular observation, Y_i^* is the latent variable under study, and DY_i is a binary variable that takes a value of 1 whenever Y_i^* is greater than zero else it is zero.

A general truncated model can be specified as:

$$Y_i = \alpha_0 + \alpha_1 X_{1i} + ... + \alpha_n X_{ni} + u_i \quad \text{if } Y_i > c \qquad \text{-----(3)}$$

where Y_i is the intensity of the variable under consideration and is defined only for cases where Y_i is greater than constant c. A likelihood ratio test (Greene, 2002, p. 915) is available to determine which of the two models, that is, Tobit or Double Specification (Probit + Truncation) is more suitable for the data.

Table 2 describes the variables and their definitions used in the present study. Export intensity (EXPI) is the explained variable. Four variables representing the technological efforts of the firm are R&D intensity (RDI), import of capital goods intensity (MKI), import of technology (designs, drawings, and blueprints) intensity (RI), and foreign equity participation (FE).

Table 2: Variables and Definitions

Sl.	Variable	Symbol	Definition Used in the Study
1	Decision to Export	D_{expi}	D_{expi} = 1 when the firm exports in the year D_{expi} = 0 otherwise
2	Export Intensity	EXPI	[Exports / Sales Turnover] * 100
3	R&D Intensity	RDI	[R&D expenses / Sales Turnover] * 100
4	Import of Capital Goods Intensity	MKI	[Foreign Expenditure on Capital Goods / Sales] * 100
5	Import of Design, Drawings, and Blueprints Intensity	RI	[Royalty Expenses / Sales Turnover] * 100
6	Foreign Equity Participation	FE	[Equity held by Foreign collaborators and promoters / Total Equity] * 100
7	Firm Size	SIZE	Logarithm of Sales Turnover in Crores of Rupees
8	Age of the firm	AGE	Relevant Year – Year of Incorporation of the concerned firm
9	Profit Margin	PROFIT	[Gross Profits / Sales Turnover] * 100
10	Skill Intensity	SKILL	[Salaries and Wages / Sales Turnover] * 100
11	Software Firm	$D_{software}$	$D_{software}$ = 1 when the firm is a software producing firm $D_{software}$ = 0 otherwise
12	Services Firm	$D_{services}$	$D_{services}$ = 1 when the firm is a service providing firm $D_{services}$ = 0 otherwise

Size of the firm (SIZE), age of the firm (AGE), profit margin of the firm (PROFIT), skill intensity of the firm (SKILL) are some of the potential non-technological determinants of

exports. Since the Indian IT industry can be divided into sectors, two dummy variables $D_{software}$ and $D_{services}$ representing the software and the services sub-sector respectively have been included to differentiate from the hardware sub-sector.

In the present study assuming $EXPI^*$ is the latent (index) variable, EXPI is the corresponding observed export intensity, and D_{expi} is the dummy variable that takes a value of 1 for exporting firm, the Tobit model and Double Specification (Probit + Truncation) model for export competitiveness of a firm can be specified as:

Tobit:

$$EXPI^* = \alpha_0 + \alpha_1 RDI + \alpha_2 MKI + \alpha_3 RI + \alpha_4 FE + \alpha_5 SIZE + \alpha_6 AGE + \alpha_7 PROFIT + \alpha_8 SKILL + \alpha_9 D_{software} + \alpha_{10} D_{services} + u_1$$

$$EXPI = 0 \quad \text{if } EXPI^* \leq 0$$

$$= EXPI^* \quad \text{if } EXPI^* > 0 \qquad \text{-----(4)}$$

Double Specification:

Probit:

$$D_{expi} = \alpha_0 + \alpha_1 RDI + \alpha_2 MKI + \alpha_3 RI + \alpha_4 FE + \alpha_5 SIZE + \alpha_6 AGE + \alpha_7 PROFIT + \alpha_8 SKILL + \alpha_9 D_{software} + \alpha_{10} D_{services} + u_2$$

where

$$D_{expi} = 0 \quad \text{if firm does not export}$$

$$= 1 \quad \text{if firm exports} \qquad \text{-----(5)}$$

Truncation:

$$EXPI = \alpha_0 + \alpha_1 RDI + \alpha_2 MKI + \alpha_3 RI + \alpha_4 FE + \alpha_5 SIZE + \alpha_6 AGE + \alpha_7 PROFIT + \alpha_8 SKILL + \alpha_9 D_{software} + \alpha_{10} D_{services} + u_3 \quad \text{if } EXPI > 0 \qquad \text{-----(6)}$$

A likelihood ratio test similar to the one suggested by Sterlacchini (1999) was carried out in the present study. The Double Specification model was favored as against Tobit model. However, in the present study the authors have reported the Tobit results as well for comparison.

