# Technology Acquisition and Competitiveness: Evidence from Indian IT Industry

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**Abstract:**
This paper attempts to examine the impact of technology transfer [through FDI and the market] on the international competitiveness [defined in terms of export intensity] of Indian information technology [IT] firms. The study broadly follows the evolutionary theoretical approach of Nelson and Winter [1982], Dosi, Pavitt and Soete [1992] and Fagerberg [1996]. Specifically, this paper analyses the differences in the role played by technology and other firm specific characteristics like size, degree of vertical integration, capital intensity, and age of the firm in explaining export intensity of firms across three different segments [computer hardware, software and IT enables service providers] of the Indian IT industry. Data for the statistical analysis is largely drawn from the balance sheets and annual reports of companies made available in the PROWESS database of the Centre for Monitoring Indian Economy. The study uses firm level data for 428 IT companies for the years 2000-01 to 2004-05. There are year-to-year changes in the sample set due to the entry and exit of firms. The observations for six years across all these segments of the IT industry have been pooled for the empirical analysis. Since the dependent variable, export intensity, is zero for some firms the study uses the Maximum Likelihood estimation of the Tobit model. On the whole the results confirm the hypotheses that inter-firm variation in export competitiveness is broadly explained by the variables representing technology acquisition, firm size, capital intensity and vertical integration. Firms in the Indian IT sector, which have facilitated intra-firm transfer of technology through foreign equity participation emerged more competitive than those that rely on other modes of technology acquisition. Large sized firms, which not only enjoy scale advantages in production, but also are in a position to take the risk of external markets, emerged more competitive than their smaller counterparts. Further, the results also highlight the differences in the role played by vertical integration and capital intensity in determining export intensity. Vertically integrated firms did not turn out to be more export intensive, whereas capital intensity emerged significant with a positive sign in determining export intensity. In sum the results clearly highlight the differences in the role of technology acquisition and other conduct variables in determining export performance of Indian IT firms. The nature and direction of the relationship between these explanatory variables and export intensity for an emerging industry like IT has very important policy implications.

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## 1. Introduction

With increasing liberalisation and necessity to face competition it is imperative that India concentrates, revives and supports the industries that have the capability to do well. This paper attempts to analyse the factors that determine exports of the information technology [IT] firms in India. The IT sector has the potential to grow, provide employment and internationalise. The literature on international trade, whether based on technology gap and product life cycle models of trade (Posner 1961, Hufbauer 1966, Vernon 1966) or on the more recent 'new trade' theories [Grossman and Helpman 1991], clearly put forth the idea that international technological differences form a fundamental basis for trade between countries. However, it is the evolutionary theoretical approach of Nelson and Winter (1982) that considers firm to be the point from where the differences emanate. Dosi (1984) demonstrated this approach of firm's technological evolution in case of the semi-conductor industry. Though Posner (1961) had also considered firm level learning as a factor for inducing technology gap, however, it was Dosi (1984) and Pavitt (1984) who discussed the evolution of technological capabilities within a firm and the role of differences in these technological capabilities in explaining inter-firm differences in competitiveness. Dosi et al (1992) describe in detail how the long-term trends in trade performance can be considered to be due to different degrees of innovativeness and technological dynamism of the economy. In the process they have also discussed the possibility of growth or exit of a firm depending on their relative technological success.

Over the last decade the IT industry in India has grown at a very high pace becoming one of the important industries contributing to Indian exports sector. As of today in India the software and IT services industry employs 1 million people approximately and by 2008 these industries are expected to employ 2.2 million Indians. Mainly driven by the IT industry (also oil and construction) the Bombay Stock Exchange (BSE) benchmark sensex had touched 12,000 from 7,500 over a period of one year in the new millennium.

The present study is an attempt to understand what determines the export competitiveness of firms in the Indian IT industry. An attempt has been made to especially understand what modes of technology acquisition are important for driving exports in this industry. For this

study an unbalanced panel data sample of total 428 firms covering software, services and hardware sub-sectors of the IT industry for a period of six years from 2000 to 2005 has been analyzed using maximum likelihood estimation of a Tobit model specification.

The following section gives a brief history of the IT industry in India. Section 3 gives an overview of literature dealing with exports and its determinants. Section 4 deals with the econometric model being used in the present study. Section 5 discusses the empirical analysis results. The final section gives the summary and conclusions drawn from the present study.

## 2. Brief History of IT Industry in India

The initiation development of IT industry in India dates back to early 1960s. During the1960's and 1970's, the govt kept self sufficiency as the aim in computers and electronics to be achieved in 3 steps:

a) Indian participation in ownership and control of foreign computer subsidiaries in the country.
b) Indian producers should become capable of meeting the computer requirements with foreign units meeting only the most complex and large technical needs
c) India should be able to obtain and manufacture the most advanced systems in the international market.

In this period IBM (International Business Machines) and ICL (international Computers Ltd.) were the 2 main players in India of which IBM alone accounted for 70% of the sales. The govt. proposed Indian nationals should share in the ownership to which the companies responded negatively. In fact IBM, claiming that its international presence required centralized coordination and control, threatened to leave India. ICT split its operations in two a manufacturing unit with 40% Indian ownership and a sales unit with no Indian involvement. But the sales unit had complete powers. Govt formed a Dept. of Electronics (DOE) and a new Electronics Commission to formulate and oversee implementation of policies. ECIL (Electronics Corporation of India Ltd.) was formed for microcomputer production.

In 1975 Burroughs (US) entered into joint venture with Tata Consultancy Services (TCS) to export software and printers. Computer Maintenance Corporation (CMC) was also established with monopoly to maintain all foreign computer systems. Under renewed pressure from the govt. to share ownership IBM quit India in 1978. This exposed the

government's resolve to pursue its policy of advancement at any cost and market opened up to many Indian competitors like Hindustan Computers Limited (HCL), DCM Data products and Operations Research Group (ORG) to design and assemble systems. International Data Machines (IDM) marketed and serviced Microsystems. All these together probably employed about 4000 employees.

