Link between Exporting and Productivity: Firm Level analysis for Indian Chemical Industry

by

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Paper Submitted for Special Issue of Science, Technology and Society

Abstract

The theory that links exporting behavior and productivity consists broadly of two hypotheses- the 'self-selection hypothesis' and the 'learning by exporting hypothesis'. In the *self-selection hypothesis*, firms that are more productive tend to self-select into the export market. The *learning by exporting hypothesis* posits that firms in export markets see an increase in productivity due to the new knowledge they acquire from international buyers and competitors through contracts and agreements. This study aims at measuring the productivity differentials between exporters and non-exporters for the Indian chemical industry. Also, it tries to investigate if the self-selection hypothesis holds in the Indian context. In order to test the hypothesis, the study uses data collated from the CAPITALINE, a database from Capital Markets. After cleaning the data, the final sample has 120 firms. Exporters consist of a heterogeneous group of firms that are classified as Entrants, Switchers, Continuers and Exiters.

The first objective of the study tests the empirical regularity that exporters are more productive than non-exporters in India. TFP is calculated from the Cobb-Douglas Production function using a fixed effects model. The productivity differential comparison between exporters and non-exporters show that Non-exporters have a higher Total Factor Productivity than Exporters. Though labour productivity is higher in exporters than non-exporters, the yearly averages show that the labour productivity of exporters is converging to that on the non-exporters. In terms of capital productivity, overall averages show that exporters are more productive, but yearly trend shows that capital productivity of non-exporters have overtaken that of exporters over the years. With respect to self-selection hypothesis, the study does not find any evidence for it for the chemical industry. Prior exporting status, size, being part of a group and age are the only factors that induce a firm to go for exporting.

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1. Introduction

The importance of exports in promoting growth and in particular promoting productivity has been debated extensively in the world context (see for example, Balassa 1988; Bhagwati, 1988, Krugman, 1994). For example, part of the South East Asian miracle has been attributed to the aggressive export promotion policies that were practiced by their respective governments. Though, on the issue of total factor productivity, evidence exists that there has not been any significant change in these countries (see for instance, Young, 1994; Krugman, 1994). It was not until a decade ago that Bernard and Jensen (1999) used modern econometric tools to analyze the relationship between trade liberalization and productivity and thereafter opened the floodgates for empirical analysis on the same.

The theory that links openness in trade to increases in productivity consists of broadly two hypotheses- the 'self-selection hypothesis' and the 'learning by exporting hypothesis'. In the *self-selection hypothesis*, firms that are more productive tend to self-select into the export market (Melitz, 2003). It is generally known that firms that sell in foreign market incur costs such as costs of setting up distribution units in foreign markets, transportation costs, production costs in modifying current domestic processes, marketing costs and so on. Hence only more productive firms can become exporters. On the other hand, the *learning by exporting hypothesis* posits that firms in export markets see an increase in productivity due to the new knowledge they acquire from international contracts and agreements. This means that there is flow of knowledge between international buyers and competitors in the foreign markets to exporters in the domestic markets that lead to increase in productivity (Grossman and Helpman 1991). This flow of knowledge may occur due to exchange of technology, importing of skills, availability and access to new forms of management and so on. This theory would imply that exporters would continuously pull away from non-exporters in terms of productivity.

In addition to these hypotheses, a heterogeneous group of studies that have shown that exporters tend to have better survival rates, they employ more factors, pay higher wages, tap the skilled labour market more intensively and tend to grow faster on average than non-exporters (see for example, Bernard and Jensen (1999, 2004) among others). Also, some studies show that there is a positive externality of having more exporters on domestic markets as well, making export promotion a popular policy for most nations (see for example, Clerides, Lach and Tybout, 1998 among others).

In search of this microeconomic phenomenon, most studies have been conducted on a panel data of firms. A larger proportion of the studies are conducted on developed nations. Aw, Chung and Roberts (1995), Bernard and Jensen (1999), Dremeir, Iarossi and Sokoloff (2002), Baldwin and Gu (2003) and Farina and Marcos (2005) have shown that the self-selection hypothesis holds across the firms studied in various industries and across nations. This tells us that more productive firms world over will self-select into the export markets. The export market becomes a potent market for competition and survival of the fittest.

