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Information Technology and Exports:

A Case Study of Indian Garments Manufacturing Enterprises

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Abstract

This study identifies and analyses the factors that influence the export performance of Indian garments manufacturing firms. The data come from a sample of seventy-four firms located in Okhla. The results show that intensity of adoption of Information Technology (IT) was the most significant variable that influenced the export performance of firms. The other variables that played an important role in augmenting the export intensity were quality of raw material and the wage rate. The results show that Managing Directors of export- oriented firms assigned more importance to flexibility in product designs. The study suggests that a higher degree of adoption of IT by Indian firms is crucial to remain internationally competitive. The use of advanced IT tools will be even more relevant once the WTO recommendations are in place.

Kurzfassung

Die Arbeit identifiziert und analysiert die Faktoren, die die Exportleistung von Firmen der Bekleidungsindustrie in Indien beeinflussen. Die Daten stammen aus einer Stichprobe, die 74 in Okhla ansässige Firmen umfaßt. Die Ergebnisse zeigen, daß der Grad der Adaption von Informationstechnologie (IT) die wichtigste Variable war, die die Exportleistung der Firmen beeinflußte. Andere Variablen, die eine wichtige Rolle bei einer Erhöhung der Exportintensität spielten, waren die Qualität des Rohmaterials und das Lohnniveau in Unternehmen. Die Analyse macht deutlich, daß Manager von exportorientierten Firmen der Flexibilität des Produktdesigns eine größere Bedeutung beimaßen. Die Studie ergibt, daß ein höherer Grad an Nutzung von IT in indischen Firmen entscheidend ist, um auf internationaler Ebene wettbewerbsfähig zu bleiben. Der Gebrauch von komplexeren IT-Anwendungen wird noch wichtiger werden, sobald die Empfehlungen der WTO umgesetzt werden.

1 Introduction

The outward-looking policies of many developing countries have in recent years played a crucial role in their social and industrial development. Comparative advantages based on natural resource endowments have been replaced by the acquired advantage (Helleiner, 1995). Many developing countries have been able to strengthen their comparative advantage by focusing on the building of technological capability, on adoption of new technologies, and on the development of skills to use these new technologies effectively and efficiently (Noland, 1997).

There has been a major emphasis on the role of technology and skill in influencing international trade. Several studies (Trefler, 1993 and 1995; Harrigan, 1995) have demonstrated the importance of technological differences in international trade. Moreno (1997) found that the technology had a significant effect on the evolution of Spanish industrial exports. Moreno's (1997) study suggests that the non-price factors such as product quality and product differentiation exert a significant influence on international competitiveness.

It has been argued by several scholars (Kaplinsky, 1982; James, 1994; Doms et al., 1997) that Information Technology (IT) can substantially contribute in augmenting the product quality and product differentiation and hence can influence the global competitiveness of firms. IT, a most recent development in technological evolution, is considered to be very pervasive. It is being widely adopted by all types of firms engaged in the manufacturing and service sectors of developing and developed nations. However, the purpose of adoption of IT may differ between countries or even between industries within a country. For instance, IT is being used for productivity gains in developed nations (Kraemer and Dedrick, 1994; Greenan and Mairesse, 1996; Lichtenberg, 1995); whereas firms in developing nations adopt IT for an improvement in product quality and flexibility in manufacturing processes (Lal, 1996). A great deal of literature on IT is concerned with the factors that determine its adoption (Brynjolfsson and Hitt, 1996; Doms et al., 1997; Lal, 1999). In contrast, we propose to analyse in this paper the consequences of the adoption of IT on the export performance of Small and Medium-sized Enterprises (SMEs) in India.

The main objective of this study is to identify and analyse the factors that influence the export performance of garment manufacturing firms. Several qualitative and quantitative variables such as intensity of IT adoption, profit margins, skill intensity, wage rates, quality of raw material, and entrepreneurial abilities were included in the analysis. The data for the study come from the seventy-four garments manufacturing firms located at Okhla. Garments manufacturing firms in India have adopted IT mainly in the Design and pre-Assembly stages of

the garments manufacturing process. These IT tools are: (1) Integrated Management Information System (IMIS); (2) Computer-Aided-Design (CAD) integrated with Marker Maker System (MMS); (3) CAD integrated with high resolution scanner used for embroidery work on fashion clothes. IMIS is used for office automation and other managerial activities. CAD and MMS are used in the Design, Grading, and Pattern-making stages of the garments manufacturing; whereas the computerised embroidery system is used at the assembly stage. Although IT tools are available for cutting of the fabric and sewing, Indian firms however do not use such tools. The main reasons for not using IT in cutting and sewing are: (1) Loss of jobs, and (2) IT tools for these stages may not be economically viable in India as these are very costly.

Entrepreneurial abilities are viewed in terms of the importance assigned by the Managing Director (MD) to 'flexibility in product design', 'international competitiveness', 'delivery schedule', and 'fabric use advantage of IT'. The opinion of MDs regarding these variables is expected to play a significant role in influencing export performance of the firms. Fabric-use advantage variable was considered to be very crucial for price-competitiveness, while the other variables could augment the non-price-competitiveness of firms. The cost of fabric accounts for roughly 50 percent of the total manufacturing cost of a garment. It was found by Hoffman and Rush (1988) that IT tools used for cutting the fabric can save up to 10 percent of the fabric cost. It was found during the survey that most of the firms were either operating in domestic markets or in overseas markets. However, there were two firms that were doing business in domestic as well as international markets. We have classified firms depending on their market preferences. Firms that were dealing in domestic markets will be called as Domestic Market Oriented Units (DMOUs). 100 percent Export Oriented Units will be referred as EOUs while the firms that were operating in both the markets have been labelled as Domestic Market and Export Oriented Units (DMEOUs).