During the 1980's the govt. encouraged exports of software and computer peripherals while permitting import of mainframes and supercomputers. This was basically due to the aim of modernizing the Indian IT industry, which was far behind the contemporary research and product frontiers in other countries. In 1984 DOE announced new computer policy to promote manufacture of latest technology computers at international comparable prices. Imports (parts and know-how) were liberalized at low duties to support domestic hardware manufacturers. In the year 1986 Software Export Development and Training Policy was announced by DOE. Duty was cut to 60%, which was subsequently cut to 25% in 1992., and 100% income tax exemption was announced to profits from software export. Most of the regulations were made lenient in this period. As a result production shot up by 100% while prices fell to 50%. And so slowly computers became affordable.

In this period DOE also invested in Knowledge Based Computer Systems (KBCS) programme with 5 IITs, IISc and NCST (National Centre for Software Technology). National Informatics Center set up NICNET a satellite-based communication network over 439 cities and towns to computerize government business at all levels.

Further, during the 1990's, DOE was reprioritized [by the Government] to promote IT rather than regulate it. Liberalization became more effective. Import duty for software, which was 112% in 1991 due to devaluation of rupee, fell to 10% by 1995. By 1993 duplication of software was permitted and piracy was made punishable. 1996 VSNL started internet service. 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 as value of net was recognized. 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 in India.

**Table 1: Summary of Indian policies for IT sector and its effects**

| Time Period | Important Policies | Effects |
|---|---|---|
| 1960s and 1970s | Indian participation in ownership and control of foreign subsidiaries mandatory. | Foreign firms like IBM quit India and domestic firms flourished with approximately 4000 employees working in the industry. |
| 1980s | In 1984 imports of parts and know-how liberalized at low duties to support domestic hardware manufacturers with duty cut to 60% in 1986 | Foreign Equity participation involving technology transfer<br>Increase in foreign trade on IT products and Services [both imports and exports] |
| 1990s | 1. Income tax exemption up to 100% for software export profits<br>2. Duty cut to 25% in 1992 for import of parts and know-how<br>3. By 1993 duplication of software was permitted and piracy was made punishable<br>4. Import duty on software fell to 10% in 1995 due to devaluation of rupee<br>5. Encouragement given in the form of tax incentives, infrastructure, free licensing to ISPs (internet standard protocol), permission to lay cables or setting up gateways, etcetera<br>6. Software Technology Parks set up to provide duty free imports of capital goods, high speed data communication links and tax holidays for 10 years. | Production shot up by 100% and prices fell to 50%.<br>Exports of Softwares. |
| From the year 2000-01 | Emphasis on the legal infrastructure for e-commerce in India via the IT Act | 1. Indian IT output value risen from $1.73 billion in 94-95 to $17.5 billion a jump of 900%<br>2. IT software and services accounted for 3 to 4% of GDP and around 35% of exports<br>3. Software exports risen from Rs.14 crores in 1995-96 to Rs.103,200 crores in 2005-06<br>4. As of today the software and IT services sectors employ 1 million people approximately<br>5. BSE benchmark sensex has touched 12,000 from 7,500 over a period of one year |

Indian IT output value has risen from $1.73 billion in 94-95 to $17.5 billion a jump of 900%. IT software and services accounted for 3to4% of GDP and around 35% of exports. Software exports have risen from Rs.14 crores in 1995-96 to Rs.103,200 crores in 2005-06. The annual growth rate of India's software exports has been consistently over 50%. Within 3 to 4 years we are expected to achieve $50 billion worth of exports as the industry continues to grow. As of today the software and IT services sectors employ 1 million people approximately and by 2008 are expected to employ 2.2 million Indians. Mainly driven by the IT industry (along with oil and construction) the BSE benchmark sensex has touched 12,000 over a period of one year from 7,500.

The IT industry in India can be broadly divided into IT services, software products; IT enabled services and e-businesses. They have a large export market with a small domestic component as well. The IT enabled service industries like call centres, back offices, etc. have also shot up from the small beginning in early 90s with American Express, British Airways and GE. The only thing which may stand in the way may be the infrastructure which has not kept pace with the requirements with the industry as seen in many cities like Bangalore, Mumbai, Hyderabad, etc. Also the trained manpower that has not kept up with the advances in the industry has to be retrained by the companies most of the time. Then there is something called the last mile problem. The communication networks have reached the towns but from there to the villages is a jump yet to be made. That requires intense investment and engineering due to the terrain involved. Also the IT industry depends on the high cost telecom structure imported from abroad. Efforts should be made to develop them in-house.

Table 2 gives the statistics on electronic production during the period 2000-01 to 2005-06. The data for this analysis has been taken from various publications of the Government of India and the McKinsey Report. As it is evident from the Table 2, during each financial year from 2000-01 to 2005-06 software production (sum of rows 5 and 6 in Table) has contributed to more than 50 percent of the total electronic production. Again one can clearly infer by comparing rows 5 and 6 of Table that most of the software produced is exported. Further the percentage share of software for exports in total electronic production has steadily increased from approximately 41 percent in 2000-01 to nearly 56 percent in 2005-06. It should be noted that in 1990 the Indian government had announced 100 percent income tax exemption on software export profits after which India has been witnessing phenomenal increase in software production and exports.