The evidence of the learning effects in these studies is however mixed. A study by Clerides, *et al*. (1998) does not find evidence for learning effects. However, studies by Baldwin and Gu (2003) and Greenway and Yu (2005) find the presence of learning effects. The selection of industries, the choice of commodities exported, and the countries that exporters export to can be various factors that affect the learning in that industry. For example, an industry such as the chemical industry that trades with the OECD countries will be an effective source for learning since the markets will demand that firms are cost efficient, quality conscious and technologically advanced.

All the studies that have been reviewed have found evidence that Exporters are more productive than Non-Exporters. Within the domestic economy, access to foreign technology,

rate of diffusion of technology and information within the economy, policies instituted by the government can be some additional factors that contribute to differences in productivities between Exporters and Non-Exporters.

In the Indian context, the 1990s liberalization has led to many structural changes in the economy. The once closed economy has now seen an increase in volume of trade, inflow of Foreign Direct Investment and Foreign Institutional Investment, entry of Multinational firms and so on. Liberalization has not only made imports cheaper but it has also forced firms to look for avenues outside the country. With more Indian firms expanding their operations across the world, greater outsourcing, exports have seen a phenomenal increase in the last decade.[1] One is motivated to question - which kind of firms venture out? Are there some benefits from exporting for Indian exporters such as leading to economies of scale which finally resulting in increases in productivity or are there some other factors that are motivating them? Until now, there has been no published study in India that tries to examine if there are differences in productivity between Indian exporters and Non-Exporters. Consequently, there has been no study verifying the *self-selection* or the *learning by exporting* hypotheses.

Under this backdrop this study will try to measure the productivity differentials between exporters and non-exporters in the Indian Chemical Industry. In addition it will attempt to see if the self-selection hypothesis holds in the Indian context, as found in large number of other countries. The chemical industry has been chosen because of its export intensity. The export of the Chemical industry is given a weight of 15% in the country's exports and is 7th in the overall ranking of exports. The industry is also technology-intensive. The third reason to why there is a focus on a particular industry within the manufacturing sector is to avoid any potential bias that might arise due to possible links between exporting and productivity (Greenway and Yu, 2005).

The remaining paper is divided as follows: Section 2 reviews the literature. Section 3 gives the methodology of the paper. This is followed by a description of the data and variables in Section 4. Section 5 provides the results and the interpretation of the econometric analysis. Section 6 summarizes the study and put forth some of the policy implications of the study.

2. LITERATURE REVIEW

There have been extensive studies carried out across countries, both developed and developing countries, which examine the relationship between productivity and participation in the export markets. In order to estimate the productivities of firms most studies have used Cobb-Douglas production function to estimate the value of productivity. Labor productivity controlled for capital labor ratios has also been used as a measure of total factor productivity. An exception to using productions functions to estimate productivity is the Clerides, Lach and Tybout (1998) paper, which uses an average cost function as a measure for factor productivity.

Clerides *et al.* (1998) study tries to examine if there is an association between exporting and efficiency reflected as a 'causation flowing from exporting experience to improvements in productivity', i.e. they test for the presence of learning effects. Using average variable costs as a measure for factor productivity, they analyze a panel data of firms from Columbia, Morocco and Mexico. Their analysis shows that there is no evidence of learning by exporting in other words there is no evidence for the presence of learning effects that might have helped

[1] The data shows that the manufactured exports as percentage of GDP which were 2.6% in 1980-81, rose to 4.2% in 1990-91 and thereafter increased to nearly 7% by 1996-97 (Sharma, 2000). Similarly, exports which were 4.7% of GDP in 1990-91 rose to nearly 20% by 2003-04. In terms of average growth during the period, exports growth between 1990 to 2004 was 20% against GDP growth of 6%.

exporters becoming more productive than non-exporters over time. However, they show that more efficient firms self-selected into the export markets. The study also shows that the presence of exporters helped domestic firms break into the export markets more easily since there was some externality spill over into the domestic markets.