5. Empirical Analysis

Subsection 5.1 describes some characteristics of the sample data. Subsection 5.2 deals with the results of the Tobit and Double Specification models.

5.1 Characteristics of the Sample

Table 3 describes the mean and standard deviation of the variables for full sample as well as for the three sub-sectors- hardware, software, and services. The firms in the sample are moderately export oriented with mean export intensity of the sample at around 40 percent. It is clear that software and services sub-sectors are more export intensive than hardware. Software firms are more R&D intensive than both hardware and services. In fact, none of the service firms in the sample is investing on in-house R&D. Rather services firms, as compared to software and hardware firms are investing more on imports of capital goods. An average hardware firm is investing more on import of designs and drawings than an average software and services firm.

Table 3: Mean and Standard Deviation (in parenthesis) of Variables

Sl.	Variables	Full Sample	Hardware	Software	Services
1	EXPI	39.42 (42.81)	10.35 (20.74)	43.49 (43.78)	43.24 (40.15)
2	RDI	1.00 (7.69)	0.34 (1.11)	1.18 (8.48)	0 (0)
3	MKI	1.49 (4.85)	0.67 (3.14)	1.42 (4.44)	4.25 (9.96)
4	RI	0.57 (4.44)	2.60 (9.38)	0.27 (3.18)	0.44 (1.68)
5	FE	2.89 (11.51)	2.46 (9.32)	2.80 (11.53)	5.11 (14.96)
6	SIZE	2.86 (2.25)	3.71 (1.69)	2.80 (2.29)	1.92 (2.32)
7	AGE	11.81 (6.82)	11.92 (5.55)	11.55 (6.66)	15.17 (10.06)
8	PROFIT	-81.44 (1027.03)	-5.74 (40.96)	-97.51 (1133.77)	-14.44 (86.15)
9	SKILL	28.44 (29.59)	10.71 (14.27)	30.62 (30.94)	35.12 (19.44)
	Number of Observations	930	114	762	54

Source: Compiled from Prowess database provided by Center for Monitoring Indian Economy

The equity held by foreign collaborator and promoter firms in the total equity is only around 3 percent for a typical firm in the sample. The mean age of the firm in the sample is around 11 years. Software and services firms spend relatively more on salaries and wages (SKILL) than the hardware firms, reflecting the attempt in the sub-sectors to retain experienced and skilled employees in the company.

Table 4 represents the correlation matrix for the variables. The correlation coefficients of two of the technology variables, namely, import of capital goods and foreign equity participation, with export intensity is statistically significant with positive sign. Size, profit, and skill are also positively correlated to export intensity. The value of all the correlation coefficients in the matrix is low suggesting that the multicollinearity problem is unlikely to arise in the present study.

Table 4: Correlation Matrix

	EXPI	RDI	MKI	RI	FE	SIZE	AGE	PROFIT	SKILL
EXPI	1.00								
RDI	-0.02	1.00							
MKI	0.25[c]	-0.01	1.00						
RI	0.03	-0.02	-0.03	1.00					
FE	0.20[c]	0.02	0.05	0.03	1.00				
SIZE	0.34[c]	-0.02	0.02	0.04	0.13[c]	1.00			
AGE	0.05	0.01	-0.06[c]	0.03	-0.02	0.27[c]	1.00		
PROFIT	0.07[c]	-0.003	0.02	0.01	0.01	0.22[c]	0.02	1.00	
SKILL	0.30[c]	0.10[c]	0.14[c]	-0.06[c]	0.10[c]	-0.13[c]	-0.04	0.01	1.00

[c] *represents statistical significance at 10%*

5.2 MLE estimates of the Tobit and Double Specification Models

Table 5 gives the maximum likelihood estimation (MLE) results for the Tobit and Double Specification models. As was mentioned earlier, the likelihood ratio test suggested that the Double Specification model is more appropriate than Tobit model for the present sample. However, Tobit results have also been presented for comparison purpose. The following sub-section (5.2.1) would describe the results of Probit model, that is, the factors affecting the decision to export for the IT firms. Sub-section 5.2.2 would discuss the results of Truncation model, that is, determinants of the export intensity of the firms. The dissimilarity between the results of Double Specification model and Tobit model would also be highlighted.

5.2.1 Factors affecting the decision to export

Of the four technology variables, efforts on technology imports, whether in the form of capital goods or in the form of design, drawings, and blueprints, are favorable for the decision to export for the IT firms (Table 5). It should be noted that most of the exporting firms in the present

sample are solution and package providers. The firms need to have the knowledge of the latest technology available in the global market to provide business and technology solutions, and packages and tools to their foreign clients. The firms are able to obtain the latest technologies through technology imports.