**Table 2: Value of Electronics Production during 2000-01 to 2005-06 period (Rs. Crore) [with Percentage share of Total in parenthesis]**

| Sl. No. | Item | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 |
|---|---|---|---|---|---|---|---|
| 1 | Consumer Electronics | 11950 (17.36) | 12700 (15.85) | 13800 (14.23) | 15200 (12.85) | 16800 (11.02) | 18500 (9.96) |
| 2 | Industrial Electronics | 4000 (5.81) | 4500 (5.62) | 5550 (5.72) | 6100 (5.16) | 8300 (5.45) | 9300 (5.01) |
| 3 | Computers | 3400 (4.94) | 3550 (4.43) | 4250 (4.38) | 6800 (5.73) | 8800 (5.77) | 10500 (5.66) |
| 4 | Equipments and Components | 11750 (17.07) | 12000 (14.98) | 13900 (14.33) | 15700 (13.27) | 16600 (10.89) | 17700 (9.53) |
| 5 | Software for Exports | 28350 (41.18) | 36500 (45.55) | 46100 (47.53) | 58240 (49.23) | 80180 (52.60) | 103200 (55.59) |
| 6 | Domestic Software | 9400 (13.65) | 10874 (13.57) | 13400 (13.81) | 16250 (13.74) | 21740 (14.26) | 26460 (14.25) |
| 7 | Total | 68850 | 80124 | 97000 | 118290 | 152420 | 185660 |

## 3. Review of Literature

This section would discuss the theories and empirical literature on export competitiveness and its determinants. Subsection 3.1 gives a background on technological theories on trade. Subsection 3.2 gives an overview of some of the empirical studies dealing with relationship between technology variables and export in developing countries' context. Subsection 3.3 discusses some non-technology based determinants of exports considered in various studies.

### 3.1 Background on Technological Theories of Trade

The relationship between technology and international competitiveness has been an important area of study in both theoretical and empirical literature on trade. Fagerberg (1996) and Wakelin (1997) give a detailed review of the studies linking technology and international competitiveness of a country where the focus is on analyzing how differences in technological capabilities determines trade performance. Posner's (1961) in his seminal paper proposed an alternative paradigm where a firm that introduced a new product enjoyed an export monopoly from the country of origin, at least until the imitators entered the market. He developed a set of concepts that became the basis for various 'technology gap' theories of trade. Posner (1961) not only discussed the existence of technology gaps between nations, but also pointed out that these gaps are maintained by the nations and firms through further

increasing investments on research and development (R&D), clustering of technical innovations, and through dynamic economies of scale.

Soon, Hufbauer (1966) empirically validated the technology gap theory in his study of international trade in synthetic materials where he found a distinct relationship existing between trade performance and innovative leadership. Later, for a sample of 40 industrial sectors in OECD countries, Soete (1981) considered technology variable as a potential determinant of export performance and found that the technology variable was indeed essential in explaining inter-country variation in export performance for most of the industries. The new trade theories too, by incorporating innovative activities within imperfect competition models of trade and growth, recognize the importance of technology factor in facilitating trade (Grossman and Helpman 1991).

Innovations provide countries and industries with comparative advantage over and above given by unit labour costs alone. The firm invests in product/process innovation to improve performance and create knowledge flows. The capability to internally and indigenously develop mechanically/technically complex products enables firms to build competitive intensity in the markets through better information processing, reduced product lifecycle and shorter development period. The results of most of the empirical studies on the relationship between technology variables and countries' export performance with a "technology-gap" approach (Vernon 1966, Krugman 1979, Fagerberg 1988 and Dosi, et al 1992) find robust correlation between national technological capabilities and export performance.

With the advent of globalization firms have started making their presence felt in more than one country especially through equity participation. For a purely domestic firm, to collect information on consumer preferences, regulations, distributions channels, and market characteristics is costly and difficult. The affiliation with foreign owners makes it comparatively easier and advantageous (Caves, 1971; Hymer, 1976; Dunning, 1980). The foreign equity ownership provides access to technology, brand names, skills, experience, finance, intermediate inputs and capital goods decreasing the risk on the investment sunk in technology and development.

### 3.2 Technology and Exports

Though most of the studies discussed above are in developed countries' context there exist a few empirical studies that have examined the role of technology in export performance for developing countries as well (Hirsch and Bijoui 1985, Lall 1986, Kumar 1990, Willmore 1992, Kumar and Siddharthan 1994, Athukorala et al 1995, Haddad et al 1996 and Wakelin 1997, Wignaraja, 2002, Zhao and Zou, 2002, Bhaduri and Ray, 2004, Ozcelik and Taymaz, 2004, Siddharthan and Nollen, 2004, Narayanan, 2006). Hirsch and Bijoui (1985) tested the relationship between technology and export performance for 111 firms drawn from Israel. While regressing the rate of change in exports over a period from 1979-81 to 1975-77 on R&D expenditure in 1977 and firm size, they found R&D expenditure significantly explaining the export intensity of Israeli firms.

Lall (1986) focused on technological variables affecting export performance for data on the 100 largest Engineering and 45 largest Chemical firms in India. He considered different forms of technology variables, namely, the value of royalty and licensing fees paid abroad, the percentage of equity held by foreign firms, and R&D. He found that foreign share positively influenced the export performance of only the Chemical firms. R&D efforts had a positive influence on exports in Chemical industry indicating that R&D investments in enhancing process technology improved the quality and design characteristics product to meet international standards. However, in case of Engineering firms, R&D turned out to be significant with a negative sign, implying that the R&D was more of an adaptive nature that made the products suitable for the Indian resource conditions but did not enable them to compete internationally.

Kumar (1990) considered technology intensity of an industry as a potential determinant of export performance for a sample drawn from forty-three Indian manufacturing industry sectors. On analyzing the sample, after dividing the sample into foreign controlled and local firms for highlighting the differences between the foreign affiliates and local firms, he found that technology factor was not significant in determining the export competitiveness for Indian manufacturing industry.

Willmore (1992) studied the role played by transnational corporations in Brazil's trade performance. He analysed the determinants of both exports as well as imports for a cross-section of 17,053 industrial firms in Brazil. The results of the study indicated that the

dummy variable representing foreign equity ownership had a very strong positive effect on both export performance and import propensities. However, R&D activities undertaken by the firm turned out to be insignificant in determining exports.

Kumar and Siddharthan (1994) analysed the effect of R&D expenditure on the exports for 640 Indian firms across thirteen industries. The period under study was from 1987-88 to 1989-90 when partial de-regulation of trade and investment controls had been undertaken in India. The authors classified the industries into low, medium and high-technology categories. They found R&D to be positively influencing the export performance of both low and medium technology firms. However for the firms in two high-technology engineering industries investments on import of design and drawings seemed to help them in competing in foreign markets.