The remainder of the paper is organised as follows. Section I presents a theoretical framework. Data and characteristics of sample firms are presented in Section II. Section III formulates the hypotheses and also presents a specification of the econometric model. In Section IV, the statistical results are discussed whereas the findings and conclusions are presented in Section V.

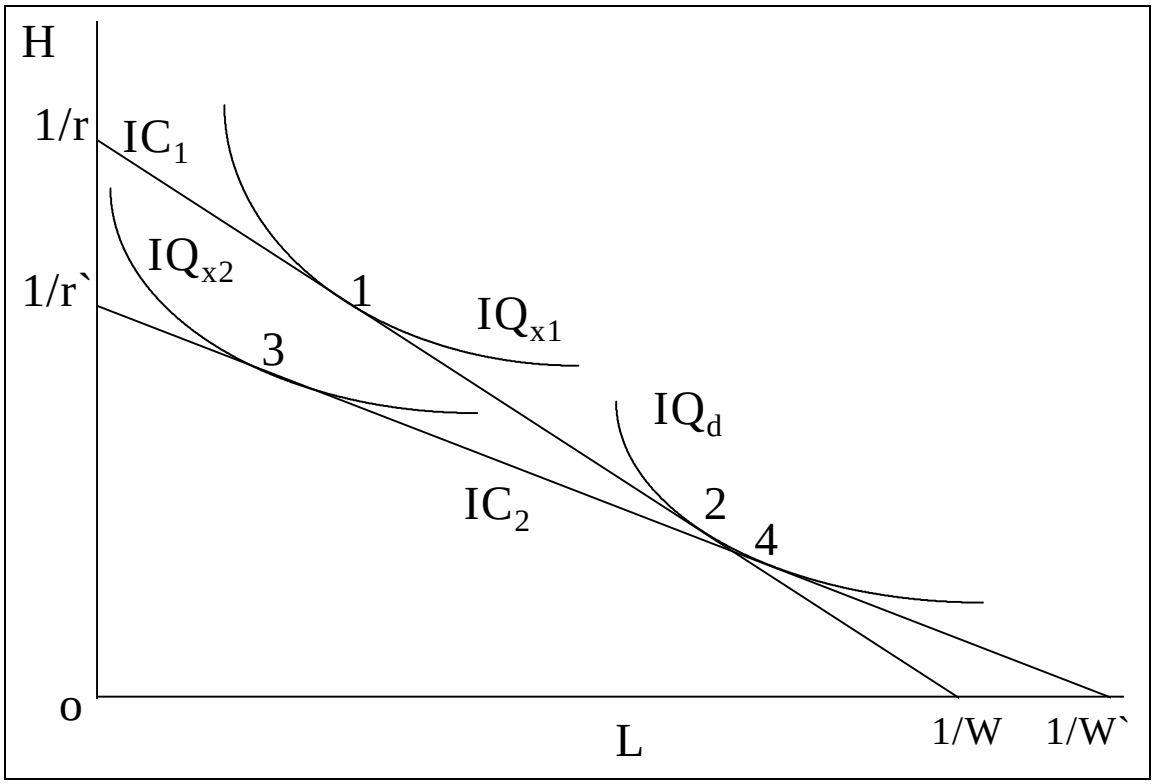
2 Theoretical Framework and Methodology

It is argued in this paper that the export performance of firms is significantly influenced by internal and external factors. These factors induce changes in production processes that result in an efficient utilisation of inputs and improvements in product quality. Since EOUs are expected to use high quality raw material to be competitive in the world market, the unit isoquants of EOUs and DMOUs are likely to be different. We will first theoretically discuss the impact of internal and external factors on isocost and isoquant curves of garments manufacturing firms. External factors are buyer countries' tariff structure, Multi-Fibre-Arrangement (MFA) quota, and technological profile of firms of competing countries. A strong technological profile of competing firms i.e. the use of latest technologies, is likely to compel Indian firms to adopt similar tools. Therefore the degree of adoption of IT is viewed as an external factor. The impact of tariff and MFA quota will be the same on all firms. Hence, these factors are not included in the model. Internal factors are basically the production factor intensities and prices, quality of raw material, and export subsidies. Export subsidies, being the same for all firms, will not be included in the model. Our model mainly concentrates on the impact of intensity of IT adoption, quality of raw material, and abundant unskilled labour on the export performance of firms.

1.1 Intensity of IT adoption

The technological evolution that has taken place in this industry over time has created a tremendous pressure on Indian firms to adopt new technologies. The technological development in the world market mainly affects the export-oriented firms. Garments exporting firms are compelled to adopt new technologies in order to remain competitive in the global markets. Figure 1 presents the unit isoquant curves of EOUs and DMOUs in H-L space, where we denote skilled labour/human capital with H and unskilled labour with L. Unit isoquant curves of EOUs are shown by IQxi(i=1,2), whereas IQd is the unit isoquant curve of DMOUs. The unit isocost lines are shown by ICj(j=1,2).

Fig. 1: Exports, Information Technology and Wages



If *r* and *w* are the payments of per skilled and unskilled workers, then unit isocost line can be written as :

$1=rH+wL$ or $H=1/r-(w/r)L$

If factor intensities do not change and under the assumption of price equal to marginal cost and constant returns, the tangential unit isocost line will represent the equilibrium.