The study by Bernard and Jensen (1999) uses a panel data model to show that exporting firms exhibit little evidence of increases in their productivity, meaning there were no learning effects in the export markets. However the export markets provide more opportunities for more productive firms. They also find that some exporting firms grow no faster and sometimes even slower than non-exporters. Hence exporters do not have any major advantage over non-exporters. One of their major findings is that exporters have a greater probability of plant survival and their failure rates are lower than non-exporting firms.

Dremeir, Iarossi and Sokoloff (2002) use a cross section analysis of firms in five south East Asian countries (Korea, Thailand, Malaysia, Indonesia and Philippines) to analyze if firms make a conscious decision to increase their productivity before they enter export markets. They find that firms make a conscious decision to improve their productivity and then are able self-select into the export markets. Their analysis has an important policy implication. They discover that if an economy is less industrialized and more protected, an increase in the openness of the markets would increase productivity very rapidly in the initial stages of development. Thus new economies have the advantage of faster growth through openness.

Baldwin and Gu (2003) examine the relationship between the productivity of a manufacturing plant and its participation in export markets using a panel data of plants in the Canadian manufacturing units. They find that more productive firms expand into the export markets and less productive firms remain as non-exporters. More importantly their study is one of the few, which establishes that participation in the export market will lead to further increase in productivity, as they find evidence for the learning effects. In addition to these results they determine that older plants tend to be more productive than new plants in the export markets. However, it is the younger plants that exhibit faster increase in productivity than the older firms. The latter result is also consistent for domestic vs. foreign firms.

The study by Greenway and Yu (2005) use a linear probability model with fixed effects in order to analyze the relationship between participation in the export markets and productivity in the technology intensive Chemical industry in the U.K. Their study finds that while exporter and non-exporters do not differ significantly in size, exporters tend to be more efficient. Their analysis verifies the self-selection and the learning by exporting hypotheses. The greater the productivity of the firms, the more likely it is that the firm will become a producer in the future and the learning effects also contribute positively to productivity growth for exporters.

Farinas and Marcos (2005) study uses a Cobb-Douglas production function to estimate the productivity of firms. By employing the GMM method of estimation they are able to reduce the heterogeneity bias of the OLS and provide more efficient estimators of the measure of productivity. They establish a relationship between productivity and the time pattern of entry. That is, they are able to establish the self-selection hypothesis. They determine that there is no significant relationship between productivity and the height of the sunk costs in the export markets or the export intensity or the geographical location of the firms.

As can be seen from a brief literature review, most of the studies have been able to show that *self-selection* exists in the market but for *learning by exporting* the results are mixed. In the Indian context, incidentally, no study exists that looks into the self-selection hypothesis or the survivability of exporters in the event of shocks. This paper tries to fill the gap for the former case.

3. Methodology

This section discusses the methodology used to test the proposed objectives. In order to fulfill the first objective, i.e. to check if exporters are productive than non-exporters, a measure of productivity is required. Capital, labour and Total Factor Productivity are the measures used to compare the productivities. The section gives the methodology that has been used for computing Total Factor Productivity. The second objective of the paper is to test for the presence of self-selection in the Indian context. A model for testing this hypothesis is proposed later in the section.

Productivity Measures

In the first objective the study tests whether exporters are more productive than non-exporters. Three measures for productivity are used: Total Factor Productivity, Labour Productivity and Capital Productivity. Capital Productivity is obtained as the ratio of the value of output to the value of physical capital. Labour productivity is obtained as the ratio of the value of output to the number of man-days worked. Total Factor Productivity is obtained from the Cobb-Douglas function specified in the next section.

In order to find the productivity differentials for these measures, a simple average is taken across the various categories and sub-categories of firms by pooling the data for all the firms and years.