Athukorala et al (1995), for a sample drawn from Sri Lankan manufacturing industry, tried to see whether multinational enterprises were more export oriented than the wholly domestically owned firms. Their results did point out that multinational affiliation was important in determining whether a firm was an exporter or not. However, no significant relationship was found between multinational affiliation and the degree of export orientation of exporting firms.

Haddad et al (1996) considered foreign share in firm ownership as a potential determinant of export share in sales for firms belonging to Morocco's manufacturing industry. The year chosen for the study was close to 1987, a period of slow but progressive opening up of Moroccan economy to foreign competition along with introduction of some incentives to export. They found a positive association between foreign share and exports indicating that knowledge gained about foreign markets were important in determining export performance.

Wakelin (1997) analysed the role of firm-specific innovative characteristics in influencing trade performance for a sample of 500 UK firms for a period of five years from 1988 to 1992. She included both sector specific (technological opportunity at the sector-level) and firm specific (R&D expenditure) technological determinants. The results showed that there were considerable differences in the reactions of innovating and non-innovating firms with respect to their export behaviour. In case of quoted firms firm-level R&D had a positive impact on the exports of the innovating firms.

Zhao and Zou (2002) considered the domestic firms from Chinese manufacturing industry for understanding the effect of external factors such as industry concentration and firm location on export competitiveness of the firms. In the analysis they also considered R&D activities as a potential determinant of export performance and found that those firms that undertook R&D activity were more likely to export than others who did not undertake any R&D, however the export intensity of the exporters was negatively affected by R&D activities.

Wignaraja (2002) for a sample drawn from the Mauritian Garment industry constructed and introduced a technology index in the equation for export performance along with other technology variables such as foreign equity participation and share of engineers and technicians in the workforce. He found that technology index and foreign equity participation positively affected export performance and the third technology variable turned out to be insignificant.

Similarly, for Indian high technology Pharmaceutical and Electronics/Electrical industry, Bhaduri and Ray (2004) constructed and introduced variables that captured the absolute and relative effects of know-how and know-why categories of R&D output, and one dummy variable capturing the effect of foreign ownership. Their results showed that foreign ownership and R&D output relative to R&D expenditure was more important than absolute R&D output variables in determining export competitiveness in Indian Pharmaceutical industry. However in case of Indian Electronics/Electrical industry only know-how output (both absolute and relative to R&D expenditure) was important in determining exports.

Ozcelik and Taymaz (2004), in addition to R&D investments, introduced foreign ownership and technology transfer through licenses and know-how agreements in different models as potential determinants of export competitiveness for Turkey's manufacturing industry. They found that R&D and foreign ownership had positive effect on export competitiveness for the sample as a whole. However, technology transfer did not turn out to be significant in determining exports.

In another study Siddharthan and Nollen (2004) for Indian Information Technology sector divided the sample into three groups- multinational enterprise (MNE) affiliates, technology importers that do not have foreign equity participation but make lump sum, royalties or license payments to import technology, and domestic firms that neither import technology nor have foreign equity participation. They found that MNE affiliates in this industry are

using only one of- arms length technology purchases or tacit technological skills from their foreign equity holder firms- to compete in foreign markets. Another technology variable, that is, import of capital goods was found detrimental for export performance of MNE affiliates in this industry. Again, for the group of licensees (without FDI) import of technology through arms length purchase had a negative effect on exports.

Recently, Narayanan (2006) studied export competitiveness of firms in the Indian Automobile industry by dividing the sample into three periods (licensing, deregulation, and liberalization) based on the prevailing policy environment. For the study, apart from R&D three other technology variables, namely, import of capital goods, import of technology in the form of designs and drawings, foreign equity participation were used. Also, in order to test the joint effect of the three technology variables with in-house R&D, three more interactive variables were introduced. Foreign equity participation positively determined exports in both licensing and liberalized periods. For the deregulation period embodied technology as well as disembodied technology imports were having negative effects on exports. From the interactive terms, only R&D with import of capital goods turned out to be clearly favourable for export competitiveness, but only in the deregulation period.

Some other empirical studies have also, in general, obtained positive and significant relation between innovation and exports. However, as stated by Sterlacchini (1999) that innovation in terms of Royalty or R&D intensity is not always significant in determining exports as it ignores innovative efforts (expenditure on design and trials; technological level of capital stock) of small firms and non R&D intensive firms. This fact has also been noted by Lefebvre et al. (1998), and Beccheti and Rossi (2000) who found that these variables neither increased the probability of exporting nor affected the export intensity. Aggarwal (2001) found foreign ownership to be significant in influencing exports for only medium-high technology industries and insignificant in for other cases including high-technology industry. Sjöholm (1999) for Indonesian firms and Kumar and Pradhan (2002) found foreign equity to be significant.

In the present study the technology variables have been defined as follows:

RDI = R&D expenses / Sales

ROYL = Royalty Expenses / Sales

MKI = Foreign Expenditure on Capital Goods / Sales

FE = Percentage of Equity held by Foreign individuals and institutions in Total Equity

Hypotheses: Positive relation between export performance and R&D intensity, Import of Technology, Import of Capital goods and Foreign Equity.

### 3.3 Other Non-Technology Variables and Exports

The non-technology variables considered in various studies on exports include size of firm, age of firm, vertical integration, capital intensity, price cost margin, and labour intensity. The following subsections discuss the empirical studies that have looked into these variables as potential determinants of export competitiveness.

#### 3.3.1 Firm size and exports

Size is supposed to have a positive impact on exports due to economies of scale in production, the opportunity to raise financing at lower cost, benefits from bulk purchasing, own marketing department. Further, large size gives risk bearing capacity (Krugman, 1979) to firms so that they become less risk averse. Larger firms are often at an advantage with respect to having brand loyalties and price-setting power (Krugman, 1979).