As can be seen in Fig. 1, the line joining the points 1 and 2 is the unit isocost line at initial equilibrium. Let us now consider the case of adoption of IT by export-oriented firms. Suppose that EOUs adopt IT tools that are quality improving and augment the labour productivity. Labour productivity gains have been found in several studies (Kraemer and Dedrick, 1994; Greenan and Mairesse, 1996; Lichtenberg, 1995). Consequently, the unit isoquant curve of these firms will experience an inward shift. The new isoquant curve of EOUs is shown by IQx2. This will result in reduction of unskilled-labour in export-oriented units. The new equilibrium will be attained at points 3 and 4. Therefore, as a result of adoption of IT, the slope of new unit isocost IC2 will decrease. Export-oriented units may improve or retain their share in the exports market due to lower production costs and better quality products. However, the impact on DMOUs will be akin to that of an increased supply of unskilled workers. This is because the reduction in demand of unskilled labour by EOUs will lead to an excess supply of unskilled workers.

Mathematically, we can denote it as follows:

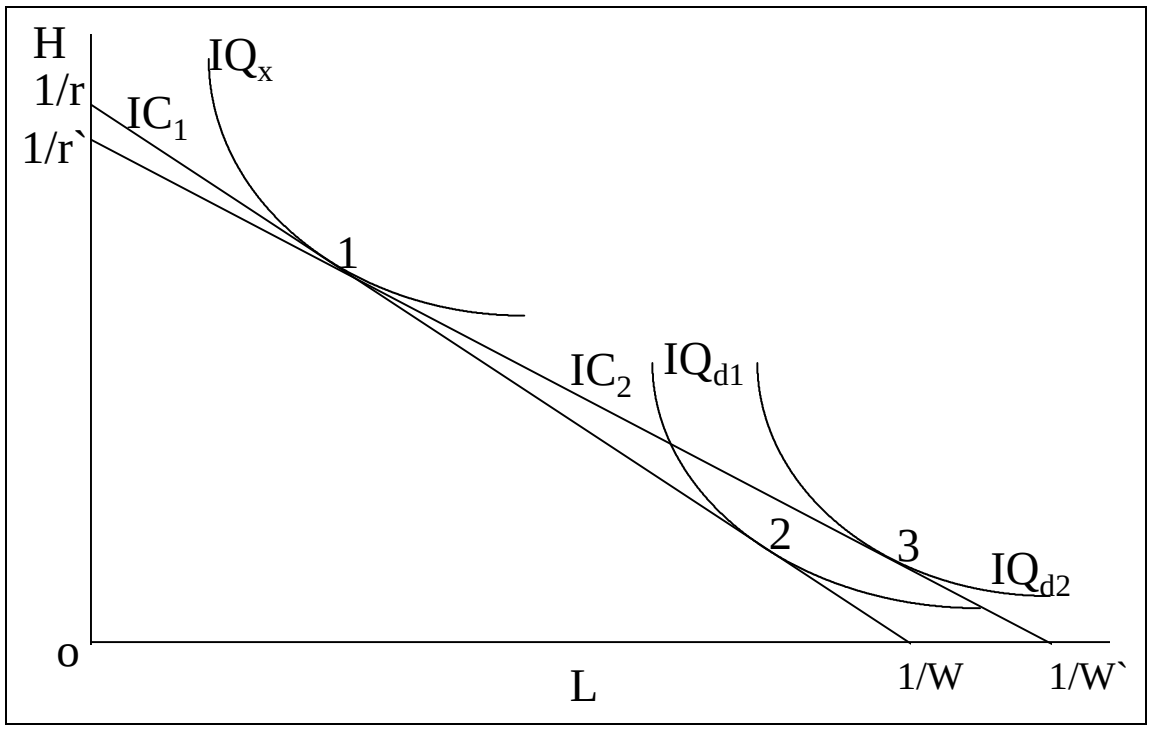
$$|(-w/r)| > |(-w`/r`)| \Leftrightarrow w/r > w`/r`$$

where $w`$ and $r`$ are the costs of one unskilled and skilled worker respectively in new equilibrium. Since $w` < w$ and $r` > r$, the gap between factor prices will increase. Now let us discuss the particular case of India, i.e. the presence of abundant unskilled labour.

1.2 Intensity of unskilled labour

Isocost and isoquant curves of EOUs and MDOUs are depicted in Fig. 2. IQx is the unit isoquant of EOUs and IQdj(j=1,2) represent the isoquant of MDOUs. ICk(k=1,2) represent the two different unit isocost lines. IC1 represents the initial equilibrium. Let us now consider the situation of excess supply of unskilled labour. Availability of more unskilled labour will reduce the price of *L*, i.e., *w*. Consequently, there will be an outward shift of unit isoquant curve of DMOUs. The new equilibrium is represented by isocost line IC2. The new unit isocost is traced by joining points 3 and 4.

Fig. 2: Exports, Factor intensity and Wages



As shown in Fig.2, IC2 is flatter than IC1. Consequently, the relative factor price (unskilled labour) will be lower in new equilibrium. Therefore, we may conclude that the abundance of unskilled labour will lead to substantial wage differences between two type of firms. Then net effect will be the greater disparity in wages and a significantly different level of IT adoption in EOUs and DMOUs. While describing the theoretical framework it is assumed that the growth of demand of readymade garments is less than the growth of unskilled labour in the economy:

$$\frac{\partial L}{\partial t}\left(\frac{1}{L_b}\right) \geq \frac{\partial D}{\partial t}\left(\frac{1}{D_b}\right)$$

where L_b and D_b denote the amount of unskilled labour force available and the total demand of garments respectively in the base year.

The theoretical framework considers the role of adoption of IT, quality of raw material, and wage difference in export performance. However, the model assumes that other variables such as firm size and entrepreneurship remain the same. In the empirical analysis, these variables have also been included.

