Technological Efforts, Firm Size and Exports in Basic Chemical Industry in India

Savita Bhat[1] and K. Narayanan[2] ¥

Abstract:

This paper attempts to examine the role of technological efforts and firm size in determining the export behavior of firms belonging to the Indian Basic Chemical industry. In India, studies dealing with export behavior of firms using censored sample data have followed the Tobit specification model (Kumar and Siddharthan, 1994; Bhaduri and Ray, 2004; Siddharthan and Nollen, 2004; Narayanan, 2006). Following Wakelin (1998), Sterlacchini (1999), Basile (2001) and others the present study compares the Tobit model with the double specification model (Probit + Truncation) for a censored sample from the Indian Basic Chemical industry and finds the double specification model to be more appropriate and robust. The four major technological efforts considered in this study are in-house research and development; import of capital goods; imports of design, drawings and formulae against lump sum, technical fees, and royalty payments; and intra-firm transfer of technology through foreign equity participation. The results of the analysis confirm that technological efforts, firm size, and other firm specific characteristics are important in explaining the export behavior of the firms in this industry. Also, looking at the organic and inorganic basic chemical groups separately, the study highlights how the factors determining export behavior differ between the two groups of firms. The paper finds that, for the full sample, R&D intensity and foreign equity participation positively determine both the probability to export and export intensity of the firm. Size of the firm is also an important factor in positively affecting the export probability of the firms in this industry. Younger firms having the latest technology and the firms that choose labor-intensive production technology are more likely to export than the others. Degree of vertical integration and ownership are also important in determining export behavior of firms in this industry.

Keywords: Technological Efforts, Competitiveness, Exports, Chemical Industry, Developing Countries, India

JEL Classification: F14, L1, L65

[1] Research Scholar, Department of Humanities and Social Sciences, Indian Institute of Technology, Bombay
[2] Associate Professor of Economics, Department of Humanities and Social Sciences, Indian Institute of Technology, Bombay, Powai, Mumbai 400076. E mail: knn@hss.iitb.ac.in Fax: 91-22-25723480.

¥ We gratefully acknowledge the comments and suggestions given by Prof. K.L. Krishna on the earlier draft of the paper. The errors that remain are our own.

Technological Efforts, Firm Size and Exports in Basic Chemical Industry in India

1. Introduction

Many studies such as Posner (1961), Vernon (1966), Krugman (1979), Fagerberg (1988) and others have tried to understand the relationship between technological modes and international competitiveness. These studies are by and large at consensus that differences in technological modes adopted by the firms are responsible for inter-industry as well as inter-firm variations in international competitiveness. In developing countries context too studies exist (Kumar and Siddharthan, 1994; Wignaraja, 2002; Bhaduri and Ray, 2004; Siddharthan and Nollen, 2004) that have been able to empirically validate the above idea. The present study is another attempt to look at the relationship between technological efforts and export behavior but for a specific sub-sector of a mature industry, that is, the Basic Chemical sub-sector of the Indian Chemical industry.

The Basic Chemical industry is one of the old industries in the world as well as in India. The firms in this industry are mainly producers of the intermediate goods that are used by various other industries including leather, textile, paints, plastics, rubber, and other chemicals. This industry is expected to be highly developed since it acts as backbone for many other industries. However in case of India the industry is considered to be lagging behind the world standards due to the influence of India's protective policy regime till 1991.

With liberalization process being undertaken in India, the domestic firms are forced to compete not just with other domestic firms but also with the world players. As a result, during the past one and half decades, various activities are taking place in this industry including adoption of differential technological strategies (Bhat and Narayanan, 2006). In-house research and development (R&D), import of capital goods, import of designs, drawings and formulae, and intra-firm transfer of technology and management practices from other countries (mainly developed countries) to the Indian Basic Chemical sector through foreign direct investments are some of the technological modes which are being used by the firms in this industry. The Basic Chemical industry can be thought to be producer of products from resource based and medium technology process industries (Kumar and Siddharthan, 1994; Lall, 1999, 2000) where competitiveness is principally in reducing the costs of production for the standardized products either through process innovations or through high scale operations. But sometimes development of specialized product based on unexploited revolutionary technology can give competitive edge to a firm over its rivals.

The aim of the present study is to examine, in the context of Indian Basic Chemical industry, how the above-mentioned four major technological efforts influence the export behavior of the firm. Following Wakelin (1998) the present study too considers export behavior in two forms, that is,

probability of exporting, and export intensity after a firm decides to export. The effect of size of the firm on export behavior is also looked into. Further, the study analyzes whether product specific factors affect exports in this industry. Specifically, the study tries to see whether factors affecting exports differ between producers of two different product subcategories of chemicals, namely, organic and inorganic chemical groups[3].

In the study a balanced panel consisting of 91 firms from the Basic Chemical industry for the time span of 7 years is used for analysis. Since the sample contains exporters as well as non-exporters therefore in the present study maximum likelihood estimation based limited dependent variable technique is more appropriate than ordinary least square regression technique (Greene, 2002; Gujarati, 2003). Further, following Wakelin (1998), Sterlacchini (1999), and Basile (2001) the authors test the suitability of the double specification model (Probit + Truncation) as against Tobit model and find the former to be better suited in the present study. However the results of both Tobit and double specification model have been presented in this study.

The following section would give an overview of the theoretical propositions and a review of the empirical evidences highlighting the relationship between technology and international competitiveness. Section 3 would deal with the characteristics of the Indian Basic Chemical industry. The recent trends in the industry with respect to exports would also be highlighted. Section 4 would give a description of the data and variables used in the study. Section 5 would explain the methodology used in the present paper including the econometric model being tested and the hypotheses. The results of the econometric exercise would be discussed in section 6 and the final section would deal with the summary and conclusions.

2. Technology and Exports

In the early 1960s Posner (1961) suggested that countries with similar production factor endowments may also trade with each other due to differences in the available technical knowledge in the countries. Further, the firm that introduced new product or process and enjoyed export monopoly may maintain the comparative advantage over its imitators by improving the original product or process innovation through continuous investments on R&D efforts.

On similar lines, Vernon (1966) put forth his product cycle approach for explaining trade between developed and developing countries. According to him the developed countries by virtue of their persistent investments in new technologies would have comparative advantage over developing countries in new and upcoming products. Thus, in the initial stages of the product development, exports

[3] As per Capitaline2000 database definition organic chemicals (also called hydrocarbons) are formed with the building blocks of carbon and hydrogen molecular structures and are petroleum based whereas inorganic chemicals are essentially salts of metals and non metals derived from minerals and ores or occur naturally

would be from developed to developing countries. However, as the product becomes standardized, the direction of trade reverses. Krugman (1979) too argued that by virtue of their ability to exploit new technology the developed countries have an edge over the developing countries in exports of technology-intensive goods. However, in order sustain the advantage the firms in the technology-intensive industry of the developed countries would have to continuously innovate.

In the context of Organization for Economic Cooperation and Development (OECD) countries, Pavitt and Soete (1980) suggested that a relatively high expenditure of resources on innovative activities in an OECD country led to production of more competitive products and processes in that country that ultimately reflected in an increase in the world market export share for the country. Later, Fagerberg (1987) tested the technology gap approach to development and growth for industrialized countries and confirmed that level of technological development was highly important in determining differences in growth between the countries. In the following year, Fagerberg (1988) for a dataset obtained for OECD countries developed a model of international competitiveness that incorporated three sets of factors that dealt with the ability of the country to compete in technology, price, and delivery or capacity respectively. His results showed that technology and capacity factors were more important than price factor in explaining the medium and long run differences in international competitiveness across countries.

Empirical studies in both developed and developing countries have found varying evidences on the relationship between technological efforts and export competitiveness of firms. The following subsections give an overview of some of the technology variables used in various empirical studies that would also be analyzed in the present study. The focus would be on empirical studies dealing with technological modes in developing countries.

2.1 Research and Development

Most of the empirical studies on technology and competitiveness have considered technological efforts in the form of R&D investments. The studies that have found a positive relationship between R&D and export competitiveness include Aggarwal (2001) for medium-high technology industry in India (that includes sample of firms belonging to “Other Engineering” and Chemical industry), Basile (2001) for Italian manufacturing industry, and Ozcelik and Taymaz (2004) for Turkish manufacturing industry.

Others have found varying effects of R&D intensity on export competitiveness. For example Wakelin (1998) for a sample of UK manufacturing firms found that sector R&D expenditure had a positive effect on the probability of non-innovative firms being exporters but the same variable had a negative effect on the export propensity for innovative as well as non-innovative firms. Similarly, Zhao

and Zou (2002) for Chinese manufacturing industry found that those firms that undertook R&D activity were more likely to export than others who did not do any R&D, however the export intensity of the exporters was negatively affected by R&D activities. Kumar and Siddharthan (1994) studied the determinants of export intensity for thirteen Indian industrial sectors covering low, medium and high technology industries individually. In line with the product life cycle theory, they found that R&D intensity was important in determining the export competitiveness for some of the low and medium technology industries (for Basic Chemical and dyestuff industry the coefficient of R&D intensity was insignificant) but not for any of the high technology industries. In contrast Bhaduri and Ray (2004), even in case of Indian high technology industries of Pharmaceutical and Electronics/Electrical found that the combined effect of firm size and R&D stock was very important in determining export performance, that is, large firms having large stock of R&D in both the sectors exported more.