Calof (1993) argues that “large firms with more resources are better able to seek out internationalization opportunities and they appear to do so with greater frequency than others… small medium-sized firms are capable of entering the same markets as are large firms. Size only limits the number of markets served”. As Bonaccorsi (1992) also points out limited resources prevent small firms from achieving a stable presence in a large number of markets. However they also note that implementing export strategies with low level of sunk costs enables easy exit for small firms. Smaller firms can have alternative resources and sources of information. Often small firms undertake collective internationalisation, as it is the easiest way to grow. The results found by Bonaccorsi (1992) strengthened the above argument since vertical integration and access to external resources (foreign equity, import of capital) enabled even the small firms to venture into foreign markets.

Similarly, Wolff and Pett (2000) found that small firms are able to pursue an equally effective export strategy by modifying their skill base and resources. Holmlund and Kock (1998) report that networking of small and medium sized firms enables faster and more efficient internationalization. But they also inferred differences in competence and knowledge of

foreign markets based upon difference of firm size with greater advantage to large firms, which Philp (1998) too maintains.

Ursic and Czinkota (1984) argue that economies of scale may stimulate smaller, younger, less resourceful firms to formulate an export strategy, as they would ensure greater gains from exports. More resourceful firms will have large sales in domestic market and so may not gain from exports. But the large firms may have the advantage of efficiency to reduce costs of exports.

Empirical evidence (Hirsch and Adar, 1974; Glejser et al, 1980; Lall, 1986; Kumar, 1990; Bannacorsi, 1992; Kumar and Siddharthan, 1994; Athukorala et al 1995; Patibandla 1995; Wignaraja, 2002; Zhao and Zou, 2002; Siddharthan and Nollen, 2004; and Narayanan, 2006) on the relationship between firm size and exports is mixed. It should be noted that in a recent study on Information Technology industry of India Siddharthan and Nollen (2004) find that (logarithm of) size is an important determinant of exports for MNE affiliates and the purely domestic firms. While in case of domestic firms larger size is an advantage for export performance, in case of MNE affiliates the smaller firms seem to be more export oriented.

Following Siddharthan and Nollen (2004), in the present study too we consider log of sales turnover as a factor for determining exports. Therefore size of the firms has been defined as:

SIZE = log (sales turnover)

Hypothesis: The effect of firm size on exports cannot be predicted in advance.

**3.3.2 Vertical Integration and Exports**

Vertical integration [VI] is the amount of control exercised by the firm (management) over its chain of productions and so is a conscious strategic decision by the firm. Vertically integrated firms operating in non-perfect markets have higher profits and lower prices. The intermediate good is transferred internally at opportunity cost i.e. marginal cost (Perry, 1989). Countries with poor institutions concentrate in industries where the current technology requires highly vertically integrated firms. Uncertainties are more in foreign markets so firms have to be flexible and reactive and may as per necessity dictate the firm's degree of integration. Empirical investigation has found the intention to trade to be a driving force behind vertical integration (Rossini and Ricciardi, 2005). VI determines the difference in technological capabilities of firms (Kathuria, 1996) and thereby should influence exports considerably.

VI = (Profit before Depreciation on Interest and Taxation + Wages and Salaries) / (Net Sales)

Hypothesis: Positive Relation for Positive Vertical Integration and Export Intensity

### 3.3.3 Capital Intensity and Exports

Capital Intensity is a firm's long term commitment to building its technological capacity and upgradation. India firms compete internationally through cost efficiencies and efficient use of capital. Capital expenditure absorbs resources in the short term and influences marginal cost but in the long run it gives positive returns and greater profitability (Lee & Blevins, 1990).

In a recent study on Indian Information Technology industry, Siddharthan and Nollen (2004) find capital-output ratio to be having a positive effect on export performance of the licensees and domestic firms. Similarly some other studies on developing countries other than India have found a positive effect of capital intensity either on probability of firms becoming exporters (Athukorala et al., 1995 in case of Sri Lanka's manufacturing industry) or on the export intensity of firms (Ozcelik and Taymaz, 2004 in case of Turkish manufacturing industry).

However there are also studies that have found negative and mixed effects of capital intensity on exports. For example Kumar (1990) in case of foreign controlled firms in forty-three Indian industries, and Zhao and Zou (2002) for Chinese manufacturing firms found coefficient of capital intensity to be negative. Willmore (1992) for a large sample of Brazilian manufacturing firms found that though capital intensity had a negative effect on the probability of a firm to be an exporter, however the effect was positive on the export propensity.

For a sample of firms drawn from Indian manufacturing industries during the period from 1987-88 to 1989-90, Kumar and Siddharthan (1994) found a negative effect of capital intensity on export performance for six low and medium technology industries (including industrial and other chemicals) and attributed this finding to the low wages prevailing in the economy during that time. At the same time for two of the three high technology industries considered in the study the authors found the relationship to be positive. Narayanan (2006) too finds mixed results while studying the effect of capital intensity on export performance of Indian Automobile industry during the licensing, deregulation, and liberalization period. He

finds the coefficient for capital intensity to be negative for licensing and deregulation periods, and positive for liberalization period.

CI = Book Value of Plant and Machinery / Sales Turnover

Hypothesis: Capital intensity and exports are positively related.

### 3.3.4 Age of the firm and Exports

The variable age acts as proxy foe experience and specialisation developed by the firms in production, management and marketing. Compared to start ups experienced firms have advantage of knowing the market and players giving them and edge in exports and performance.

In developing countries such as India, after liberalization, newer firms may find the domestic markets to be already crammed with older firms' products and therefore may try to seek the foreign markets right from the outset (Bhaduri and Ray, 2004). Some empirical evidences are in favour of older firms performing better in exports sector (Roberts and Tybout (1997) in case of Colombian manufacturing plants). Others find that the younger firms with latest equipments and technology have an edge over older firms in export market (Bhaduri and Ray (2004), in case of Indian Electronics/Electrical industry). Still others find that age of the firm may not matter. Examples include Wignaraja (2002) for a sample drawn from the Mauritian Garment industry; and Bhaduri and Ray (2004), in case of Indian Pharmaceutical industry.

AGE = Relevant Year – Year of Incorporation of the concerned firm.

Hypothesis: Positive relation for age and exports.