2 Database and Characteristics of Sample Firms

There are four major garments manufacturing centres in India. These are: (1) Okhla in Delhi, (2) Trippur in Tamil Nadu, (3) Bangalore in Karnataka, and (4) Mumbai in Maharastra. However, the data for this study come from firms located at Okhla. The survey was conducted during September 1997-February 1998. All the 106 garments manufacturing firms located at Okhla were approached. However, we could get information from only 74 firms, that is, a response rate of 70 percent. The addresses of firms were taken from a directory published in 1997 by Okhla Entrepreneurs Association (OEA). This is an annual publication of the OEA. Financial, historical, and technological data were collected from all the sample firms through a semi-structured questionnaire. The detailed information of their performance and international orientation, i.e. size of operation, exports, and collaboration with foreign firms were also collected. We could get the details of IT tools used by the firms at various stages of garments manufacturing.

Besides quantitative data, we collected qualitative data to assess the impact of entrepreneurship on the performance of the firm. The qualitative variables include the academic qualification of MDs, and the importance given by MDs to flexibility in design of garments, fabric-use advantage of IT, product quality, proximity of raw material suppliers, international competition, market networks, and delivery schedule. The opinion on these variables were measured on a three-point scale, namely: (1) The variable is not important, (2) Important, and (3) Very important. With regard to MD's qualification, the MDs who had below postgraduate level education were assigned the lowest rank, i.e., 1. MDs with postgraduate degree or LLB[1] were given a higher rank, i.e., 2; while the MDs having a professional degree like CA[2], BE[3], or MBA[4] were assigned highest rank, i.e., 3.

As mentioned earlier, the details of IT tools used by sample firms were collected. It was found that firms were using IT tools mainly at the pre-assembly stage. CAD system was being used for the design, grading, and marker making. The CAD system used in the garments industry is slightly different from usual CAD system. It is a CAD system integrated with a very high resolution plotter. CAD systems manufactured by Gerber Garment Technology (GGT), a US-based company, are very popular in India. Fourteen sample firms were using the GGT system.

[1] Bachelor of Law
[2] Chartered Accountant
[3] Bachelor of Engineering
[4] Master of Business Administration

However, a few sample firms were using simple CAD system. The firms that were involved in the manufacturing of garments with embroidery works were using IT at the assembly stage. The IT-based system used for embroidery work consists of a very high resolution CAD system integrated with a scanner. Many of the sample firms were using the Integrated Management Information System (IMIS) for office automation. Five sample firms were not using IT even for office automation

Firms were also using e-mail and internet facilities to get the latest market trends and to download the designs provided by the foreign buyers. Government of India has encouraged access to the internet by providing such facilities at a very nominal cost. It was found to be very useful for smaller firms that could not afford e-mail and internet at their plant premises. Internet facilities in Delhi are provided by Apparel Export Promotion Council and in Trippur by National Informatics Centre. Firms were categorised in three groups depending on the intensity of IT use. Firms that were not using IT even for office automation were given the lowest rank, i.e., 1 and are identified as non-IT firms. Firms that were using IT only in non-production activities were assigned a higher rank than non-IT firms, i.e., 2 and will be called as IT-n firms. Firms that were using IT tools in production as well as non-production activities were assigned the highest rank, i.e., 3. These firms will be referred to as IT-p firms.

The MDs of several firms stated that they also had a plant at Trippur and Bangalore and that the pattern of IT adoption does not differ significantly between the garment manufacturing clusters in India. Therefore, sample firms may be treated as representative of Indian garments manufacturing firms. We now precede to discuss the characteristics of domestic and export-oriented firms.

As mentioned earlier, sample firms were categorised in three groups depending on their market preferences. Thirty-three firms (44.6 %) were DMOUs whereas only two firms (2.7 %) were dealing in domestic, as well as export markets. The remaining thirty-nine firms (52.7 %) were EOUs. Analysis of variance of quantitative variables used in the analysis is shown in Table 1.

Table 1: Analysis of variance of the variables

Variables	Mean / (SD)			F-Statistics	Sig.
	DMOUs	DMEOUs	EOUs		
Investment on IT (in Rs.)	52755 (21652)	95900 (9050)	123189 (61820)	19.639	0.000
Wage rate (in Rs.)	2222.22 (497.93)	2807.69 (199.44)	2662.78 (995.31)	2.882	0.063
Raw material expenditure (% to the total manu-facturing expenditure)	53.87 (62.87)	57.29 (18.18)	58.34 (9.34)	2.784	0.069

Table 1 shows that the average investment on IT by EOUs is higher than the DMOUs. DMOUs average investment was Rs. 52,755/- while that of EOUs was Rs. 123189/-. It can also be seen from Table 1 that the difference in the mean value of investment on IT is highly significant (F-statistics: 19.639). This evidence suggests that the export-oriented firms spent significantly higher amount on IT activities than the firms doing business in the domestic markets.

It can be seen from Table 1 that the average wages paid by EOUs were higher than those were in DMOUs. However, it is found that the average wages paid to a worker by firms that were present in domestic as well as in international markets was higher than that paid by the EOUs. This is because one of the two such firms had just entered into the exports market. The firm tried to attract the best workers by offering them higher wages than what they were getting elsewhere. It was found that the firm was successful in attracting the qualified persons from other export-oriented firms. This further indicates that workers were better rewarded by export-oriented firms.

Table 1 also presents the pattern of quality of raw material used by firms. The quality of raw material is measured as percentage expenditure on raw material to the total manufacturing expenditure. Table 1 shows that average expenditure on raw material by EOUs is the highest. In formal wears, the expenditure on raw material, which is a proxy of quality, is very important particularly for export-oriented firms. It can be seen from Table 1 that F-statistics (2.784) of the difference in mean value of ratio of raw material to total manufacturing expenditure is also significant.

The pattern of adoption of IT tools and export performance is presented in Table 2. It can be seen from Table 2 that one EOU was not using IT even for office automation. This was actually a trading firm and was not involved in manufacturing activities. Although, the MD of

the firm was a very qualified person, the firm had very few employees. The firm was new and was in the process of acquiring an MIS system.