Measure of Total Factor Productivity

In order to find the total factor productivity of the firms a Cobb-Douglas production function has been used. Productivity is measured using a production function of the form

$$Q_{it} = A_i (K_{it})^{\beta 1} (L_{it})^{\beta 2} (R_{it})^{\beta 3} (E_{it})^{\beta 4} \quad (1)$$

Where, Q is Value of output, K, L, R and E are Capital, Labour, Raw material and Power and fuel cost respectively, and A_i – Total Factor Productivity when other factors are controlled for.

Taking a log on both sides we get

$$\ln(Q_{it}) = \ln(A_i) + \beta_1 \ln(K_{it}) + \beta_2 \ln(L_{it}) + \beta_3 \ln(R_{it}) + \beta_4 \ln(E_{it}) + e_{it} \quad (2)$$

Where $\ln(A_i)$ (= α_i) represents the total factor productivity of the firm that is specific to it when all other factors are controlled for and e_{it} is the usual noise component.

Methodology to test for the Self-Selection Model

This study follows the skeleton of the Bernard and Jensen (1999) model. Bernard and Jensen (1999) model the decision to export into a binary choice variable model. Exporters will export only if the profits from doing so are non-negative. In other words only more productive firms self-select into the export markets. The model is specified as below -

$$Y_{it} = 1 \quad \text{if } Z_{it} + FY_{it-1} - F + \varepsilon_{it} \geq 0 \quad (3)$$

$$0 \quad \text{otherwise}$$

where Y_{it} and Y_{it-1} is the current and lagged export status. Z_{it} and F are the firm characteristics and the sunk fixed costs respectively. The various firm characteristics that are used as independent variables and influence the decision to export are lagged productivity, age of the firm, size of the firm and a set of group dummies that classify firms according to their ownership. Productivity is measured in terms of labour and capital productivity. Thus the econometric model used is:

$$Y_{it} = \alpha \ln(\text{Productivity})_{it-1} + \beta \ln(\text{Productivity})_{it-2} + \gamma(\text{size})_{it} + \delta(\text{age})_{it} + \theta Y_{it-1} + D_{ij} + \varepsilon_{it} \quad (4)$$

Dependent variable

Binary choice variable that is described as $Y_{it} = 1$ if firm is an exporter, and 0 otherwise. Here it is assumed that firms venture into exporters since there are at least non-negative profits from exporting.

Independent Variables

- *Lagged Productivity Variables* - For the self-selection hypothesis to hold, the sign on the lagged productivity variables should be positive. This would imply that more productive firms self-select into the export markets.
- *Age* - An older firm has the more experience about markets in general and hence more confidence to enter un-chartered territories. Hence it should have a greater probability of entering the export markets.
- *Size* - Size should have a positive effect on the probability of exporting. A larger firm will be able to diversify its risks and hence will be more confident in entering the export market.
- *Lagged Export Status (Y_{it-1})* - If the firm has had experience in the export markets before, re-entering the market should be less costly to the firm. This is because, the firm faces a lower fixed cost when it re-enters the markets. These fixed costs could be set up costs; some trade restrictions imposed by countries, marketing costs to establish one's product and so on. This can be seen from the model proposed by Bernard and Jensen (1999). As per the model, when the lagged export status dummy takes the value of zero, firms are not exporting; these firms face a larger fixed cost of entry than if they were not exporting in the previous year.
- *Group Dummy (D_{ij})* - The group dummy takes the value of one when firm is part of a business group. Most business group in India are diversified and hence their risk sharing ability is higher. They will be able to venture out more aggressively in the foreign markets. Hence we expect the sign to be positive.

The model is estimated as the Probit model for panel data.

4. DATA AND VARIABLES

4.1 Sample Selection

The data set that has been used in this study has been extracted from the CAPITALINE, a database from the Capital Markets. The database provides financial statistics of firms engaged in both manufacturing and non-manufacturing activities. As mentioned earlier, this study has been conducted on the Indian Chemical industry because of their high export intensity and high weight in the country's total exports.