### 3.3.5 Some other Non-Technology variables and Exports

Skill Intensity

In developing countries like India were labour is abundant, employing of skilled labours for production may help in reducing the cost of production for firms. However as Siddharthan and Nollen (2004) note that in most of the other studies on developing countries skill intensity has not had any positive effect on export performance of the firms due to lack of high skilled labour (that is required especially in case of high technology industries such as IT) in developing countries.

SKILL = [Remunerations / Total Wage Bill] * 100

Software Producers

The Indian government has encouraged software producers by providing them with many incentives. Therefore it is likely that in case of India the software firms may behave differently as compared to the firms in services and hardware categories. Therefore we introduce dummies for software companies to measure the difference in exporting intensity of this category of firms as compared to hardware and IT services firms. We also introduce private companies dummy as a proxy for entrepreneurship.

The following table [Table 3] summarizes the definitions of the variables used in the present study.

**Table 3: The Variables and their Definitions**

| Sl. No. | Variable | Symbol | Definition Used in the Study |
|---|---|---|---|
| 1 | Export Intensity | EXPI | [Exports / Sales Turnover] * 100 |
| 2 | R&D Intensity | RDI | [R&D expenses / Sales Turnover] * 100 |
| 3 | Import of Capital Goods Intensity | MKI | [Foreign Expenditure on Capital Goods / Sales] * 100 |
| 4 | Technology Imports Intensity | MTI | [Royalty Expenses / Sales Turnover] * 100 |
| 5 | Age of the firm | AGE | Relevant Year – Year of Incorporation of the concerned firm |
| 6 | Vertical Integration | VI | [(Profit before Depreciation on Interest and Taxation + Wages and Salaries) / Sales Turnover] *100 |
| 7 | Capital Intensity | CI | [Book Value of Plants and Machinery / Sales Turnover] * 100 |
| 8 | Firm Size | SIZE | Logarithm of Sales Turnover |
| 9 | Foreign Equity Participation | FE | [Equity held by Foreign individuals and institutions / Total Equity] * 100 |
| 10 | Software Firm | $D_{soft}$ | $D_{soft}$ = 1 when the firm is a software producing firm<br>$D_{soft}$ = 0 otherwise |
| 11 | Private Firm | $D_{priv}$ | $D_{priv}$ = 1 when the firm is a private sector firm<br>$D_{priv}$ = 0 otherwise |
| 12 | Skill Intensity | SKILL | Remunerations / Total Wage Bill * 100 |

## 4. The Model

The export behaviour of firms within this industry could be analysed in the framework of the following model:

Let

$$Yi^* = b'c_i + e_i^* \quad (i = 1,2,....,n) \qquad .....(1)$$

be a regression equation which fulfils all the classical assumptions. If Y* is an index variable which is not observed for some range then instead of observing Y*, we observe Y which is

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

$$= 0 \qquad \text{if} \quad Yi^* < 0 \qquad .....(2)$$

Equations (1) and (2) represent Tobit Model. In terms of Y, equation (1) becomes

$$Y_i = b'c_i + e_i \qquad .....(3)$$

The lower tail of the distribution of $Y_i$ is cut off at zero and that of $e_i$ is cut off at $b'c_i$, and the probabilities are piled up at the cut-off points. It is important to note that the mean of $e_i$ is different from that of $e_i^*$ and the mean of $Y_i$ is also different from that of $Y_i^*$. This implies that limiting the range of values of dependent variable yields biased and inconsistent estimates if the Ordinary Least Squares (OLS) method is applied to equation (3). The OLS estimates of the slope parameters are biased towards zero. Moreover, the magnitude of the bias is proportional to the probability of the index variable being non-positive. Amemiya (1984) has shown that Maximum Likelihood Estimates (MLE) of the model are consistent and asymptotically normal. Since the dependent variable, export intensity is zero for some firms we estimate our Tobit model by the method of maximum Likelihood (Green, 1992).

The empirical form of the testable equation is given as:

$$EXPI = f(SIZE, SIZE^2, RDI, MTI, CI, MKI, FE, VI, AGE, \text{Dummy Variables})$$

where EXPI is the export intensity of a firm measured by exports as a proportion of sales turnover.

## 5. Empirical Analysis

This section would deal with the empirical analysis of the data. Subsection 5.1 would describe the data used in the present analysis. Subsection 5.2 would discuss the descriptive statistics regarding the sample data. Subsection 5.3 would deal with the results of the Tobit analysis.

### 5.1 Sample, Data and Time Period

Data for the present paper has been obtained from the CMIE (Prowess) database on Indian industry that contains data on listed industries in India. The sample period considered was from 2000 to 2005. The data on 428 companies of Information Technology industry was extracted and analysed. Of these 333 firms were software producers, 59 were IT service providers, and the rest were hardware producers. Further, out of the 333 software companies 45 are owned by (or are subsidiaries) of foreign companies.

The sample contains data for old companies as well as recent start-ups. During the period of analysis 99 new IT firms entered the industry and 20 firms exited. In other words an unbalanced panel data set has been used for the present analysis. The econometric results have been obtained with the help of STATA software.

**5.2 Descriptive Statistics**

Since the sample contains data on companies producing software, services, and hardware therefore the descriptive statistics has been discussed by differentiating between these three categories of Information Technology industry. Table 4 describes the mean and variance of the technology variables and export intensity variable for the three categories of IT industry. Table 5 depicts the mean and variance for select non-technology firm specific characteristics for this industry.

As can be seen in Table 4, the mean export intensity for the full sample is around 36 percent with both software and services categories having far better export intensity than hardware category. Since there are only few hardware firms in India therefore they are likely to be mainly catering to the needs of domestic market and so the mean intensity of exports for this category has turned out to be the lowest.