Table 2: Level of IT adoption and exports intensity

Level of IT Adoption	**DMOUs**	**DMEOUs**	**EOUs**	**Total**
Non-IT firms	4 (12.12)		1 (2.56)	5 (6.8)
IT-n firms	29 (87.88)	2 (100)	24 (61.54)	55 (74.3)
IT-p firms			14 (35.90)	14 (18.9)
Total	33 (100)	2 (100)	39 (100)	74 (100)

Note: numbers in parentheses show the column percentage.

It is evident from Table 2 that the intensity of IT use by EOUs is higher compared to DMOUs. Table 2 shows that DMOUs were either non-IT firms or using IT only in non-production activities. Whereas all extensive users of IT, i.e. IT-p firms, were EOUs.

As garments is a fashion industry, the design of garment changes very fast. What was popular in one season may not be liked by the fashion-conscious in the next year. Therefore, it was considered important to analyse the impact of flexibility in garments' design on the export performance of firms. Flexibility in designs however, can not be quantitatively measured. Therefore, the MDs were requested to express their opinions on the importance of flexibility in designs. Their opinions are presented in Table 3.

Table 3: Importance assigned to flexible designs

Flexibility in Product Design	**DMOUs**	**DMEOUs**	**EOUs**	**Total**
Not-important	8 (24.24)	1 (50.00)	9 (23.08)	18 (24.3)
Important	20 (60.61)	1 (50.00)	22 (56.41)	43 (58.1)
Very Important	5 (15.15)		8 (20.51)	13 (17.6)
Total	33 (100)	2 (100)	39 (100)	74 (100)

Note: numbers in parentheses show the column percentage.

Table 3 shows that the MDs of majority of DMOUs and EOUs considered that flexible designs are either important or very important for their business, However, a significant percentage (24.08) of MDs of EOUs did not consider that the flexibility in garments' design is important. Most of these EOUs were dealing in informal wear and flexibility may be irrelevant for them. Therefore, they did not consider flexibility an important characteristic that affects the performance.

3 Hypotheses

On the basis of the previous discussion, we now proceed to formulate the hypothesis with respect to the variables considered in this paper.

3.1 Degree of IT adoption (IT-LEVEL)

Two estimates of this variable have been considered in the analysis. One is the investment on IT while the other is IT intensity dummy. The dummy variable is defined as:

$$\text{IT-DUMMY} = \begin{cases} 1 & for\ \ IT-p\ \ firms \\ 0 & o/w \end{cases}$$

The model discussed in Section I showed that the adoption of a more advanced IT tool did result in an inward shift of the isoquant curve of export-oriented firms. This in turn enables the firms to remain globally competitive and improve or retain their market share in international markets. The effect of technological progress on international trade has been incorporated in trade models in recent years (Posner, 1961; Hufbauer, 1966; Dosi et al., 1990; Wangwe, 1992; Krugman, 1979; Cimoli, 1988). Technology variables that were included in the factor proportion trade models have generally emerged as very important in influencing the trade patterns. However, scholars have considered different indicators of technology. Stem and Maskus (1981) used the ratio of R&D expenditure to value added as a proxy of the technology variable and Soete (1981) used the number of patents as the technology variable; whereas Wakelin (1997) considered number of innovations of the firm as an indicator of the advanced technology used by the firm. All the three studies, however, found technology to be of considerable importance in explaining the export performance of firms. In view of the theoretical and empirical evidence, it is hypothesised that the degree of IT adoption is likely to influence the export performance of firms.

3.2 Wage rate (WRATE)

The theoretical model presented in Section I suggests that wage rate is likely to be significantly different between EOUs and DMOUs due to a difference in the skill levels. Several empirical studies (Bernard and Jensen, 1997; Francois and Nelson, 1998) show that the export-oriented firms pay higher wages than others to attract more skilled workers. It is argued by Bernard and Jensen (1997) and Francois and Nelson (1998) that trade is linked with wage movements. Bernard and Jensen (1997) found that the wage gap played a significant role for trade in the US manufacturing firms. In Indian context and particularly in the garments

manufacturing sector, a wage gap is likely to have bearings on the export performance. The designer's creative input makes a visible difference in the final product. Therefore, EOUs employ those designers and graders who have the best creative skills. Consequently, they have to pay much higher wages to such employees as compared to DMOUs. The high turnover of persons having creative skills is another reason for higher wages paid by the firms. Therefore, we expect a close relationship between wages and the export intensity of firms.

3.3 Quality of raw material (RAWMAT)

In a recent study of export behaviour of Mexican manufacturing firms by Aitken et al. (1997), it is found that cost of raw material was a significant factor that influenced the decision of firms whether to export or not. Moreover, the theoretical framework presented in Section I is based on the assumption that EOUs and DMOUs use different qualities of raw materials. During survey of the firms, it was noticed that the quality of raw material is determined by the buyers. Foreign buyers in the global market decide the quality of fabric, whereas the market preferences (low-income and high-income markets) of the entrepreneur determine the type and quality of the raw material in the domestic markets. Besides fabric quality, foreign buyers many times insist on specific imported accessories such as that of the button and thread to be used in the formal wears. Differences in the quality of raw materials will substantially change the cost of production. Consequently, the isoquant curves of EOUs and DMOUs will differ significantly. Therefore, as discussed theoretically, a positive relationship between export intensity and the expenditure on raw material is hypothesised.

3.4 Education Levels (EDU-LEVEL)

This variable was measured as a ratio of the degree/diploma holders to the total employees of the firm. Employees having a postgraduate, CA, MBA degree, and diploma from an institute of fashion technology were considered under this category. There is a vast literature available that deals with the employment of qualified workers and the performance of firms (Thatcher, 1978; Prais, 1981; Bernard and Jensen, 1997). It is found in all these studies that export-oriented firms employ more qualified workforce. In view of the empirical evidence, it is expected that the education level of employees is likely to play an important role in influencing the export performance of firms.