A few other studies have found that technological efforts in terms of R&D have no effect on export competitiveness. Willmore (1992) for a large sample of Brazilian manufacturing firms found that the dummy variable differentiating firms with R&D program and those without turned out to be insignificant as a determinant of exports. In a recent study, Narayanan (2006) found coefficient of R&D intensity to be insignificant for the licensing period and the liberalization period in case of Indian Automobile industry. It is interesting to note that in the same paper Narayanan (2006) has found a negative relationship between R&D and the export performance of the firm for the deregulation period.

2.2 Foreign Equity Participation

Intra-firm transfer of tacit technology through foreign equity participation is another variable whose effect on export competitiveness has been examined in various studies. Most of these studies have found foreign equity participation to have a favorable influence on export competitiveness (Kumar and Siddharthan (1994) in five Indian industrial sectors; Aggarwal (2001) for Indian medium-high technology industries; Wignaraja (2002) for Mauritian Garment industry; Ozcelik and Taymaz (2004) for Turkish manufacturing industry; Bhaduri and Ray (2004) for Indian Pharmaceuticals industry; Siddharthan and Nollen (2004) for Indian Information Technology industry; and Narayanan (2006) for Indian Automobile industry during the licensing and liberalization periods).

Athukorala et al. (1995) introduced separate foreign equity variables for affiliates of third-world MNCs and the developed country MNCs for Sri Lankan manufacturing industry. They found that being a third-world MNC affiliate positively affected the probability of a firm exporting. However being a developed country MNC affiliate had no effect on the probability. In case of Fabricated Metal Products industry in India Kumar and Siddharthan (1994) even found a negative effect of foreign equity participation on export performance.

2.3 Import of Disembodied Technology

Another non-R&D variable that has been considered in quite a few studies on exports is the expenditure on acquiring disembodied technology, that is, designs, drawings and formulae through lump sum, technical fees, and royalty payments. The findings for this variable are mixed.

While 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 Information Technology industry have found the effect to be positive, however other studies (Siddharthan and Nollen, 2004 in case of licensees of Indian Information Technology industry and Narayanan, 2006 in case of Indian Automobile industry during deregulation period) have found the effect to be negative. Some other studies like Ozcelik and Taymaz (2004) for Turkish manufacturing industry have found import of disembodied technology to be having no effect on export competitiveness.

2.4 Import of Embodied Technology

Another mode through which technology may be acquired is through imports of capital goods. Machines and equipments that have been designed and manufactured based on modern technology have the technological information embedded in them. Thus, these embodied technology imports may help a firm in producing higher quality products that are acceptable at world standards.

Sterlacchini (1999) for non-R&D performing small firms in Italy and Basile (2001) again for manufacturing firms in Italy have reported positive effects of import of capital goods on exports. However, in case of India, the studies have found the effect to be either negative (Siddharthan and Nollen, 2004 for MNE affiliates in Indian Information Technology industry and Narayanan, 2006 for Indian Automobile industry during deregulation period) or insignificant (Siddharthan and Nollen, 2004 for licencees and domestic firms in Indian Information Technology industry and Narayanan, 2006 for Indian Automobile industry during licensing and liberalization periods).

To summarize, in case of developing countries like India, by and large technological modes like in-house R&D and foreign equity participation determine exports favorably. However, the effect of imported technology on exports of firms in developing countries is not very clear.

3. Basic Chemical Industry in India

Chemical industry is one of the oldest industries in the world as well as in India. According to KPMG-CHEMTECH (2003) in the year 2002 the chemical industry constituted 6.7 percent of India's GDP and 10 percent of total exports. The Indian chemical exports accounted for 1.9 percent of the global chemicals market.

The chemical industry can be divided into three broad segments, namely, Basic Chemicals, Speciality Chemicals, and Knowledge Chemicals (KPMG-CHEMTECH, 2003). The firms in the Basic Chemical industry segment produce intermediate products such as industrial gases, organic and inorganic acids and bases, catalysts, dyes and pigments intermediaries, salts, metal compounds, and other minerals that are needed as inputs in various other industries including Leathers, Textiles, Dyes and Pigments, Paper, Plastics, Rubber, Pharmaceuticals, Food processing, and Chemicals itself. Basic Chemicals accounted for around 47 percent of the Chemicals produced in the world in the year 2002 and around 57 percent of the Chemicals produced in India in the year 2001.

Basic Chemical Industry can be characterized to be a high volume, low value added, limited product differentiated industry with high entry barriers due to high capital requirement and stringent regulations (KPMG-CHEMTECH, 2003). Use of skill and scale intensive technologies, and moderately high levels of R&D investments aimed at either improving the equipment and/or optimizing production processes can give competitive edge to the firms in this industry (Lall, 2000).

Indian Chemical industry was highly protected during the inward looking regime, with high tariff rates and quotas discouraging competition from abroad. Also, restriction on production, with the help of licensing, ensured that there was no competition even from domestic firms. The growth of Indian Chemical industry during that period was mainly based on the requirements and opportunities provided by the import substitution policy regime. As part of the import substitution policy, Indian government gave tax reduction and other incentives to encourage firms to invest on in-house R&D for product and processes innovations. However, the amount spent by Indian firms on R&D was, and still is, hardly anything compared to the world players (Ganguly 1999; KPMG-CHEMTECH, 2003). Many small and medium scale chemical enterprises flourished during the protected and licensing regime in the Indian Chemical industry. The few larger and older firms that could have become their competitors did not invest in any meaningful R&D or marketing or human resource development. A few multinationals that existed during that time fared better than the domestic firms in performance because they had access to R&D and technological options from their parent firms in other countries.

The global scenario has changed a lot in the last half a century; however the Indian firms where left untouched by these changes during the inward looking policy regime. With liberalization, most of the restrictions have been removed and the Indian Chemical industry is now thrown open to the global challenges. Most chemicals and petrochemical products have now become freely importable and tradable, automatic approval of foreign equity up to 51 percent in most drugs and formulations is now possible, and with India becoming a signatory to the general agreement on tariffs and trade (GATT) in 1993, firms in India have to adhere to both product and process patents (Trivedi et al., 2000). Thus the

competitiveness for Indian Chemical firms now lies in meeting with the global challenges that include discovering new environment and ecology friendly technologies, reducing the exploitation of hydrocarbon or petroleum based energy source, focusing on speciality chemical production rather than on cyclic commodity chemicals (Ganguly, 1999).

Historically in Indian Chemical industry, except for a few firms that decided to be global from the start, most of the other players have been focusing on domestic markets and export markets was considered mainly to dispose off the excess capacity (KPMG-CHEMTECH, 2003). With most of the quantitative restrictions abolished, the firms are now able to produce at full capacity. They are also able to import modern more efficient machinery to produce better quality products in bulk. But the per capita consumption of chemicals in India is still small compared to the industrialized countries and the high potential demand for chemicals within India is not yet an actuality (KPMG-CHEMTECH, 2003; Malvi, 2003). In other words if the firms produce at their full capacity then they may have to bank on export markets to sell their excess goods at least till the domestic market flourishes. As Ganguly (1999) too notes that majority of the firms in the Indian Chemical industry are presently high volume producers and traders but with low margins.

The products that are to be sold in export market have to meet the world standards. But as was noted earlier, the Indian Chemical firms in the highly protected regime where oblivious to the technological developments taking place in the world. Therefore after the liberalization process started firms were forced to use various techniques including mergers and acquisitions, collaborations, and rigorous in-house R&D[4] to become globally competitive. Most of the collaborations in the industry during the last two decades have taken place with firms in European Union (mainly in Germany and United Kingdom), North America (mainly United States), and North East Asia (mainly Japan) countries.

The firms in the Basic Chemical industry as well as in the present sample can be grouped (based on the end products produced by the firms) under the categories defined by the Indian Trade Classification based on Harmonised System or the ITC (HS) code. The ITC (HS) code categories for the present sample at two-digit level include HS 28 (inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, or radioactive elements, or of isotopes), HS 29 (organic chemicals), HS 36 (explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations), and HS 38 (miscellaneous chemical products). Table 1 gives an idea about the exports of basic chemicals during 1997-98 and 2003-04 periods.

[4] See various articles in the Internet version of Business Line provided by THE HINDU group of publications for details. Capitaline2000 database too provides information on collaborating countries, collaborator firms, and type of collaboration.

As can be seen in Table 1, among the four categories, HS 29 that consists of only organic chemicals has largest value of exports as well as compound growth rate of exports. HS 38 category though has higher export value than HS 28 category, has lower compound growth rate than latter. The lowest export growth rate was registered for HS 36 that consists of firms producing explosives. This is logical since there is still licensing and other restriction on the production of explosives.

Table 1: Export performance of Basic Chemicals during 1997-98 and 2003-04 periods[1]

ITC HS Code →	HS 28	HS 29	HS 36	HS 38
Value of Exports (In US $Million) in 1997-98	207.75	1214.98	15.17	350.65
Value of Exports (In US $Million) in 2003-04	424.09	2823.55	15.59	575.27
Compound Annual Growth Rate of Exports for the period 1997-98 to 2003-04 (in Percentage)[2]	12.63	15.09	0.456	8.60

[1] Data source is the data available on the website of Ministry of Commerce and Trade, Government of India. ITC (HS) stands for Indian Trade Classification based on Harmonised System. The codes stand for the following- HS 28: inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, or radioactive elements, or of isotopes; HS 29: organic chemicals; HS 36: explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations; and HS 38: miscellaneous chemical products

[2] Calculated by author using the value of exports (in US $ Million) for the periods 1997-98 and 2003-04 from the data source[1]. Here export growth rate is calculated as: 100*(Antilog [1/6*Log (Value in period 03-04/Value in period 97-98)] – 1).