**Table 4: Mean and Variance of the Technology Variables and Export Intensity for the Indian IT industry**

| | RDI (%) | MTI (%) | FE (%) | EXPI (%) | MKI |
|---|---|---|---|---|---|
| Software | 0.73<br>(0.004) | 0.46<br>(0.00093) | 4.067<br>(139.93) | 39.7<br>(0.755) | 0.04117<br>(0.42709) |
| Services | 0.028<br>(0.000079) | 0.44<br>(0.000499) | 1.171<br>(43.8) | 30.99<br>(0.163) | 0.0843<br>(0.12188) |
| Hardware | 0.25<br>(0.0000862) | 1.94<br>(0.0059) | 2.9103<br>(71.215) | 7.899<br>(0.0318) | 0.005698<br>(0.000709) |
| Total | 0.6 | 0.6 | 3.582 | 35.8 | 0.0422 |

| | | | | | |
|---|---|---|---|---|---|
| | (0.00324) | (0.0014) | (122.02) | (0.635) | (0.3559) |

Firms in software category on an average seem to be investing more on R&D as a percentage of sales. In India the concentration on research and development for IT services and hardware has been miniscule compared to that of software companies. This gets reflected in the low mean intensity of R&D in case of services and hardware categories. It is clear from Table 5 that the software producers in this sample are also the ones with highest mean foreign equity participation, however with high variability.

The hardware producers in this sample of IT firms are on an average investing highest on importing technology through royalty payments. Due to lack of high skilled hardware personnel in India and with the Indian government concentrating more on encouraging software producers, the hardware producers seem to be relying more on buying rights to pre-existing technologies for their production. Setting up of Software Technology Parks in the 1990s to provide duty free imports of capital goods, high speed data communication links and tax holidays for 10 years is likely to have encouraged the firms in the software and services categories to import higher percentage of capital goods (as a ratio of sales turnover) as compared to the hardware firms. It should be noted that the services and software producers are also clients for hardware producers (who are producers of computers, network switches, network cables and other communication equipments). With very few quality hardware producers in India, the firms in software and services categories will have to rely on foreign market for latest hardware.

Table 5 depicts the mean and variance of non-technology firm characteristics. The hardware producers are on an average larger in size (in logarithm of sales) than either the software or the services category firms. Hardware producers are also more vertically integrated than the other two category firms. The firms in the service and software sub-sectors are on an average younger but more skill intensive than the hardware sub-sector firms. Services and software firms require human reasoning and intelligence to tackle problems efficiently (especially when the problem is posed by a human client) and this requires high skill. However in firms producing hardware that usually use routine assembling and other well-defined processes of production, mechanical devices can replace skilled labour.

**Table 5: Mean and Variance for Non-Technology firm characteristics**

| | SIZE | SKILL | VI | AGE | CI |
|---|---|---|---|---|---|
| Software | 2.0043<br>(5.959) | 2.143<br>(116.35) | -0.7278<br>(172.99) | 10.4<br>(51.43) | 2.822<br>(510.34) |
| Services | 1.7056<br>(5.121) | 3.61<br>(221.88) | -0.20534<br>(13.137) | 7.54<br>(4) | 2.742<br>(253.37) |
| Hardware | 3.76<br>(3.395) | 0.893<br>(16.308) | 0.00947<br>(1.5825) | 13.55<br>(47.22) | 0.53799<br>(4.305) |
| Total | 2.13881<br>(5.91) | 2.175<br>(117.89) | -0.605<br>(140.52) | 10.409<br>(53.197) | 2.598<br>(436.61) |

It is interesting to note that the software and services category firms that belong to the tertiary sector have higher mean capital intensity than the more sophisticated technology based hardware firms. This could be because the firms in software and services categories might be investing on various kinds of modern equipments to produce better quality products as compared to hardware producers who might be using a standard method of production that requires a definite amount of capital investment.

### 5.3 ML Estimates of the Tobit Model

Table 6 presents the maximum likelihood estimates of the Tobit model obtained for the sample of firms from the IT industry of India. As is evident, size of the firm has turned out to be highly important with positive effect on the export performance of the firm. However the square of size did not turn out to be statistically significant. It should be noted that Siddharthan and Nollen (2004) too had found size to be an important factor in determining exports for an earlier (from years 1994-98) sample taken from this industry. With the Indian government giving tax and other incentives to software exporting firms, permitting duplication of software by 1993, and with the fall in the import duty for software by 1995, the IT sector especially software seems to be witnessing economies of scale in production.

**Table 6: Determinants of Exports Intensity: ML Estimates of Tobit Model**

| **Regressors** | **Coefficient** |
|---|---|
| Constant | -0.7618 |
| SIZE | 0.2033* |
| $SIZE^2$ | -0.0058 |
| RDI | -0.5047 |
| MTI | 0.7787 |
| MKI | 0.0816 |

| | |
|---|---|
| CI | 0.0042* |
| FE | 0.0094* |
| VI | -0.1796* |
| AGE | -0.0067 |
| $D_{soft}$ (dummy) | 0.3672* |
| $D_{priv}$ (dummy) | 0.0185 |
| N | 1867 |
| Log Likelihood | -2091.8077 |
| $Chi^2(11)$ | 265.37 |

* indicates 5 % and above level of significance of the estimated co-efficient by two-tailed test.

Foreign equity turned out having a statistically significant positive effect on export performance in this sector. This result is similar to that found by Siddharthan and Nollen (2004) where the degree of foreign equity participation was important for the export performance of the MNE affiliates. This means that firms with foreign equity continue to be successfully making use of the tacit technological, managerial and marketing skills acquired from the foreign equity holders for enhancing their export competitiveness.

However, it should be noted that the other technology variables such as in-house R&D and import of technology did not turn out to be statistically significant. The firms that are importing technology might be using it for capturing domestic markets. Also, with intellectual property rights being weak in India the firms in India might not be interested in doing any new product development oriented R&D due to fear of imitation, rather they might be doing more of problem solving R&D to efficiently produce standardized products that are being used world over. For the same reason the technology exporter from abroad may not be keen enough to sell their technology to the Indian firms unless they have a stake in the firm. In a study by Bhaduri and Ray (2004) for a sample taken from Indian electrical/electronics in the mid-1990s the interactive term of R&D and size had turned out to have a positive effect on exports. However it should be noted that Bhaduri and Ray (2004) excluded software firms from their sample whereas in the present sample software firms are in majority.