3.5 Labour productivity (LABPROD)

During the survey of firms it was found that many firms were involved in subcontracting. Therefore, the labour productivity was computed as the ratio of value added to the total employment. In a recent study by Robert and Wright (1998), it was found that UK has given stiff competition to developing countries by augmenting the productivity of manufacturing

sector. The authors suggest that the developing countries' firms need to improve their productivity in order to maintain their share in the international market. The main source of productivity gains is the acquisition and use of new technologies. Wakelin (1997) found that labour productivity was positively related to exports. As argued in the theoretical framework presented in Section I and in view of the findings of these studies, we expect that the export-oriented firms are likely to be more productive.

3.6 Size (SIZE)

Sales turnover has been used as a proxy of size in export-related studies. In this study, we can not consider sales turnover as a representative of size since many sample firms were found to be engaged in subcontracting. Therefore, number of employees has been treated as a proxy of size. Export-size relationship has been studied by many scholars (Wakelin, 1997; Kumar and Siddharthan, 1994; Willmore, 1992; Hughes, 1986; Lall, 1986). The findings of these studies have been mixed. Hughes (1986) found a linear size-export performance relationship to be significant. Whereas Willmore (1992), Wakelin (1997) and Kumar and Siddharthan (1994) found an inverted-U shaped relationship. As rightly argued by Kumar and Siddharthan (1994), the emergence of an inverted-U shaped relationship could be attributed to the oligopolistic hold of very large firms in the domestic market. Garments manufacturing, being a low-tech industry, is dominated by SMEs in India. In absence of large firms in this industry, we hypothesise a linear size-export performance relationship.

3.7 Opinion variables (OPINIONS)

Entrepreneurial abilities were also considered to be important factors that could influence the export performance of firms. The opinion of MDs about the importance of 'fabric use advantage of IT', 'flexibility in product design', 'international competition', and 'delivery schedule' were considered as proxy of entrepreneurship. These variables have been found as very important in the international trade of garments (Hoffman and Rush, 1988). We also hypothesise that entrepreneurial attitude might influence the export performance of firms.

To assess empirically the effect of the variables discussed above on the export performance, we use the following form of export function:

$$EXi = f(IT\_LEVELi, EDU\_LEVELi, LABPRODi, WRATEi, (RAWMATi/STOi), SIZEi, OPINIONSi) \quad (1)$$

Following several studies (Aitken, 1997; Moreno, 1997; Hughes, 1986), the form of the export function used in this study is presented in Equation 2.

$$EXi = a + b1\ log(IT\_LEVELi) + b2\ log(WRATEi) + b3\ log(RAWMATi/STOi) + b4\ log(FLEXi) + ei \quad (i=1,nf), \quad (2)$$

Where,

nf ----------> No. of sample firms
STOi ----------> Sales turnover
EXi ----------> Export intensity
IT_LEVELi-----> Level of IT adoption
WRATEi -------> Monthly wages paid
RAWMATi------> Expenditure on raw material
FLEXi----------> Flexibility in designs

4 Statistical Analysis and Interpretation of Results

The variables were analysed by applying a censored regression model, i.e. TOBIT. Censored regression model was used because the dependent variable, i.e. export intensity has values between 0 and 1. Export intensity was computed as the ratio of exports to the total sales turnover. The correlation matrix of all the variables is presented in Appendix II. Table 4 presents the estimation of equation 2 using TOBIT technique. Another equation was estimated by replacing IT-DUMMY with investment on IT. The results of the estimates are presented in Appendix I.

Table 4: Maximum likelihood estimated of TOBIT model

Variable	**Coefficient**	**T-ratio**	**Significance**	**Variable Label**
IT-DUMMY	0.80268	4.062	0.00005	Level of IT adoption
RAWMAT	1.48140	2.559	0.01051	Quality of raw material
FLEX	0.60270	2.510	0.01207	Flexibility in design
WRATE	0.64418	2.371	0.01773	Wages per month
Log-Likelihood -60.70238				

It can be seen from Table 4 that the intensity of IT adoption has played a significant role in influencing the export performance of firms. Wakelin (1997) argued and found that export performance is determined by the firm and industry-specific characteristics. The arguments neither dispute the factor intensity theory nor challenge the theory of comparative or competitive advantage. However, technological innovations and adoption have been widely used to explain the variations in export performance. For instance, in science-based sectors innovative capabilities are very important, whereas in labour-intensive industries such as footwear and clothing, the adoption of new technologies plays a crucial role (Dosi et al., 1990; Abd-el-Rahman, 1991; Pavitt, 1984; Hirsch and Bijaoui, 1985; Freeman, 1982, and many others). Therefore, considering the labour-intensive nature of the garments industry, the findings of this study are in line with the existing literature that explains the differential trade performance in terms of technological capabilities.

Table 4 shows that export performance was influenced by the expenditure on raw material. A higher expenditure on raw material implies the better quality of raw material. The quality of raw material is viewed as a representative of product quality in the garments industry (Hoffman and Rush, 1988; Keesing and Wolf, 1981). Product quality in general has bearings on the exports performance (Cohen, 1975). In the garments industry, sometime foreign buyers insist on a particular type of fabric that is not manufactured in India. EOUs are then compelled to use the imported fabric and other raw materials. Firms in domestic market do not encounter these problems. NEDO (1971) and Keesing and Wolf (1981) predicted that the "garments manufacturing industry may experience a shift from developed to developing countries as developing countries have an advantage of abundant unskilled workforce. The quality of fabric, however, would determine their share in the international market". The findings of this study support these arguments.