Table 2 depicts the top three regions to which the products in the four ITC (HS) categories were exported during 1997-98 to 2003-04. As can be observed from Table 2, in each year the value of organic chemical (HS 29) exports leads the values in other categories. Organic chemicals are exported mainly to European Union (EU), North East Asia (NE Asia), and North America (N. America). It should be noted that majority of foreign collaborators of Indian Basic Chemical firms too come from these regions.

Table 2: Top three regions in descending order of value of exports (in US$ Million within the brackets) for HS 28, HS 29, HS 36, and HS 38 chemicals during the financial years[1]

Financial Year	HS 28	HS 29	HS 36	HS 38
1997-98	N. America (41.67) NE Asia (39.4) ASEAN (33.11)	EU (385.15) NE Asia (263.56) N. America (161.84)	ASEAN (3.87) WANA (3.73) EU (2.63)	EU (132.57) WANA (69.4) NE Asia (35.45)
1998-99	NE Asia (28.71) EU (24.23) WANA (18.76)	EU (338.37) NE Asia (232.48) N. America (166.53)	WANA (2.06) W. Africa (1.4) ASEAN (1.1)	EU (96.95) WANA (65.44) NE Asia (36.08)
1999-00	WANA (28.24) EU (25.06) NE Asia (23.3)	EU (377.96) NE Asia (278.89) N. America (185.05)	EU (1.89) ASEAN (1.56) E. Africa (1.48)	EU (110.4) WANA (100.86) ASEAN (51.43)
2000-01	EU (38.17) S. Asia (30.81) ASEAN (30.19)	EU (445.89) NE Asia (357.03) N. America (257.39)	ASEAN (3.28) WANA (2.83) E. Africa (1.62)	EU (121.08) WANA (106.93) ASEAN (64.24)
2001-	WANA (82.66) NE Asia (42.37)	EU (426.94) NE Asia (303.68)	WANA (2.8) ASEAN (1.86)	EU (132.94) ASEAN (67.47)

02	EU (30.35)	N. America (261.86)	E. Africa (1.71)	WANA (48.7)
2002-03	NE Asia (104.83) WANA (92.35) Other CIS (48.73)	EU (568.01) NE Asia (404.69) N. America (303.33)	WANA (3.66) E. Africa (2.44) W. Africa (1.57)	EU (134.9) ASEAN (80.2) WANA (60.96)
2003-04	NE Asia (127.01) WANA (59.24) ASEAN (49.28)	EU (718.47) NE Asia (498.51) N. America (404.71)	E. Africa (3.34) WANA (3.12) W. Africa (2.33)	EU (168.6) ASEAN (91.57) WANA (67.93)

[1] Data source is the data available on the website of Ministry of Commerce and Trade

Again, European Union is the most popular region for the exports of the miscellaneous chemicals (HS 38, that consists of mainly specialty organic or inorganic chemicals that have not been incorporated in other HS categories). North East Asia, Association of Southeast Asian Nations (ASEAN), and West Asia North Africa (WANA) regions are also importers of Indian miscellaneous chemical exports. The top three destination regions for exports of HS 28 products (consisting of both organic and inorganic chemical compounds) have been varying. However, North East Asia and WANA feature in the top three export destinations for HS 28 products in most of the years. HS 36, which consists of explosives, is the least contributor to the exports among the four categories and seems to be mainly catering to the needs of the oil-rich WANA countries and the African subcontinent.

4. Sample, Variables and Descriptive Statistics

As mentioned earlier the data used in the present analysis is a balanced panel consisting of 91 firms from the Indian Basic Chemical industry for a period of 7 years (from 1997 to 2003). The source of the data is Capitaline2000 database provided by Capital Market. Capitaline2000 follows its own classification for the firms and according to its classification the present sample belongs to the 'Chemicals' category. After examining the end products produced by the firms under this category and consulting literature (Capitaline2000 database; KPMG-CHEMTECH, 2003) on those chemicals, the authors are able to state that the firms in this category are mainly producers of basic chemicals that are used as inputs by firms in various industries. Therefore the present sample is considered to belong to the Basic Chemical industry.

4.1 Variables

For constructing the variables data has been collected for various firm characteristics such as value of exports, expenditure on research and development, expenditure on import of capital goods, expenditure on royalty and technical fees, foreign equity participation, sales turnover, year of incorporation, gross block, value addition, expenditure on advertisement, ownership, wages, salaries, and bonuses. Table 3 gives the definitions of the variables used in the present paper.

Table 3: The Variables and their Definitions

Sl. No.	Variable	Symbol	Definition Used in the Study
1	Export Intensity	EXPI	(FOB Value of Exports / Sales Turnover of the

			firm) * 100
2	R&D Intensity	RDI	(Expenditure on R&D / Sales Turnover of the firm) * 100
3	Import of embodied technology (capital goods) Intensity	MKI	(Expenditure on import of capital goods / Sales Turnover of the firm) * 100
4	Import of disembodied technology Intensity	LRI	(Lump sum, royalty, and technical fees payments in foreign currency / Sales Turnover of the firm) * 100
5	Size in terms of Market Share	SIZE	(Sales Turnover of the firm / Sum of the Sales Turnover of all the firms) * 100
6	Age of the firm	AGE	One added to the difference between the year of incorporation and the year in the study
7	Advertisement Intensity	ADVT	(Expenditure on advertisements/ Value Added by the firm) * 100
8	Vertical Integration	VI	(Value Addition by the firm / Sales Turnover of the firm) * 100
9	Choice of Technology	LABCAP	(Expenditure on Wages, Salaries and Bonuses/ Gross Block of the firm) * 100
10	Foreign Equity Participation	D_{fe}	D_{fe} = 1 when foreign equity participation exists D_{fe} = 0 otherwise
11	Ownership	D_{house}	D_{house} = 1 when firm is owned by a business house D_{house} = 0 otherwise
12	Organic Chemical Firm	D_{org}	D_{org} = 1 when observation is organic chemical producer D_{org} = 0 otherwise

The explained variable in this study is export intensity (EXPI). The technology variables that have been considered as potential determinants of exports are in-house R&D intensity (RDI), import of capital goods (MKI), import of technology against royalties and technical fee payments (LRI), and dummy variable representing foreign equity participation (D_{fe}). As discussed in section 2 various studies on developing countries including India have found technological modes to be important in determining export competitiveness of firms. The following subsections give an overview of some of the non-technology variables that have been considered in the present study.

4.1.1 Firm Size (SIZE)

One of the most commonly used non-technology variables in the analysis of export competitiveness is size of the firm. The rational behind inclusion of firm size as a potential determinant of export performance in various studies is that large firms with their vast resources and influential position have an edge over smaller firms in catering to the needs of domestic as well as international markets. Bonaccorsi (1992) carried out a survey of research studies that dealt with the relationship between firm size and export behavior with focus on Italian manufacturing industry. He found that though on the whole the findings of the literature on the relationship were mixed but majority of the studies emphasized a positive relationship. Other recent empirical studies that have found a positive relationship

between firm size and export competitiveness include Basile (2001) again for Italian manufacturing firms, Aggarwal (2001) for Indian medium and low technology industries, Zhao and Zou (2002) for Chinese manufacturing firms, and Narayanan (2006) for the Indian Automobile industry.

Athukorala et al. (1995) for Sri Lankan manufacturing industry found that firm size positively affected the probability of a firm being exporter but had no effect on export intensity of the firm. In a recent study, Siddharthan and Nollen (2004) found a mixed effect of size variable on export performance of firms in the Indian Information Technology sector- for domestic firms taken alone size had a positive effect, for the MNE affiliates taken alone it had a negative effect and for licensees of technology taken alone it had no effect. At the same time for the sample as a whole, they found that in comparison to domestic firms, size factor in case of both MNE affiliates and licensees was disadvantageous for exports. Wignaraja (2002) for a sample drawn from the Mauritian Garment industry found that size of the firm did not matter for export performance.

4.1.2 Firm Age (AGE)

Another non-technology factor considered in empirical studies is the age of the firm. Age of the firm may affect the cost of capital and the firm's learning experience. 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 favor 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.

4.1.3 Advertisement Intensity (ADVT)

Extensive market promotion of a product may help a firm in creating a niche market for the product. Further, as Kumar and Siddharthan (1994) note that in the process of creating brand names the firms are compelled to maintain minimum quality level which in turn is an important factor for success of a firm in export market. In the same study Kumar and Siddharthan (1994) found that advertisement intensity to positively determine exports in five Indian industries, however for Industrial Chemical industry the coefficient of advertisement intensity took a negative sign but was statistically insignificant.

4.1.4 Choice of Technology (LABCAP)

The firm's choice of production technology (labor intensive technology or capital intensive technology) is also important in determining exports. In a labor abundant and relatively capital scarce country such as India adoption of a more labor-intensive technique of production by a firm might give it a competitive edge over its rivals in the export market (Kumar and Siddharthan, 1994).

The findings of the studies that have considered the effects of the choice of technology on export behavior are mixed. For example Athukorala et al. (1995) in case of Sri Lanka's manufacturing industry, Ozcelik and Taymaz (2004) in case of Turkish manufacturing industry, and Siddharthan and Nollen (2004) in case of Indian Information Technology industry) find capital intensity (or capital-output ratio) to have a positive effect on exports. At the same time others like Kumar and Siddharthan (1994) for six low and medium technology industries (including industrial and other chemicals), and Zhao and Zou (2002) for Chinese manufacturing firms find capital intensity to have a negative effect on exports.