Capital intensity, which represents the amount of capital investment made for per unit of output, has turned out to have a positive effect on exports. Kumar and Siddharthan (1994) in

case of Indian high technology industries and Siddharthan and Nollen (2004) for Indian IT industry during 1990s found similar results. The firms in this industry must be investing on procuring various types of modern equipments that would help them produce export quality products. Again since majority of the firms in the sample belong to the IT services and software sector, one can also argue that because the firms in the tertiary sector of software and IT enabled services have to work round the clock for producing surplus of products (to make it cost-effective for exports especially if the products are standardized) therefore the wear and tear of the plants and machinery (computers and ancillaries in these cases) must be high, and these firms require constant replacement of overused hardware.

Vertical integration doesn't seem to help in better export performance of firms in this sector. It should be noted that the firms that are producers of software and services cater to the needs of clients from various industries. However, they rarely produce the computer and other inputs required by them on their own, but generally buy these inputs from specialized computer vendors. The computer and other hardware vendors in India too mainly assemble the components procured from other sources and so do not incorporate all stages of hardware production within the firm. Thus the firm trying to internalise all the production stages within the firm may not be successfully producing a product competitive enough for the export market.

The coefficient for the dummy variable representing software firms has turned out to be having a statistically significant positive sign. Even Siddahrthan and Nollen (2004) had found the licensees and domestic software producers to be more export intensive than others. This reinforces the fact that the encouragement given by the Indian government to the software producers has been effective in making this sub-sector more export intensive in the whole of IT sector.

Age of the firm and the dummy variable capturing entrepreneurship in this sector has not turned out to be statistically significant. For a sample of electrical/electronics firms from India in mid-1990s Bhaduri and Ray (2004) had found similar insignificant results for variable capturing entrepreneurship but age variable had turned out to be statistically significant with younger firms being more export intensive. It should be noted that software firms have also been included in the present study and since duplication and imitation is easier in software therefore one can say that presently the firms in this sector are on the same

technological frontier making experience and entrepreneurship unimportant in determining exports.

## 6. Summary and Conclusions

The present study attempted to examine the determinants of exports performance for the IT industry in India in the new millennium. A Tobit model was formed and analysed for an unbalanced panel consisting of 428 firms taken over a period of six years (2000-2005). The main findings of the present study and their implications for export competitiveness in Indian IT industry can be summarized as follows:

1. Like the findings of Siddharthan and Nollen (2004) for a sample of firms taken from the Indian IT industry during 1990s in this study too foreign equity participation is an important factor in determining exports for this industry for a sample taken from the starting years the new millennium. The percentage of equity stakes of the foreign investors in total stake remains an important factor for export competitive of Indian firms since equity stakes can influence the amount of tacit knowledge that the foreign firms are willing to transfer to the Indian firms. Therefore, the Indian government could continue to encourage transfer of intra-firm technology through foreign equity participation in this industry.
2. Size of the firm has been found to be positively affecting export performance in this industry. This finding is in line with the idea that larger firms with more resources are in a better position to venture into investment intensive and risky export market than the smaller ones. Therefore to increase the export competitiveness of this industry the government should undertake policy initiatives to consolidate and curb mushrooming of sub-optimal scale firms in this industry.
3. Similar to the findings of Kumar and Siddharthan (1994) for Indian high technology industries and Siddharthan and Nollen (2004) for Indian IT industry, capital intensity also turned out to have a statistically significant positive sign in the present analysis. This reinforces the proposition that in the IT industry the firms have to constantly invest on modern equipments for becoming export competitive.
4. Since coefficient of vertical integration has taken a negative sign, it seems that complete internalisation of the various production stages in this industry may currently be detrimental to the export performance of firms in this industry. In other words the IT sub-sectors such as software and IT enabled services should concentrate

on bringing in efficiency and quality in their products without bothering about producing the computer and other ancillaries within the firm. Similarly since India presently does not have a comparative advantage in hardware sub-sector therefore the hardware firms should continue with assembling of procured parts rather than trying to produce them within the firm.

5. Software firms have been found to have an edge over other firms in Indian IT industry when it comes to export performance. This was expected because India has been encouraging software firms to export by giving them various incentives such as 100 percent income tax exemption on export profits, permission to duplicate software, duty-free imports of capital goods and so on. If proper incentives are given to hardware and services sectors then they may also be able to perform better in the exports market.
6. Other technology variables such as R&D intensity, import of technology whether against payments of royalties or whether through imports of capital goods have not turned out to be statistically significant in the present study. This might imply that presently majority of the R&D efforts and technology imports are being used by Indian firms to have an edge over their rivals in the local markets. In other words the goods and services being offered in the domestic markets might be of high quality or even new ones, however in the foreign markets these may be standardized goods. Since the labour charges in India are less as compared to those in developed countries, the firms in developed countries are finding imports of standard IT products from India more cost-effective than producing the same in their countries, which may be the reason behind better export performance of Indian software and services firms. Again lack of strong intellectual property rights (IPR) regime in India might be a factor that is deterring the IT technology exporters abroad to sell their world-class know-why and know-how knowledge to Indian firms. Therefore the government needs to quickly bring out policies to strengthen IPR in India such that Indian firms are able to compete in the world market using innovative products rather than cost-effective products. Since under the terms of the World Trade Organisation (WTO) India is required to implement WTO-standard IPR protection laws by 2005 therefore after 2005 the technology factors other than foreign equity might also become important in determining exports.

In the IT industry in developing countries, especially in software and services sub-sectors entrepreneurial qualities are very likely to influence exports. This has been beyond the scope of the present paper. However, efforts are being made to collect data for the unlisted companies and carry out further analysis to check the hypotheses developed in this paper. For the listed companies, nevertheless, the findings have very important policy implications in terms of encouraging foreign equity participation and allowing the smaller firms to consolidate to reap economies of scale. The State, so far, has played a very important proactive role in the development of IT industry in India. The State could continue to provide appropriate incentives for the promotion of both the software as well as hardware sectors and help them with most modern infrastructure facilities for faster growth of exports.

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