The impact of wage differences on export performance has been analysed by several scholars (see among others Wakelin, 1997; Bernard and Jensen, 1997). These studies concluded that export-oriented firms pay higher wages than others. Bernard and Jensen (1997) included apparel-manufacturing firms of the US in their sample. The findings of this study are similar to the other studies mentioned. Wage differences in Indian garments manufacturing can be attributed to the unique skill embodied in the designers employed. Designers, pattern makers, and graders are generally the persons who have inherited this profession. These activities involve the creativeness of unique individuals. Therefore, the demand for a very high salary exists. EOUs can not afford to lose such persons as they have to meet the foreign buyers' demand within a stipulated period. Although garments manufacturing firms in India very rarely use IT in the assembling of garments, highly efficient tailors are employed by EOUs to ensure that no stitching faults occur. Consequently, EOUs have to pay higher wages to their employees.

The results also show that the MDs of EOUs considered the flexibility in garment designs as very important. This is quite obvious as the design of garments in international market changes much faster than in the domestic market. Flexibility in the garment's design depends on the technology used at the grading and marker making stage of manufacturing. Firms that use IT based grading and marker-making system can achieve the highest flexibility in design. The graded patterns of the garments are traced on the paper mounted on the plotter. The grader can easily change the design and pattern on the monitor of the CAD system and new designs can be traced by pressing a few sequences of the keystrokes of the system. Whereas in the manual process, the graded patterns are traced on the cardboard which is then cut along the traces of the pattern. It is very difficult and costly to change cardboard markers frequently. Consequently, firms that use cardboard markers can not alter the garment design frequently. In contrast, EOUs can not survive with a manual process of marker making as flexibility is very crucial for them. Significant contributions of CAD in flexible product designs have been found by many scholars (Haffman and Rush, 1988; Lal, 1996; Faulkner, 1980).

5 Conclusion

The study identified and analysed the factors that influenced the export performance of garments manufacturing firms in India. The data for the study come from 74 garments manufacturing firms located at Okhla in the national capital Delhi. All firms located at Okhla were approached. However, we could get data from 74 firms out of total 106 garments manufacturing firms. Although, there are four major garments manufacturing clusters in India, the pattern of IT adoption is likely to be the same in other clusters. This was reported by many sample firms that had a plant in other clusters also. Therefore, the sample may be treated as representative of Indian garments manufacturing firms. A semi-structured questionnaire was prepared to collect historical, financial, employment, and technological data of firms. Data on performance and international orientation were also collected. The addresses of the firms were taken from a directory published by the Okhla Entrepreneurs Association. The survey was conducted during September 97 to February 98. Qualitative data that represent the entrepreneurial abilities of MDs were also collected. Prior appointment was taken with the MDs before visiting the firms.

The censored regression model, i.e. TOBIT was used to analyse the export behaviour of sample firms. TOBIT model results show that the intensity of adoption of information technology emerged a significant variable that influenced the export performance of firms. Export-oriented firms might have adopted more advance information technology tools to achieve greater flexibility in garment designs and to manufacture international quality products. The other variables that played an important role in augmenting the exports of firms were the expenditure on raw material and the wage rates. Expenditure on raw material was used as a proxy of product quality. TOBIT results show that the importance given by the Managing Directors to flexibility in product designs was also significant. The results of the study support the findings of earlier studies (Soete, 1987; Hoffman and Rush, 1988; Bernard and Jensen, 1997).

The study concludes that Indian garments manufacturing firms should adopt the latest information technology tools available in the world market. This is crucial to remain internationally competitive. At present, 74 percent of the total exports account for quota countries (WTO annual report 1996). These markets are protected by the Multi-Fibre-Arrangement for Indian products. However, this protection will no longer be available once WTO recommendations are in place. The relevance of information technology based production systems will increase in the WTO regime. One way to face these challenges is through a higher degree of adoption and use of information technology.

Appendix

Table I: Maximum likelihood estimated of TOBIT model

Variable	Coefficient	T-ratio	Significance	Variable Label
IT_INVESTMENT	0.07745	1.727	0.08415	Level of IT adoption
RAWMAT	1.34760	2.103	0.03549	Quality of raw material
FLEX	0.58923	2.128	0.03337	Flexibility in design
WRATE	0.59078	1.918	0.05516	Wages per month
Log-Likelihood -66.95676				

Table 2: Correlation matrix

	EXP-INT	IT-ACT	WRATE	FLEX	RAWMAT	IT-INV
EXP-INT	1.00					
IT-ACT	0.455284					
WRATE	0.261437	0.202945				
FLEX	0.355836	0.395481	0.088134			
RAWMAT	0.265657	-0.07146	-0.11125	0.166582		
IT-INV	0.594707	0.721605	0.236995	0.471776	0.05729	1.00

References

Abd-el-Rahman, K., 1991, 'Firms' Competitive and National Comparative Advantages as Joint Determinants of Trade Composition', *Weltwirtschaftliches Archiv*, 127(1): 83-98.

Aitken, Brian, Gordon H. Hanson and Ann E. Harrison, 1997, 'Spillovers, foreign investment, and export behaviour', *Journal of International Economics*, 43: 103-32.

Bernard, A. B. and B. Jensen, 1997, 'Exports, skill upgrading, and the wage gap', *Journal of International Economics*, 42: 3-31.

Brynjolfsson, E. and Hitt, L., 1996, 'Paradox Lost? Firm-level Evidence on the Returns to Information System Spending', *Management Science*, 42(4): 541-58.

Cimoli, M., 1988, 'Technological Gaps and Institutional Asymmetries in a North-South Model with a Continuum of Goods', *Metroeconomica*, 39: 245-74.

Cohen, B., 1975, *Multinational firms and Asian Exports*, New Haven: Yale University Press.

Dosi, G., Keith Pavitt and Luc Soete, 1990, *The Economics of Technical Change and International Trade*, London: Harvester Wheatsheaf.