4.1.5 Vertical Integration (VI)

Vertical integration is the degree of internalization of various processes in the firm. A highly vertically integrated firm may be able to reduce the cost of production since most of the raw materials would be produced internally and so the firm would not have to depend on external market for inputs. The firm may thus be able to offer lower prices for its products and capture larger market.

Willmore (1992) for a large sample of Brazilian manufacturing firms found higher vertical integration to worsen export performance. But Narayanan (2006) for the Indian Automobile industry found vertical integration to be positively affecting export performance during the licensing period. However, for the other two periods, namely, deregulation and liberalization, Narayanan (2006) found vertical integration had no statistically significant effect.

4.1.6 Ownership (D_{house}) and Product Type (D_{org})

Two dummy variables have been especially included to investigate whether ownership and the type of end product produced by the firm have any effect on the export behavior of the firms. The ownership variable takes a value of one for those firms who are owned by business houses. Being part of a business house may give extra advantage to the firms in the export market since they are able to sell their products using the brand value of the business-house.

As noted earlier, the firms in the chemical industry can be classified as organic chemical firms and inorganic chemical firms. Since the intrinsic nature of the organic chemicals (which are petroleum based) is different from the inorganic chemicals (which are mineral or soil based) therefore there is likely to be differences in factors that determine the export behavior for the two groups of firms.

4.2 Preliminary Analysis

In this section, Table 4 gives the sample characteristics (minimum value, maximum value, mean, and standard deviation). The differences in the mean of the firm characteristics for the exporters and non-exporters are highlighted in Table 5. Since the authors are expecting differences in the structure and behavior of organic and inorganic firms therefore the mean and standard deviation of the variables for the organic and inorganic firms is also given in Table 5. The correlation matrix is depicted in Table 6. All the statistical analyses in the present study have been carried out using STATA 8 statistical package.

Table 4 shows the mean, standard deviation, maximum, and minimum values for the variables. For the dummy variables, the frequency of their occurrence (with percentage of the total in the brackets) in the dataset has been mentioned. As can be seen, the dataset contains non-exports to nearly hundred percent exporters; however, the mean of export intensity is only around sixteen percent. The maximum intensity of the technology variables- in-house R&D, import of embodied technology and import of disembodied technology is below seven percent. The mean intensity value is highest for R&D and lowest for import of capital goods. More than 1/3rd of the observations have foreign equity participation.

Table 4: Minimum value, maximum value, mean, and standard deviation for the sample

Variables	Minimum	Maximum	Mean	Std. Deviation
EXPI	0	99.321	15.827	24.087
RDI	0	6.710	0.386	0.970
MKI	0	0.397	0.004	0.02
LRI	0	4.610	0.114	0.466
SIZE	0.0009	7.963	0.892	1.107
AGE	1	82	25.74	14.31
ADVT	0	40.21	1.36	4.49
LABCAP	0	46.43	7.47	7.16
VI	2.992	433.333	35.178	23.618

Total Number of Observations = 637

The observations in the sample are fairly experienced with the mean age of the firm being approximately 26 years. The firms in the sample are moderately vertically integrated. The mean expenditure on advertisements is around 1 percent with maximum advertising expenditure at nearly 40 percent of the sales. There does not seem to be any clear monopolist in the market since the maximum market share for an observation in the sample is around 8 percent and the mean is only around 1 percent.

Table 5 shows how the mean of the firm characteristics differs between exporters and non-exporters, and between inorganic chemical producers and organic chemical producers. As can be observed the mean value of R&D intensity, import of capital goods intensity, firm size, age, and labor-capital ratio is higher for exporters as compared to non-exporters. However mean expenditure on advertisement is higher for non-exporters.

Table 5 also shows how the inorganic and inorganic chemical firms differ in the mean values of some of the firm characteristics. Around 70 percent (441 out of 637 observations) of the sample consists

of organic chemical producers. As can be seen the average export intensity of the organic group is clearly higher than the inorganic group. Of the technological variables the mean value of R&D intensity for organic firms is higher than inorganic firms. Mean size of organic firms is also higher than inorganic firms. However inorganic chemical firms are on an average older, more labor intensive, and more vertically integrated than organic firms.

Table 5: Means and Standard deviations (in parentheses) of the variables for Non-Exporters & Exporters and Inorganic & Organic groups.

Variables	Non-Exporters	Exporters	Inorganic Firms	Organic Firms
EXPI	-	22.45 (25.97)	10.34† (20.40)	18.27† (25.19)
RDI	0.06* (0.17)	0.52* (1.12)	0.14† (0.40)	0.49† (1.11)
MKI	0.0009* (0.004)	0.006* (0.03)	0.004 (0.02)	0.005 (0.02)
LRI	0.11 (0.51)	0.11 (0.45)	0.10 (0.39)	0.12 (0.50)
SIZE	0.39* (0.46)	1.10* (1.22)	0.50† (0.43)	1.06† (1.26)
AGE	22.46* (16.20)	27.11* (13.21)	27.28† (12.18)	25.05† (15.12)
ADVT	2.19* (6.09)	1.02* (3.56)	1.3 (5.72)	1.39 (3.82)
LABCAP	4.92* (4.87)	8.53* (7.68)	8.66† (8.49)	6.94† (6.42)
VI	35.32 (36.74)	35.12 (15.11)	41.86† (14.85)	32.21† (26.07)
NOB	188	449	196	441

** indicates the differences in the means of the firm characteristic for Non-Exporters and Exporters at t-statistic significance level better than or equal to 5 percent*

† indicates the differences in the means of the firm characteristic for Inorganic and Organic firms at t-statistic significance level better than or equal to 5 percent

Table 6 gives the correlation matrix for the variables. As can be observed the correlation coefficient values are low. Of the correlation coefficients between the technology variables and export intensity only import of disembodied technology is statistically significant but with negative sign. Other firm characteristics like age, advertisement intensity and vertical integration also have a statistically significant negative correlation coefficient with export intensity.

Table 6: Correlation Matrix (NOB = 637)

	EXPI	RDI	MKI	LRI	AGE	SIZE	ADVT	LABCAP	VI
EXPI	1.00								
RDI	0.04	1.00							
MKI	0.06	-0.02	1.00						
LRI	-0.08*	-0.04	0.04	1.00					

AGE	-0.19*	0.27*	-0.03	0.19*	1.00				
SIZE	-0.03	0.53*	0.02	0.16*	0.29*	1.00			
ADVT	-0.12*	0.06	-0.04	-0.03	-0.04	0.28*	1.00		
LABCAP	-0.06	0.32*	-0.05	-0.0001	0.45*	0.21*	0.002	1.00	
VI	-0.08*	-0.02	0.004	-0.05	0.02	-0.11*	-0.06	-0.04	1.00

** indicates statistical significance of greater than or equal to 10%*

5. Methodology, Econometric Model and Hypotheses

Since non-exporters have also been considered in the present study therefore the sample consists of a large number of observations taking zero values on the explained variable. For such a censored sample where information on regressand is not available for some observations, coefficients obtained using ordinary least square (OLS) technique are biased toward the censoring point- zero in the present case. However the qualitative response, truncated or censored regression models that use maximum likelihood estimation technique do not suffer from this bias and therefore are considered to be more appropriate than ordinary least square (OLS) estimation for studies dealing with censored data (Greene, 2002; Gujarati, 2003; Siddharthan and Nollen, 2004; Narayanan, 2006).

The maximum likelihood estimation based 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; Narayanan, 2006 for studies in Indian context). According to these studies 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:

$$
\begin{aligned}
Y_i^{*} &= \alpha_0 + \alpha_1 X_{1i} + \ldots + \alpha_n X_{ni} + u_i, \\
Y_i &= 0 \qquad \text{if } Y_i^{*} \leq 0, \\
&= Y_i^{*} \qquad \text{if } Y_i^{*} > 0.
\end{aligned}
\qquad \text{-----(1)}
$$

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.

In the present study the Tobit model for export competitiveness of a firm can be specified as:

$$
\begin{aligned}
EXPI^{*} &= \alpha_0 + \alpha_1\, RDI + \alpha_2\, MKI + \alpha_3\, LRI + \alpha_4\, SIZE + \alpha_5\, AGE + \alpha_6\, ADVT + \alpha_7 \\
&\quad LABCAP + \alpha_8\, VI + \alpha_9\, D_{fe} + \alpha_{10}\, D_{house} + \alpha_{11}\, D_{org} + u_1 \\
EXPI &= 0 \qquad \text{if } EXPI^{*} \leq 0 \\
&= EXPI^{*} \qquad \text{if } EXPI^{*} > 0
\end{aligned}
\qquad \text{-----(2)}
$$

where $EXPI^{*}$ is the latent (index) variable and EXPI is the corresponding observed export intensity.

Wakelin (1998), Sterlacchini (1999), and Basile (2001) note in their respective papers on exports that Tobit technique intrinsically assumes the explanatory variables to have same effect on the decision to export and on the export intensity; however this may not always be a correct assumption. 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:

$$DY_i = \alpha_0 + \alpha_1 X_{1i} + ... + \alpha_n X_{ni} + u_i,$$
$$DY_i = 0 \quad \text{if } Y_i^* \leq 0,$$
$$= 1 \quad \text{if } Y_i^* > 0. \qquad \text{-----(2)}$$

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 DY_i is zero.