The chemical industry as given in the CAPITALINE consists of 13 subcategories. The key among them are organic chemicals, inorganic chemicals, pharmaceuticals, fertilizers, plastics, soaps and toiletries etc. The total exports of these 13 categories make up close to 46% of the country's Chemical industry export.

The data was extracted for the year 1997 to 2004. The data indicates that there are 282 firms belonging to the chemical industry. The data cleaning involved three stages. This include dropping of firms - a) for which some of the variables were having zero values for some years, b) firms having foreign ownership; and c) firms having govt. ownership. The last two truncation rules were required as a foreign-owned firm may be part of the value chain of the parent firm, having ready access to the already established markets of the parent firm and

would be having sufficient resources to venture abroad. Similarly, for the government-owned firms profit is not the sole objective and these firms often operate on a soft budget – thereby less constrained by the resources. The data cleaning resulted in a final sample of 120 domestically owned firms for which analysis was carried out.

4.2 Construction of variables

Output – Output is measured as the real gross value of output. To convert nominal output to real output, it is deflated using the relevant industry index of Wholesale Prices.

Material – It is calculated by deflating the cost of intermediate inputs by the relevant weighted material cost deflators. The material cost deflators are determined from the Wholesale Price index. The largest firm of each sub-industry, on the basis of sales, was chosen and two of its most extensively used inputs are found. The share of the inputs in the total inputs are then used as the weights for the material cost deflator.

Energy: The total *power and fuel* cost that a firm incurs in a year is extracted from the CAPITALINE database. It is then deflated by the Wholesale Price Index of energy.

Labor – Since annual report data gives only the salaries and wages, not the number of workers, man-days have been computed. The total salaries and wages furnished at the firm level are divided by the average wage rate of the relevant industry to arrive at the total man-days worked in each firm. The wage rate is computed using the 3 digit classification of the NIC from the Annual Survey of Industries and is defined as below,

Average wage rate = Total Emoluments and wages/ Total number of Mandays worked

Capital – The capital stock (GC) of the firm is given in terms of its purchase prices (i.e., the historical cost of the capital). This capital is converted into current prices using the *Perpetual Inventory Method* as has been used by other researchers (see for instance, Kathuria, 2000). To generate the capital stock series, the reported capital stock needs to be converted into constant prices. The Accumulated Depreciation (AD) is used for this purpose. Since the exact age of the capital stock for each firm during 1998-99 is not known, the Average Age (AA) is calculated using the formula -

$$AA = (AD_{98\text{-}99})/GC_{98\text{-}99}*16$$

For accounting purposes, it is assumed that the full depreciation of capital stock takes 16 years, implying that if we assume a straight-line depreciation method, we can say that capital is depreciating at the rate of 6% per annum (Kathuria, 2002). The above average age (AA) is then used to construct a price deflator of capital (CD_i) for each firm in order to deflate capital for the year 1998-99. All deflators are for the base year, 1993-94.

The net capital stock for each firm at constant prices for the first year of the study (i.e., 1998-99) would be

$$NC_{98\text{-}99} = (GC_{98\text{-}99}/CD_{i,AA}) * (1\text{-}0.06)^{AA}$$

Net capital stock for the year 1999-2000 would be

$$NC_{99\text{-}00} = (NC_{98\text{-}99}) * (1\text{-}0.06) + NI_{99\text{-}00}/PC_{99\text{-}00}$$

Where $NI_{99\text{-}00}$ is the Net Investment for the 1999-2000 and $PC_{99\text{-}00}$ is the price deflator for the year 1999-2000 with the base of 1993-94. The capital stock for the rest of the years is computed using the same formula.

Labour Productivity: In theory, labour productivity is the ratio of the value of output to the number of labourers. In other words it is defined as the average productivity of labour with

respect to output. Since we do not have data on the number of workers employed by the firm, we define labour as the number of man days worked.

Capital Productivity: Capital productivity is the ratio of the value of output to the value of physical capital used by the firm. It is also known as average productivity of capital with respect to output.