Investment on in-house R&D or foreign equity presence is not likely to affect the decision to export for a firm in this industry. There are many domestic firms in India, especially in the special economic zones (SEZs) and software technology parks (STPs) that offer software solutions and services to overseas clients without having any share of foreign promoter or collaborator in their equity.

Table 5: Maximum Likelihood Estimates[d] for Export as Explained Variable

Sl.	Regressors	Symbol	Tobit	Double Specification	
				Probit	Truncation
1	Constant	-	-58.67 (-9.47)[a]	-1.36 (-6.95)[a]	-121.31 (-5.87)[a]
2	R&D intensity	RDI	-0.64 (-1.58)	-0.001 (-0.19)	-2.51 (-3.36)[a]
3	Capital Goods Intensity	MKI	1.98 (6.28)[a]	0.12 (4.20)[a]	1.32 (3.70)[a]
4	Designs and Drawings Intensity	RI	1.07 (3.12)[a]	0.03 (1.95)[c]	1.25 (2.58)[a]
5	Foreign Equity	FE	0.39 (2.92)[a]	0.005 (0.75)	0.47 (3.12)[a]
6	Size of the firm	SIZE	12.35 (14.42)[a]	0.39 (12.40)[a]	5.89 (4.41)[a]
7	Age of the firm	AGE	-0.47 (-1.88)[c]	-0.005 (-0.49)	-0.16 (-0.45)
8	Profit Margin	PROFIT	0.01 (1.26)	0.0001 (0.46)	0.03 (1.58)
9	Skill	SKILL	0.57 (9.75)[a]	0.01 (6.68)[a]	0.58 (6.60)[a]
10	Software Firms	$D_{software}$	41.19 (7.86)[a]	0.54 (3.56)[a]	130.64 (7.26)[a]
11	Services Firms	$D_{services}$	41.69 (4.92)[a]	0.73 (2.57)[a]	125.09 (6.26)[a]
	Number of Observations		930	930	636
	Log Likelihood	-	-3527.19	-409.33	-3050.80
	Chi^2	-	432.84[a]	341.82[a]	129.37[a]

[d] t-statistics in parenthesis for Tobit results, and z-statistics in parenthesis for Probit and Truncated Results
[a], [b], [c], represent statistical significance at 1%, 5%, and 10% level respectively

Larger firms and firms investing more on skilled employees are more likely to export. The large firms in this industry such as Infosys Technologies Limited, Wipro Limited, Satyam Computer Services Limited, H C L Infosystems Limited, Tech Mahindra Limited are also well established

firms who have been in export business for quite some time. These are also the firms that are able to retain their high skilled employees through high salary and wage packages. It should be noted that the authors did carry out estimation for a reduced sample by excluding the three largest firms, that is, Infosys Technologies Limited, Wipro Limited, and Satyam Computer Services Limited. However, the statistical significance of the variables in the Double Specification model was not affected by dropping observations corresponding to the largest three firms from the sample.

As was expected, a software or service firm is more likely to export as compared to a hardware firm. Age of the firm and availability of internal finance does not affect the decision to export for a firm in this industry. With support from the government, even the young firms are able to have outward orientation from their very inception.

5.2.2 Factors affecting the export intensity

Of the four technology variables, three, namely, import of capital goods, import of designs, drawings, and blueprints, and foreign equity participation favorably affect the export intensity of the exporters (Table 5). Unlike the findings of Siddharthan and Nollen (2004), in the present study, which is based on a more recent data set, import of capital goods has a statistically significant positive sign in determining export intensity. Most of the technologically active firms in this study are involved in relatively higher end products and services such as providing business and technological solutions, producing domain specific tools, and developing software packages that are compatible with the latest available hardware. Hence, by importing the latest hardware, these firms are able to provide more contemporary and efficient products and services. As Kumar (2005) too notes that the established Indian companies are now trying to export more sophisticated, higher value-added software and services.

Foreign equity is favorably affecting the export intensity of the exporters. This finding is in line with that of Siddharthan and Nollen (2004) for an earlier sample period from IT industry in India. In the new millennium too, the exporting firms in this industry are able to take advantage of intra-firm transfer of technological, managerial, and marketing capabilities from the foreign equity participants for better performance in the foreign markets.