A general truncated model can be specified as:

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

where Y_i is the intensity of the variable under consideration and is defined only for cases where the dummy variable DY_i is 1.

In the present study the double specification model would estimate separate models for decision to export (DX) and intensity of export (EXPI) for a firm. Here the decision to export (DX) for a firm can be specified as:

$$DX = \alpha_0 + \alpha_1 RDI + \alpha_2 MKI + \alpha_3 LRI + \alpha_4 SIZE + \alpha_5 AGE + \alpha_6 ADVT + \alpha_7 LABCAP + \alpha_8 VI + \alpha_9 D_{fe} + \alpha_{10} D_{house} + \alpha_{11} D_{org} + u_1$$

and $DX = 0$ if firm does not export

$= 1$ if firm exports -----(5)

The truncated model for the export intensity of exporter (EXPI) can be specified as:

$$EXPI = \alpha_0 + \alpha_1 RDI + \alpha_2 MKI + \alpha_3 LRI + \alpha_4 SIZE + \alpha_5 AGE + \alpha_6 ADVT + \alpha_7 LABCAP + \alpha_8 VI + \alpha_9 D_{fe} + \alpha_{10} D_{house} + \alpha_{11} D_{org} + u_1 \quad \text{if } DX = 1 \qquad \text{-----(6)}$$

where EXPI is the observed export intensity for a firm which is defined only when the corresponding latent export intensity ($EXPI^*$) for the firm is greater than zero, that is, the firm is an exporter.

Wakelin (1998), Sterlacchini (1999), and Basile (2001) used likelihood ratio test (Greene, 2002, p. 915) to determine which of the two models, that is, Tobit or double specification (Probit + Truncation) is more suitable for their data. A similar test has been carried out in the present study and Tobit specification model has been rejected in favor of double specification model. However, in the present study the authors have reported the Tobit results as well for comparison purpose.

Though the correlation matrix in Section 4.2 revealed low levels of pair-wise correlation values among the variables however there was a possibility of higher order collinearity among the variables where one explanatory variable is a linear combination of more than one other explanatory variable. Also cross-section studies generally suffer from the problem of heteroscedasticity (Gujarati, 2003).

Table 7: Variance Inflation Factor (VIF) and Breusch-Pagan / Cook-Weisberg test results

Variables	Full Sample (NOB: 637)		Inorganic Firms (NOB: 196)		Organic Firms (NOB: 441)	
	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
RDI	1.56	0.64	1.97	0.51	1.54	0.65
MKI	1.02	0.98	1.07	0.94	1.02	0.98
LRI	1.14	0.88	1.27	0.79	1.16	0.86
AGE	1.45	0.69	1.50	0.67	1.52	0.66
SIZE	1.85	0.54	1.83	0.55	1.88	0.53
ADVT	1.14	0.87	1.43	0.70	1.23	0.81
LABCAP	1.37	0.73	2.56	0.39	1.41	0.71
VI	1.06	0.95	1.24	0.81	1.02	0.98
D_{fe}	1.16	0.86	1.30	0.77	1.19	0.84
D_{house}	1.21	0.83	1.33	0.75	1.27	0.78
D_{org}	1.18	0.85	-	-	-	-
Mean VIF	1.28	-	1.55	-	1.32	-
Breusch-Pagan / Cook-Weisberg test[1]	$Chi^2 = 87.06$ Prob > $Chi^2 = 0.0000$		$Chi^2 = 94.72$ Prob > $Chi^2 = 0.0000$		$Chi^2 = 55.25$ Prob > $Chi^2 = 0.0000$	

[1] In Breusch-Pagan/ Cook-Weisberg the null hypothesis is that variance of residuals is homogeneous. Since the computed Chi^2 exceeds the critical Chi^2 value at 1 percent significance therefore the null hypothesis is rejected, thus accepting the alternative hypothesis that variance is not homogenous in other words present sample is heteroscedastic.

Therefore, following Wignaraja (2006), in the present study too, variance inflation factor (VIF) test (to check for higher order multicollinearity of the form where a variable is linear combination of other independent variables) and Breusch-Pagan / Cook-Weisberg test (to check for heteroscedaticity) were carried out. The results of the tests are given in Table 7. As can be seen the variance inflation factor values for the full sample, organic group and inorganic group are low with mean VIF closer to 1 implying multicollinearity should not be a problem for present sample. However the Breusch-Pagan / Cook-Weisberg test reveals heteroscedasticity in all the three cases. Therefore in order to correct for the problem of heteroscedasticity, Probit and Truncated models were estimated using robust option (available in STATA 8 for Probit and Truncation) for the samples.

The four technology variables (RDI, MKI, LRI, and D_{fe}) have been included in the econometric models to examine the disparities in the effects of technological modes on the export behavior of the firms. In the context of Indian Basic Chemical industry the empirical evidences on effects of R&D on exports are mixed (Kumar and Siddharthan, 1994 for Basic Industrial Chemicals and Dyestuff industry found the coefficient to be insignificant and Aggarwal, 2001 for medium-high technology including Other Engineering and Chemical industry found coefficient to be positive). For import of capital goods, Basile (2001) in case of Italian manufacturing firms had found investment on capital equipments aimed at developing new products and employing less labor to be having a favorable effect on export performance. In the present sample the exporters have higher average R&D and import of capital goods intensities than the non-exporter. Therefore it is hypothesized that RDI and MKI will positively determine exports.

Studies on India such as Aggarwal (2001) have found foreign equity to positively determine export performance for medium-high technology firms (that includes industrial chemicals). Kumar and Siddharthan (1994) though found foreign equity stake to positively affect exports in five Indian industries, but Chemical industry was not one of them. However most of the empirical studies are in favor of foreign equity participation being important for developing country firms' export performance especially due to the notion that the developing country firms can use the brand names and managerial skills of foreign firms to do well in foreign markets. Again, in the present sample higher percentage of exporters consist of foreign equity firms. Hence, it is hypothesized that D_{fe} will be positively affecting exports in this industry.

When it comes to import of disembodied technology, that is, import of designs and drawings against licenses, royalties, and technical fees payments (LRI) the empirical evidences dealing with various industries in different countries are mixed. In the Indian Industrial Chemicals context, Kumar and Siddharthan (1994) found the coefficient of this variable to be insignificant. In Table 5 the difference between the mean values of import of disembodied technology for exporters and non-exporters was not statistically significant. At the same time the coefficient of correlation between LRI and EXPI for the present sample was found to be statistically significant with negative sign (but a low value). Therefore it is likely that import of designs and drawings may not affect the decision of the firm to export though one cannot clearly postulate the effect of LRI on export intensity of the exporters.

As has been discussed in Section 3, historically, most of the Indian chemical firms have looked at export markets as an outlet for clearing out excess goods after serving the domestic demand. For a scale intensive industry such as Basic Chemicals, large-scale production can give cost advantages to the firms and thus they may be able to compete in export market with low-priced products. In the protected

regime the firms were forced to produce at lower scale; however after liberalization process started the firms are allowed you utilize their full capacity. If the demand for their products does not grow at the same rate if not at a higher rate than the total capacity of the industry then firms would have no choice but to consider exports market to sell their products. Therefore larger size in terms of larger market share (SIZE) is likely to have positive effect on both export probability of the firms and export intensity of the exporters.

The mean age of the firm (AGE) in the present sample is around 26 years (see Table 4 in Section 4.2), which gives the impression that on an average the firms in this industry are fairly experienced. Again as per Table 5 an average exporter is older than an average non-exporter. However, average export intensity for the sample is only around 16 percent in spite of the fact that there exist nearly hundred percent export oriented firms in the sample. This observation is also reflected in the statistically significant negative correlation coefficient between AGE and EXPI. Therefore it is conjectured that age may negatively affect the export behavior of the firms in this industry.

In Basic Chemical industry where there is not much scope for product differentiation, rigorous marketing strategy in terms of high investments on advertisement is likely to add to the cost of the product thereby making the product relatively expensive in the export market. As has been discussed in Section 4.2 the mean advertisement intensity of the non-exporter firm is higher than the exporter firm for the present sample. Also, the correlation coefficient between advertisement intensity and export intensity is negative. As Kumar and Siddharthan (1994) reasoned on finding advertising intensity taking negative sign for Indian Textile industry that if advertising helps the firms to capture more of domestic market then the products of the firms would be absorbed in here and little would remain for selling in foreign market. In the present study too higher advertisement intensity (ADVT) might be detrimental for both probability of the firm becoming an exporter and export intensity for an exporter.

As discussed in Section 4.1.4, the cost of labor in India as compared to the developed countries is quite low. At the same time India is also abundant in skilled technical human resource (Lall, 1999). Therefore labor-intensive technologies would be more suitable in Indian context. In Table 5 too the mean labor-capital ratio for exporters is higher than for non-exporters. Hence, the variable representing the choice of technology (LABCAP) is postulated to positively determine export probability as well as export intensity for the present study.

As discussed earlier, by vertically integrating, a firm can reduce the cost of inputs and thereby would be able to offer similar quality products as its rivals at lower prices. At the same time one should note that in a scale intensive industry such as Basic Chemicals, higher degree of vertical integration of a firm might act as a barrier for another firm in entering into the industry. Thus the vertically integrated firm

would face less competition in the domestic for its products and therefore may not be inclined to venture into export market. In Table 5 the difference between the mean degree of vertical integration for non-exporters and exporters was not statistically significant. This gives an impression that both exporters and non-exporters in this sample are likely to have similar degree of vertical integration. In other words, vertical integration (VI) may not be a factor determining which firm becomes an exporter. At the same time the correlation coefficient between vertical integration and export intensity is negative. Hence, it is postulated that vertical integration may not have a favorable effect on exports.