Doms, Mark, Timothy Dunne, and Kenneth R. Troske (1997), 'Workers, Wages, and Technology', *The Quarterly Journal of Economics*, CXII: 253-90.

Faulkner, H. W., 1980, *The Apparel Industry's' Self-Revival*, Boston: Applied Technology Management.

Francois, J. F. and Doulas Nelson, 1998, 'Trade, Technology, and Wages: General Equilibrium Mechanics', *The Economic Journal*, 108: 1483-99.

Freeman, C., 1982, *The Economics of Industrial Innovation*, 2nd edn, London: Pinter.

Greenan, N. and J. Mairesse, 1996, 'Computer and Productivity in France: Some Evidence', *NBER Working Paper*, no. 5836, November.

Harrigan, J., 1995, 'Technology, Factor Supplies and International Specialisation: Testing the Neo-classical Model', mimeo, University of Pittsburgh, June.

Helleiner, G. K. (ed), 1995, *Manufacturing for Exports in the Developing World: Problems and Possibilities*, USA and Canada: Routledge.

Hirsch, S. and I. Bijaoui, 1985, 'R&D Intensity and Export Performance: A Micro View', *Weltwirtschaftliches Archiv*, 121: 138-51.

Hoffman, Kurt and Howard, Rush (1988), *Micro-electronics and Clothing : The Impact of Technical Change on a Global Industry*, New York and London: Praeger.

Hufbauer, G.C., 1966, *Synthetic Material and the Theory of International Trade*, London: Gerald Duckworth.

Hughes, Kristy, 1986, *Exports and Technology*, London and New York: Cambridge University Press.

James, Jeffrey, 1994, 'Microelectronics and the Third World' in Charles Cooper (ed.) *Technology and Innovations in the International Economy*, Tokyo: United Nations University.

Kaplinsky, R., 1982, *Computer-Aided Design: Electronics, Comparative Advantage, and Development*, London: Frances Pinter.

Keesing, D.R. and M. Wolf, 1981, 'Questions on International Trade in Textiles and Clothing', *The World Economy*, 4(March): 79-101.

Kraemer, K. L. and J. Dedrick, 1994, 'Payoffs from investments in information technology: Lessons from the Asia-Pacific Region', *World Development*, 22(12): 1921-31.

Krugman, Paul, 1979, 'A Model of Innovation, Technology Transfer and the world Distribution of Income', *Journal of Political Economy*, 87: 253-66.

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

Lal, K. ,1996, 'Information Technology, International Orientation and Performance: A Case Study of Electrical & Electronic Goods Manufacturing Firms in India', *Information Economics and Policy*, 8(3): 269-80.

------- ,1998, 'The Adoption of Information Technology and its Consequences : A Case Study of Indian TV Manufacturing Firms', *Science Technology & Development* 16(1): 81-100.

------- ,1999, 'Determinants of the Adoption of Information Technology: A Case Study of Electrical and Electronic Goods Manufacturing Firms in India', *Research Policy*, Forthcoming.

Lall, Sanjaya, 1986, 'Technological Development and Export performance in LDCs: Leading Engineering and Chemical Firms in India', *Weltwirtschaftliches Archiv*, 122: 80-91.

Lichtenberg, F., 1995, 'The Output Contribution of Computer Equipment and Personnel: A Firm Level Analysis', *Economics of Innovation and New Technology*, 3(3-4): 201-17.

Moreno, Lourdes, 1997, 'The determinants of Spanish industrial exports to the European Union', *Applied Economics*, 29: 723-32.

NEDO (National Economic Development Organisation), 1971, *Technology and Garment Industry*, London: NEDO.

Noland, Marcus, 1997, 'Has Asian export performance been unique?', *Journal of International Economics*, 43: 79-101.

Pavitt, K., 1984, 'Sectoral Patterns of Technological Change: Towards a Taxonomy and a Theory', *Research Policy*, 13(6): 343-73.

Posner, Michael V., 1961, 'International Trade and Technical Change', *Oxford Economic Papers*, 13: 11-37.

Prais, S. J., 1981, 'Vocational Qualifications of the Labour Force in Britain and Germany', *National Institute of Economic Review*, no. 98, November.

Robert, C. H. and P. W. Wright, 1998, 'Trade with Low-wage Economies, Employment and Productivity in UK Manufacturing', *The Economic Journal*, 108: 1500-10.

Soete, Luc, 1981, 'A General test of Technological Gap Theory', *Weltwirtschaftliches Archiv*, 117: 638-59.

------- , 1987, 'The Impact of Technological Innovation on International Trade Pattern: The Evidence Reconsidered', *Research Policy*, 16: 101-30.

Stem, R. and K. Maskus, 1981, 'Determinants of the Structure of US Foreign Trade 1958-76', *Journal of International Economics*, 11: 207-24.

Thatcher, A.R., 1978, 'Labour Supply and Employment Trends' in Blackaby, F. (ed.), *De-industrialisation*, London:Heinemann Educational Books.

Trefler, D., 1993, 'International Factor Price Differences: Leontieff Was Right', *Journal of Political Economy*, 101: 961-87.

-------- , 1995, 'The Case of the Missing Trade and Other HOV Mysteries', American Economic Review, 85(5): 1029-46.

Wakelin, Katharine, 1997, *Trade and Innovation*, Cheltenham and Massachusetts: Edward Elgar.

Wangwe, Samuel, 1992, 'New Trade Theories and Developing Countries: Policy and Technological Implications', *UNU/INTECH Working Paper No. 7*, Maastricht: UNU/INTECH.

Willmore, Larry, 1992, 'Transnationals and Foreign Trade: Evidence from Brazil', *The Journal of Development Studies*, 28(2): 314-35.