Exporter: One of the issues in choosing an exporter is that the data shows that there are several firms with negligible exports (say a few lakhs) but are exporting at least in one year. Is it appropriate to call such firms as exporters? Also, there are large sized firms that have export that can be valued in Rs. Crores but the export intensity, measured as the ratio of the exports to the sales of the firm, is less than 1%. Can we classify these firms as Exporters? The present study uses three alternative definitions to classify a firm as exporter. The definition also facilitates testing for the robustness of the results. Table 1 gives the different criteria to classify exporters and Table 2 gives the number of firms falling in each category. As can be seen from the criteria, it becomes stringent as we move from Exporter to Exporter 2 category. Consequently, the number of exporting firms also declines.

Table 1 – Definition of Exporter

Category	Export Value (Lakhs)	Export Intensity
Exporter	>10	>5% in the exporting history of the firm.
Exporter 1	>10	>10% at least once in the firm's exporting history
Exporter 2	>10	>10% at least twice in the firm's exporting history

Table 2 – Number of Exporter and Non-exporter firms from the sample

Category	Number of Firms		
Non Exporter	45	54	58
Exporter	75		
Exporter 1		66	
Exporter 2			62

The next issue in defining exporters is that there are a heterogeneous group of firms that make up the broad category of exporters. Some firms have a long standing history of exports while other have only recently entered. Some firms may be leaving the markets and others can be switching between being Exporters and Non-Exporters depending on macroeconomic conditions. Hence we cannot assume that these exporters behave as a homogeneous category. By separating them out as entrant, continuers, switchers and exiters, we can ensure that we capture the behaviors of each homogeneous group. This will give us a clearer idea about how the productivity of exporters is distributed among these groups. Table 3 gives the criteria for the sub classification of exporters. Table 4 gives the number of exporting firms in each of the sub-classification.

Table 3 – Sub-Classification of Exporter

Group	Sub-Category	Description
1.	Entrants	If they entered the export market anytime after 1995, but stayed till 2004
2.	Continuers	If they were exporting throughout between 1995 and 2004.
3.	Switchers	If they switched between being exporters and non-exporters between 1995 and 2004.
4.	Exiters	If they exited the export markets before 2004.

Table 4 –Number of firms from the sample

Category	Exporter (No.)	Exporter 1 (No.)	Exporter 2 (No.)
Continuer	31	28	28
Entrant	16	15	13
Switchers	12	9	7
Exiter	16	14	12

Lagged Productivity: One and two year lags for productivity are created from the two measures of productivity - labour and capital productivity.

Age of the Firm: Data on the year of incorporation of the firm is extracted from the CAPITALINE database and used in the calculation of the age of the firm.

Size of the Firm: There are different ways to compute the size of the firm. A firm, for example, should not be categorized as a large firm just because it is in the fertilizer segment of the Chemical industry. Size is a relative term. Ideally one should use fixed assets of the firm in relation to the minimum efficient scale of the industry. In the absence of such data, Industry average has been used as a proxy. Data on the fixed assets of the firm are extracted. The industry average (IA) is the average of the fixed assets of all the firms in a given industry. Thus, size of the firm (Size):

$$\text{Size} = \frac{FA_{it}}{IA_t}$$

Lagged Export Status: $Y_{it-1} = 1$ If the firm is an exporter in the previous year
0 otherwise

Group Dummy: The group dummy represents whether a firm belongs to a business group or not. It can be formally defined as Group Dummy = 1 if firm is owned by a business Group, and 0 otherwise

Table 5 gives the descriptive statistics of different variables used in the Cobb-Douglas production function to estimate total factor productivity and variables used in the self-selection model. Columns 2 and 3 compare the values for exporters and non-exporters.