If a business house owns a firm then the firm can easily make use of the brand name and resources of the business house for venturing into export market. At the same time it is likely that the present firm is just a subsidiary for another firm owned by the same business house. In such a case ownership may negatively affect the probability of the firm becoming an exporter. But in the present sample more than half of the exporters are owned by business-houses as compared to only 16 percent of the non-exporters (see Table 5), therefore one can postulate that belonging to business house is likely to be favorable for export behavior of the firm.

In the econometric models for the full sample, dummy variable for organic firms has been included to probe whether the type of chemical produced has any effect on the export behavior of the firms in this industry. As discussed in Section 4.2, since higher percentage of exporters consist of organic chemical group than inorganic chemical group and the average export intensity for the organic chemical firms is higher than that for the inorganic chemical firms therefore it is expected that being an organic chemical firm would positively determine both export probability as well as export intensity for the present sample. Since Table 5 reveals differences in the mean values of some of the characteristics for the two groups of firms therefore in the present study two Tobit and double specification models have been fitted separately for the inorganic and organic groups of firms along with the full sample models.

6. Results and Discussion

Table 8 gives the results for the econometric models. As was mentioned earlier the likelihood ratio test was in favor of the double specification model as being the more appropriate than Tobit model in the present context. One should note that the Tobit results are not robust with respect to heteroscedasticity in the data (since STATA 8 package does not have the option to correct for heterscedasticity in Tobit) whereas results of Probit and Truncation take into account that the sample is heteroscedastic.

From Table 8 one can clearly see that the results of double specification differ substantially from that of Tobit specification. In general Tobit coefficients are statistically significant whenever the Probit and Truncation model coefficients are statistically significant with same sign. However if the coefficients of Probit and Truncation models turn out to be statistically significant with opposite signs then the

coefficient of the corresponding Tobit model will most likely be statistically insignificant. Again, in all the three cases (full sample, inorganic group, and organic group) the importance and effects of the variables in the Probit model differs from those of Truncation models. This reinforces the idea that the factors affecting decision to export may be different from those determining the export intensity of the exporter.

Table 8: Tobit, Probit and Truncation model results[1]

	Full Sample			Inorganic Group			Organic Group		
	Tobit	Double Specification		Tobit	Double Specification		Tobit	Double Specification	
		Probit (Robust)	Trunc. (Robust)		Probit (Robust)	Trunc. (Robust)		Probit (Robust)	Trunc. (Robust)
Const.	6.78 (1.48)	**-0.50 (-2.52)[b]**	77.86 (1.50)	**28.99 (4.14)[a]**	-0.61 (-1.28)	**141.55 (4.92)[a]**	5.75 (1.36)	**-0.59 (-3.41)[a]**	**82.82 (2.81)[a]**
RDI	1.23 (0.82)	**0.21 (2.21)[b]**	**15.52 (1.71)[c]**	4.48 (0.78)	0.57 (0.60)	**27.32 (1.89)[c]**	0.93 (0.59)	**0.21 (2.30)[b]**	10.78 (1.52)
MKI	73.68 (1.51)	12.53 (1.31)	30.45 (0.09)	11.42 (0.14)	39.10 (1.60)	-557.05 (1.26)	71.86 (1.27)	6.75 (0.77)	71.19 (0.32)
LRI	-2.67 (-0.95)	-0.14 (-1.02)	**-144.41 (-2.31)[b]**	-8.01 (-1.63)	**-1.07 (-2.72)[a]**	-22.80 (-0.92)	-1.73 (-0.53)	-0.07 (-0.40)	**-85.98 (-2.07)[b]**
AGE	**-0.54 (-5.09)[a]**	**-0.02 (-2.77)[a]**	**-6.27 (-3.33)[a]**	**-1.09 (-5.99)[a]**	**-0.04 (-3.70)[a]**	**-10.48 (-5.00)[a]**	**-0.35 (-2.82)[a]**	-0.006 (-0.84)	**-2.89 (-3.21)[a]**
SIZE	2.07 (1.42)	**0.67 (4.49)[a]**	**-28.89 (-2.61)[c]**	**22.38 (4.17)[a]**	**3.00 (4.34)[a]**	**89.71 (3.56)[a]**	-0.10 (-0.07)	**0.43 (3.97)[a]**	**-32.30 (-3.41)[a]**
ADVT	**-1.74 (-4.70)[a]**	**-0.07 (-3.71)[a]**	**-21.72 (-2.33)[b]**	-2.94 (-1.65)	**-0.17 (-3.64)[a]**	-6.11 (-1.02)	**-1.32 (-3.10)[a]**	**-0.06 (-2.60)[a]**	**-13.80 (-2.46)[b]**
LABCAP	**0.32 (1.66)[c]**	**0.06 (4.77)[a]**	-3.04 (-1.40)	0.23 (0.71)	**0.09 (3.08)[a]**	**2.35 (2.23)[b]**	0.17 (0.63)	**0.04 (3.15)[a]**	-2.34 (-1.38)
VI	-0.08 (-1.24)	0.002 (0.96)	**-2.55 (-2.64)[b]**	- 0.12 (-0.90)	0.009 (1.11)	0.26 (0.26)	-0.03 (-0.42)	0.003 (1.04)	**-2.01 (-2.40)[b]**
D_{fe}	**14.06 (5.07)[a]**	**0.55 (3.88)[a]**	**54.37 (2.44)[b]**	-5.66 (-1.36)	0.20 (0.77)	**-61.18 (-3.05)[a]**	**24.27 (7.06)[a]**	**0.85 (4.78)[a]**	**69.76 (3.54)[a]**
D_{house}	**12.75 (4.71)[a]**	**0.96 (6.64)[a]**	-26.28 (-1.17)	1.40 (0.35)	0.07 (0.26)	**-46.56 (-3.09)[a]**	**20.05 (5.84)[a]**	**1.47 (7.55)[a]**	0.47 (0.03)
D_{org}	**9.20 (3.17)[a]**	0.15 (1.16)	**72.26 (1.95)[c]**	-	-	-	-	-	-
NOB	637	637	449	196	196	130	441	441	319
Chi^2	**99.64[a]**	**142.34[a]**	**18.71[c]**	**65.03[a]**	**59.80[a]**	**40.38[a]**	**83.92[a]**	**143.26[a]**	**25.47[a]**
LL	-2283.16	-280.51	-1766.54	-629.75	-81.23	-406.54	-1619.73	-177.19	-1296.74

[1] *Year dummy variables were introduced in the equations, however they did not turn out to be statistically significant and therefore the models involving year dummy variables have not been reported in this study*
Value in bracket is t-statistics for tobit and z-statistics for probit and truncation

Statistically significant values are represented in bold where [a], [b], and [c] denote 1%, 5% and 10% significance level respectively

The statistical significance and signs of the coefficients for the full sample largely resembles those of the organic group. This is not surprising since nearly 70 percent of the firms in the present sample are organic chemical producers and so the results obtained for full sample merely reflects the factors important for export behavior of organic chemical firms. But one should note that in the models fitted for the full sample the dummy variable representing organic chemical firms is statistically significant in only Truncation model of the double specification. This means that both inorganic and organic firms are equally likely to become an exporter, however, once a firm starts exporting, the product specific factors become important in determining the export intensity. By fitting similar models for the organic and inorganic group of firms separately, the present study would highlight how the characteristics of the firms can have varying effects on exports for the two groups.

The following subsection would discuss the factors that affect the probability to export (results of the Probit models). In the light of the Probit results, the factors affecting intensity of export (results of the Truncation models) would be discussed in subsection 6.2. The focus of the discussion would be on the results obtained in the double specification model, though some comparison to the Tobit results would also be made while discussing the results of the Truncation model. Since the findings for the whole sample are similar to those of organic chemical firms therefore for each factor first the findings for the whole sample (which would in general be also true for the organic chemical firms) would be mentioned. Disparity in the findings (for the variable) for organic and inorganic groups would also be mentioned. This would be followed by a discussion on the findings for the factor.

6.1 The Probability of Exporting

Let us consider first the four technology variables. As was postulated, for the sample as a whole, R&D intensity and foreign equity participation positively determine the probability of exports. The same is true for the sub-sample of organic chemical firms. However for the inorganic chemical firms both these variables did not turn out statistically significant. As was hypothesized import of technology against royalty and technical fees is also not statistically significant in determining exports for the full sample (and organic chemical groups) but is important with a negative effect on export probability for inorganic group.

For organic chemical firms innovations through R&D investments, and the brand names and managerial skills of the foreign equity participants seem to be helping them in entering the exports business. In case of inorganic firms, disembodied technology imports seems to be more useful for competing in the domestic markets but with respect to the world standards the same technology could be

obsolete. Therefore inorganic firms that are importing more and more of disembodied technology are not entering export market.

For the sample as a whole, and for the organic and inorganic sub-samples, import of capital goods did not turned out to be a statistically significant factor in determining export probability. Again, it should be noted that the average intensity of capital goods import is the least among R&D, import of disembodied technology, and import of embodied technology through import of capital goods (see Table 4). This means that unlike the Italian manufacturing firms (Basile, 2001) the Indian Basic Chemical industry firms are not investing much on imported capital equipments that can help in developing new products for export market or can help in improving efficiency of production.