In the present study, coefficient of R&D takes an unexpected negative sign in truncation model explaining. Zhao and Zou (2002) too, in the case of Chinese manufacturing industry, found export intensity of the exporters to be negatively affected by R&D activities. It was suggested that import-substituting R&D undertaken by the Chinese firms, aimed at capturing domestic markets rather than export market, was responsible for this unexpected result. In the case of IT industry in India too, firms with high R&D intensity during 2000-2005, such as Odyssey Technologies Limited that provides products for information security and Ramco Systems Limited (part of Ramco Group) that provides enterprise solutions and services, mainly cater to the needs of well-known domestic clients. At the same time, many other IT firms that have invested on in-house R&D, such as Infosys Technologies Limited, Wipro Limited, and Flextronics Software Systems Limited (earlier Hughes Software Systems Limited), are multinational companies (MNCs) with overseas production facilities. It is quite possible that the in-house R&D undertaken by these firms are for the benefit of their overseas production units rather than for improvement of the products and services that they offer in the form of exports.

Larger size of the firm is favorable for decision to export as well as export intensity of exporters. As duplication of IT products and services is not very difficult, large turnover brings down per unit cost of production, and hence increases their export performance. Higher relative investments on skilled employees also favorably affect the export intensity. Many of the software and service providers in India have obtained ISO 9001 and Capability Maturity Model (CMM) standards' certifications. This implies that the firms in the industry have acquired skills for efficiently undertaking complex projects (Arora et al, 2001), a factor that can attract large foreign clients.

Software and service providers are likely to export at higher intensities than hardware providers. Many of the software and services firms in India have overseas marketing offices, development centers, and subsidiaries. These help the firms in capturing large foreign markets. Hardware providers in India such as VXL Instruments Limited, T V S Electronics Limited, D-Link (India) Limited, and Zenith Computers Limited mainly cater to the needs of domestic market. Although, many of the hardware firms are now trying to get into exports by providing services, some firms

like VXL Instruments Limited have remained in hardware sector and formed joint ventures with firms in foreign countries to capture overseas markets.

Age of the firm is not important for the export intensity of the exporters. In an industry where the product life cycle is very short, the experience gained over time is not likely to give extra advantage to the older firms in export market unless they keep updating their technological knowledgebase. However, the result of the Tobit model suggests that younger firms have advantage in export market as compared to the older firms. Profit margins of the firm also do not seem to affect the export intensity of the exporter. With various other sources of funds such as venture capital being available for the standard IT software and services (Arora et al, 2001), profit margins is may not turn out to be that significant for export competitiveness of the IT firms in India.

6. Summary and Conclusions

The present study attempts to investigate the inter-firm differences in the effects of technological efforts on the export behavior of the firms in the context of IT industry in India. The export behavior of the firm is defined in terms of two aspects, the decision to export and the export intensity of exporter. Likelihood test suggests that Double Specification model (Probit + Truncation) is more appropriate for the present sample. The following points emerge in the present study.

First, in line with the findings of other empirical studies such as Siddharthan and Nollen (2004), in this study too technological efforts are important as determinants of export behavior of IT firms. Import of technology through arms length purchases and the managerial and technical expertise of foreign promoters and collaborators help the IT firms to keep pace with the rapidly changing IT technology in the world so that the firms are able to provide relatively higher end products and services, such as business and technological solutions, to their international clients. However, to sustain exports in the long run, there is a need to encourage in-house R&D in the emerging areas of the IT industry so that the firms provide original products and services rather than simply solutions to the problems posed by the international clients.

Second, large size of the firm positively influences both the decision to export as well as the export intensity of the exporters. The firms in this industry can reap the benefits of economies of scale, as duplication of IT products and services is easy. By helping the small firms in this industry to network with others, including larger firms, one can ensure that the small firms are also cost-effective from their very inception.

Third, skilled employees improve the export performance of the firms in this industry. With many of the Indian IT firms obtaining ISO 9001 and CMM certifications, one can admit that the IT employees in India have software development and project management skills. However they may still be lacking the entrepreneurial ability to foresee up-coming areas in IT where new products can be developed. The knowledge of the latest developments in the IT industry can be imparted to the skilled workforce through regular training sessions so that they can contribute towards innovative product and process development.

Fourth, the incentives provided by the Indian government have encouraged even the young firms to become exporters from the beginning itself. In the light of increasing competition from Chinese and Philippines firms, there is a need to continue providing support to the innovative young software and services firms in terms of tax incentives and infrastructure support.

Thus, unlike other studies on IT industry in India, the present study analyzes a more recent dataset using a more appropriate methodology to understand the export behavior of the IT firms in India. The paper suggests that technological up gradation through imports is important to sustain the export competitiveness of the IT industry in India. However, in future, with the reduction in the technological gap between India and other developed countries, production of unique products and services through in-house R&D efforts is likely to become more important for export competitiveness of the firms in this industry. In the light of increasing competition from other developing country firms, the study reveals a need to encourage the firms to continuously put in efforts on in-house R&D and skill enhancement that can enable the firms to foresee and develop products and services in the emerging areas of IT industry.

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