As postulated, size of the firm positively determines whether a firm exports or not in this industry. This is in line with the findings of many other studies and thus reinstates the fact that exporting is an investment intensive and risky activity that can be undertaken only by a firm having sufficient resources. Again as conjectured labor to capital ratio is having a positive effect on the probability of a firm becoming an exporter. In India skilled labor being in abundance a firm that uses more technicians is more likely to produce chemicals of export quality.

As was anticipated, advertisement intensity has a negative effect on export probability for the firms in this industry. Through continuous projection of their products the firms in this industry might have succeeded in increasing the demand for their products in the domestic market itself and so they did not feel the need to get into export market.

Again, as was predicted for the full sample, younger firms have higher probability of getting into export markets. This finding is also true for the inorganic group, but in case of organic sub-sample age does not matter for deciding whether to export or not. It is possible that older firms, due to difficulty in writing off the older equipments, are still using them and producing chemicals by means of inefficient techniques. However, the younger firms with modern technology and equipments would be in a position to offer more quality products at lower costs than others. Also, as Bhaduri and Ray (2004) note that with the advent of globalization the newer firms entering any industry in a developing country such as India are more likely to adopt an export oriented policy from the outset.

For the industry as a whole as well as for the inorganic and organic subgroups degree of vertical integration does not seem to influence the decision to export. In other words more internalization of process of production is not enough to help a firm to get into export market. After liberalization process was undertaken most of the chemicals in this industry are now freely importable and tradable. Since the firms can buy contemporary raw materials from the market at competitive prices therefore high degree

vertical integration may not affect the cost of the product and therefore not give an edge to the firm in the export market.

Again, as was conjectured, for the full sample as well as for the organic group, belonging to a business-house positively determines the export probability of the firm. However ownership is not important for the probability of an inorganic chemical firm becoming an exporter.

6.2 Export Intensity

As was postulated R&D intensity positively affects the export intensity for the exporters in this industry. This result is especially true for the inorganic group. However in case of organic group once a firm becomes an exporter R&D intensity is no longer important for its export intensity. This means that inorganic chemical exporter has to continuously upgrade its products and processes through in-house R&D investments in order to further increase its export performance. But in case of organic firms R&D is needed only for getting the initial thrust into export market after which factors other than R&D become more important for export performance.

Again, as conjectured, having foreign participants in equity is important as a determinant of export intensity of the firms in this industry. For the organic chemical group foreign equity participation has a positive effect. However surprisingly, for the inorganic group, having foreign equity participation is detrimental to the export performance of the exporters. The reason for this discrepancy in the effects of foreign equity on export intensity for the two groups could be that in case of organic firms the foreign equity participants could be transferring their tacit knowledgebase to the Indian firms in order that the latter are able to produce better quality products that in turn can be imported as input by the collaborator firm itself or can be sold as intermediate products to other firms in the world. But in case of inorganic chemical firms, foreign equity participation could be more domestic market seeking type. In other words, here the foreign firms might be taking part in the equity stakes of an already exporting firm (which would be minimally competent) and using its resources and expertise to capture Indian markets.

Import of designs and drawings through lump sums, royalties and technical fees payments negatively determines export intensity of the industry, especially for the organic chemical group. This could be because the firms are not able to properly assimilate and use the imported technology for improving the quality of the existing product if not for producing new product, thereby losing the foreign markets to other more capable firms. The variable is not statistically significant for inorganic group. The fourth technology variable, that is, import of capital goods has no statistically significant effects even on the export intensity for the exporters.

As conjectured, size of the firm is an important factor in determining export intensity of the exporting firms in this industry. However it is interesting to note that size has opposite effects on export intensity for inorganic and organic groups. Again, as is visible, the coefficient of size variable in Tobit results for full sample (and for organic group) is not statistically significant because of opposing effects of size on exports probability and export intensity for the sample (and organic group). The larger inorganic firms seem to be using their resources efficiently to produce export quality products. However, in case of organic firms, larger firms might have initially got into exports market to dispose off their excess stock, but once into export market the larger firms might have found it difficult to manage the incessant requirement of improving the quality of the product, which is essential for sustained export performance.

For the sample as a whole (and in the organic group) the exporters that are less aggressive in terms of investment on advertisements are performing better in the export market. As was noted earlier, Basic Chemical industry has less scope for product differentiation. Therefore aggressive marketing strategy simply adds to the cost of production of the product thereby making it unattractive in the export market. Further, if the aggressive marketing strategy is successful in creating demand for the products in local market, the firm may opt to sell more in the domestic market (since exporting is more investment intensive and risky) and thus the export market for the firm's product may shrink.

Again as was hypothesized, in this industry, younger firms with latest technology are performing better than older firms in the export market. Those who are subcontracting rather internalizing the process of production are performing better in the export market. In case of inorganic chemical group use of more labor-intensive technology seems to be advantageous for export performance of the exporter. Again, the inorganic chemical exporting firms who are not owned by business-houses have higher export intensity. In case of organic firms labor-intensive technology and ownership, though important for venturing into export markets, do not affect the export intensity of the exporters.

Table 9 gives the marginal effects for the variables that were found to have statistically significant coefficients for the double specification models in Table 8. The marginal effects have been calculated at the mean of the continuous explanatory variables. For the dummy explanatory variables the marginal effect is the change in probability/intensity of the explained variable due to discrete change in the dummy variable from a value of 0 to 1, when all other variables are held constant.

As can be seen in Table 9, belonging to a business-house has the highest positive effect on the export probability of the full sample (and the organic chemical group). For the inorganic sample larger firm size has the most positive effect on the probability of the firm becoming an exporter. Once into exporting business, in case of the organic group, having foreign equity participation improves its export

performance by more than eight times. At the same time the organic firms who are importing a lot of technology are performing very badly in the export market.

Table 9: Marginal Effects[1]

	Double Specification					
	Full Sample		Inorganic Group		Organic Group	
	Probit (Robust)	Trunc. (Robust)	Probit (Robust)	Trunc. (Robust)	Probit (Robust)	Trunc. (Robust)
RDI	0.06	0.96	-	1.28	0.05	-
LRI	-	-8.91	-0.27	-	-	-9.32
AGE	-0.004	-0.39	-0.01	-0.49	-	-0.31
SIZE	0.18	-1.78	0.75	4.21	0.10	-3.50
ADVT	-0.02	-1.34	-0.04	-	-0.01	-1.50
LABCAP	0.01	-	0.02	0.11	0.01	-
VI	-	-0.16	-	-	-	-0.22
D_{fe}*	0.13	3.53	-	-2.66	0.18	8.35
D_{house}*	0.23	-	-	-2.31	0.31	-
D_{org}*	-	4.09	-	-	-	-
NOB	637	449	196	130	441	319

[1]*The marginal effects have been reported for only those coefficients that were statistically significant in Table 9 for the double specification models. Since none of the coefficients for MKI were statistically significant therefore the variable has been dropped from Table 9*

** dy/dx is for discrete change of dummy variable from 0 to1*

Again, larger size and excessive advertising is also proving to be disadvantageous for export intensity of the organic chemical exporters. In contrast, for the inorganic group firms a unit increase in size not only positively determines the export probability but also brings about more than four times increase in the export intensity of the exporters. Of the technology variables R&D intensity has some positive effect on exports of inorganic exporters. For inorganic firms not having foreign equity would improve their export performance by more than two times as compared to those having foreign equity participation.

7. Summary and Conclusions

The present study tried to investigate the differences in the effects of adoption of technological efforts on the export behavior of the firms in the context of Indian Basic Chemical industry. The export behavior of the firm was considered to consist of two aspects, the decision of whether to export or not and the intensity of export once the firm decides to export. The results of both Tobit and double

specification model (Probit + Truncation) were reported. Further, investigation was carried out to determine whether the kind of product (organic or inorganic) produced by the firm is important in influencing the export behavior of the firm in this industry. In the present study on export behavior of Indian Basic Chemical industry the following points are noteworthy:

1. In line with many other empirical studies this study also finds that investment on technological efforts is an important determinant of export behavior of a firm. Further, the effect of the technology variables is different for the probability of exporting, and export intensity of the exporters. Of the four technology variables considered in the study except for import of capital goods intensity all others, namely, in-house R&D intensity; import of designs, drawings, and formulae; and foreign equity participation have turned out to be statistically significant in determining export behavior of the firms.

2. The effects of the various explanatory variables, including technology variables, on export behavior differ between the organic and inorganic chemical groups. This implies that there are differences in the intrinsic characteristics of the organic and inorganic firms which results in dissimilarity in the effects of the factors on the export behavior for the two groups.

3. An organic chemical firm having foreign equity participation or having higher in-house R&D intensity is more likely to export than others. However once an organic chemical firm starts exporting, only brand names and tacit knowledge got from the foreign equity holder firms is highly important for improving the export intensity of the firm. At the same time, for the organic chemical exporter, higher import of designs, drawings, and formula surprisingly turns out to have detrimental effect on export intensity. A likely explanation for this is that the products generated using the imported technology is new for the local market and therefore the demand for the products in local market increases thereby shrinking the export market for the chemicals. At the same time investments on R&D doesn't turn out to be statistically significant for export intensity of organic firms although it is important in determining whether an organic firm exports or not. This means that some product quality improvements through in-house R&D may be required for reaching the level of product quality in the export market but after that any incremental improvements on the product does not have much effect on export performance.

In case of inorganic chemical firms lesser investments on importing designs, drawings and formulae is likely to induce a firm to export. This could be because, with fewer numbers of inorganic chemical producers in the domestic market, the better-quality chemicals produced by utilizing the imported designs, drawings, and formulae get sold in the domestic market itself with little left for export market. But once in the export business, only incremental innovation through higher investments on in-house R&D is important to increase export performance for inorganic firms. Foreign equity participation in inorganic firms seems to be inducing the firms to sell their products domestically. However, to draw firmer conclusions, further investigation needs to be carried out to understand the kind of strategy followed by the foreign firms in inorganic group.

4. Larger firms with more resources and power are more likely to export in the Basic Chemical industry. However once a firm starts firm size negatively affects the export intensity for organic firms. In India, larger organic firms are by and large well-established firms therefore they are most likely to sell majority of their products in the domestic market and use export market only for disposing off products excess of demand in domestic market. The smaller firms in the organic group might be producers of specialized products that have more demand in the world market.

   For inorganic group size is an important factor for both, probability and export intensity. As part of liberalization process quantity related restrictions for most of the chemicals have been discarded. In such a changed scenario the amount of inorganic chemical produced due to full capacity utilization might far exceed the demand for the chemicals in the local market. Therefore larger sized inorganic firms have to sell higher proportions of their products in foreign markets. Further, the large inorganic firms (in terms of market share) are relatively smaller as compared to the large organic firms and so they could be utilizing their resources more efficiently for export market as compared to large organic firms.

5. Younger firms in this industry are more likely to export than the older and more experienced firms. Further the export performance of the younger organic exporter firms is also better than the older organic exporter firms. The younger firms are having the latest equipments and so are able to produce export quality products. Also, following Bhaduri and Ray (2004), it can be argued that since the newer firms might be finding the domestic market too crowded with the products of the older firms, they must be using an export-oriented policy from the beginning itself.

6. Choice of technology is also found to be an important factor in determining exports. A firm that adopts a labor-intensive technology is more likely to export than a firm using a capital-intensive technology. In India human resource is abundant and inexpensive. Therefore employing more highly trained technicians can help the firm in bringing down the cost of production and increasing the quality of the chemicals.

7. In this industry, rigorous marketing strategy is unfavorable for export probability. By indulging in excessive advertising the firms in the industry might have become successful in creating demand for their products in the domestic market itself and therefore there is no incentive to export. For an organic chemical exporter increase in advertisement expenditure has an undesirable effect on even the export intensity of the firm. Since Basic Chemical industry does not have much scope for product differentiation, excessive advertising might be pulling up the price of the product thereby making it unattractive in the foreign markets. Therefore a firm desirous of improving its export intensity should try to make investments on other activities like in-house R&D efforts rather than on promotional activities alone.

8. For the organic chemical firms having higher vertical integration is detrimental to the export intensity of the firm. It should be noted that after the liberalization process began most of the chemicals are now freely importable in India. Therefore internalizing more stages of the production process might be a deterrent for the vertically integrated firm to produce more variety of products. At the same time a subcontracting type of firm can be more flexible in terms of the kind of chemicals that it uses and so may be able to produce more ranges of products for export market.

9. Belonging to a business house positively determines the probability of an organic firm becoming an exporter. This is because the firm is able to use all the resources including brand name of the business house to venture into export market. However once into export market, ownership has no effect on the export performance of the organic exporters. For inorganic chemical exporters belonging to business house has a negative effect on the export intensity. This could be because as the demand for the products in the local market increases firms belonging to the business-houses might be able to quickly sell their products in the domestic markets and also without much effort.

Thus in the present study, the results obtained using the double specification model (Probit + Truncation) are found to be more robust than those obtained using Tobit model. On the whole, the variables capturing technological efforts and firm size emerge statistically significant not only in determining the decision to export but also in explaining the inter-firm differences in export intensity of the exporters. The paper also asserts the importance of considering product specific peculiarities while determining the effects of the firm characteristics on export behavior.

References

Aggarwal, A. (2001). Liberalisation, Multinational Enterprises and Export Performance: Evidence from Indian Manufacturing. *Indian Council for Research on International Economic Relations (ICRIER) Working Paper No. 69*.

Athukorala, P., Jayasuriya, S., and Oczkowski, E. (1995). Multinational firms and export performance in developing countries: Some analytical issues and new empirical evidence. *Journal of Development Economics*, 46, 109-122.

Basile, R. (2001). Export behaviour of Italian manufacturing firms over the nineties: the role of innovation. *Research Policy*, 30, 1185-1201.

Bhaduri, S., and Ray, A.S. (2004). Exporting Through Technological Capability: Econometric Evidence from India's Pharmaceutical and Electrical/Electronics Firms. *Oxford Development Studies*, 32 (1), 87-100.

Bhat, S., and Narayanan, K. (2006). Globalization and Technological Behavior of firms: A study of Indian Basic Chemical Industry. Paper presented at the *4th AIB India International Conference on "Globalization and Sectoral Development"* held during 17-19 February 2006 at IILM, New Delhi, India.

Bonaccorsi, A. (1992). On the relationship between firm size and export intensity. *Journal of International Business Studies*, 23 (4), 605-35.

Fagerberg, J. (1987). A technology gap approach to why growth rates differ. *Research Policy*, 16, 87-99.

--------- (1988). International Competitiveness. *Economic Journal*, 98, 355-374.

Ganguly, A. (1999). Rebirth of Chemical Industry in India. *Chemical Business*, 13 (11), 31-35.

Greene, W.H. (2002). *Econometric Analysis*. Delhi: Pearson Education Asia.

Gujarati, D.N. (2003). *Basic Econometrics*. New Delhi: MacGraw-Hill.

KPMG-CHEMTECH (2003). The Indian Chemical Industry: New directions, new hope. *A report by KPMG India-CHEMTECH foundation.* Retrieved on January 2, 2006 from http://www.kpmg.de/library/pdf/030117_KPMG_Chemtech_Report_en.pdf

Krugman, P. (1979). A Model of Innovation, Technology Transfer and the World Distribution of Income. *Journal of Political Economy*, 87, 253-266.

Kumar, N., and Siddharthan, N.S. (1994). Technology, Firm Size and Export Behaviour in Developing Countries: The Case of Indian Enterprises. *The Journal of Development Studies*, 31 (2), 289-309.

Lall, S. (1999). India's Manufactured Exports: Comparative Structure and Prospects. *World Development*, 27(10), 1769-1786.

--------- (2000). The technological structure and performance of developing country manufactured exports, 1985-98. *Oxford Development Studies,* 28(3), 337-367.

Malvi, M.B. (2003). Chemical industry in China and India. *Chemical Business*, 17 (1), 31-32.

Narayanan, K. (2006). Technology Acquisition and Export Competitiveness: Evidence from Indian Automobile Industry. In S.D. Tendulkar, A. Mitra, K. Narayanan, D.K. Das (Eds.), *India: Industrialization in a Reforming Economy* (pp.439-470). New Delhi: Academic Foundation.

Ozcelik, E., and Taymaz, E. (2004). Does innovativeness matter for international competitiveness in developing countries? The case of Turkish manufacturing industries. *Research Policy*, 33, 409–424.

Pavitt, K., and Soete, L. (1980). Innovative Activities and Export Shares: Some Comparisons between Industries and Countries. In K. Pavitt (ed.), *Technical Innovation and British Economic Performance* (pp. 38-66). London: The MacMillan Press Ltd.

Posner, M.V. (1961). International Trade and Technical Change. *Oxford Economic Papers*, 13 (3), 323-341.

Roberts, M.J., and Tybout, J.R. (1997). The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs. *The American Economic Review*, 87 (4), 545-564.

Siddharthan, N.S., and Nollen, S. (2004). MNE Affiliation, Firm Size and Exports Revisited: A Study of Information Technology Firms in India. *The Journal of Development Studies*, 40 (6), 146 – 168.

Sterlacchini, A. (1999). Do innovative activities matter to small firms in non-R&D-intensive industries? An application to export performance. *Research Policy*, 28, 819–832.

Trivedi P., Prakash A., and Sinate D., 2000. Productivity in Major Manufacturing Industries in India: 1973-74 to 1997-98. Development Research Group Study No. 20, Department of Economic Analysis and Policy, Reserve Bank of India, Mumbai. Retrieved on January 3, 2006 from the Reserve Bank of India Web site: http://rbidocs.rbi.org.in/rdocs/Publications/PDFs/15432.pdf

Vernon, R. (1966). International Investment and International Trade in the Product Life Cycle. *The Quarterly Journal of Economics*, 80 (2), 190-207.

Wakelin, K. (1998). Innovation and export behaviour at the firm level. *Research Policy*, 26, 829–841.

Wignaraja, G. (2002). Firm Size, Technological Capabilities and Market-oriented Policies in Mauritius. *Oxford Development Studies*, 30 (1), 87-104.

--------- (2006). Foreign Ownership, Technological Capabilities and Exports: Evidence from 205 Clothing Firms in Sri Lanka. *UNU MERIT Working Paper Series #2006-032*. United Nations University.

Willmore, L. (1992). Transnationals and Foreign Trade: Evidence from Brazil. *The Journal of Development Studies*, 28 (2), 314-335.

Zhao, H., and Zou, S. (2002). The Impact of Industry Concentration and Firm Location on Export Propensity and Intensity: An Empirical Analysis of Chinese Manufacturing Firms. *Journal of International Marketing*, 10 (1), 52-71.