Table 5 – Summary statistics of different variables

Variable Name	All firms	Exporters	Non-exporters
Ln(Value of Output)	19.10	19.72*	18.01
	(1.73)	(1.28)	(1.88)
Ln(Capital)	19.07	19.43*	18.45
	(1.22)	(1.18)	(1.04)
Ln(Labour)	10.26	10.81*	9.31
	(1.60)	(1.34)	(1.56)
Ln(Raw Materials)	18.28	18.89*	17.21
	(1.73)	(1.35)	(1.81)
Ln(Electricity)	15.96	16.50*	15.04
	(1.86)	(1.56)	(1.97)
Size	1.08	1.53*	0.45
	(1.72)	(2.06)	(0.67)
Age (Yr)	22.6	25.4	18.7
	(12.07)	(12.57)	(10.12)
Capital Intensity	32433.8	14284.1	58152.8
	(94821.26)	(27314.2)	(140001.1)
Group Membership (No.)	36	30	6
N	120	75	45

Note: * - indicates the mean value is statistically different for exporters.

From the table, following points emerge clearly: a) the value of output is significantly higher for exporters and that may be the reason for significantly higher use of factor inputs; b) the variation in output or input use is much higher for non-exporters than exporters during the period; c) exporters in general are not only older but also bigger in size; d) nearly half of the exporters belong to some business group; and e) capital intensity of non-exporters is higher than that of exporters – this could be because of inclusion of fertilizer industry in the group.

5. Results and Interpretations

This section summarizes the empirical results of the hypotheses described in Section 3. For the first objective, a panel data model has been used. The firms are categorized and classified into the sub-categories of Non-exporters and Exporters. A comparative analysis of the firm's productivity is made using different measures of productivity. For the second objective, a probit model has been used to test the hypothesis of *self-selection*.

5.1 Productivity Comparison between Exporters and Non Exporters

Table 6 gives the panel data estimation results for Cobb-Douglas production function for both fixed effect and random effect models. The Hausman statistic (row 6) is significant at 5%, indicating the appropriateness of fixed effects model for the chemical industry. This implies that the Fixed Effects are specific to the firm and can be interpreted as the total factor productivity of the firm. The LR test shows that there is heteroscedasticity in the model, which is corrected for using robust standard errors. The Wooldridge test for autocorrelation is not rejected at 10%, showing that auto-correlation is not present in the model.

From the fixed effect results, after correcting for heteroscedasticity, we find that all the input variables are significant and have correct sign. The coefficients are interpreted as the elasticity of the variable with respect to output. Incidentally, raw materials have the highest output elasticity. Since the coefficients of the model add up to a value greater than one, this implies that there are increasing returns to scale in this industry. This is expected as one of the reasons for exporting is economies of scale (Krugman and Obstfeld, 2007).

Table 6 – Cobb Douglas Production Function Estimation Using Panel data

(Dependent Variable: ln(value of output), N = 806)

	Variables	Fixed Effects	Random Effects
1	Ln(Capital)	0.066* (0.032)	0.0189 (0.023)
2	Ln(Labour)	0.321* (0.059)	0.286* (0.024)
3	Ln(Raw Materials)	0.575* (0.056)	0.605* (0.020)
4	Ln(Electricity)	0.225* (0.081)	0.175* (0.019)
5	Constant	0.441 (1.1689)	1.949* (0.433)
6	Hausman Test: chi2(4)	11.47*	
7	LR Test for Heteroscedastcity	$\chi^2(119)= 978.59$	
8	Wooldridge test for autocorrelation	F(1,119) = 2.97*	

Note: * indicates significance at 10% level, Figures in parentheses denotes the standard errors

Summary of Productivity measures

Since the model is a fixed effects panel data model, the individual firm specific effects are extracted using the estimated coefficients. They represent the Total Factor Productivity specific to each firm and are a constant over the years. A simple average is taken over the years and the firms and the TFP is categorized and summarized as below in Tables 7 and 8. Table 7 compares the average TFP of exporters and non-exporters, whereas Table 8 gives the exporter category-wise TFP.

Table 7 – Average Total Factor Productivity for Exporter category

	Non–exporter	Exporter	Exporter1	Exporter2
Number of firms	45	75		
Mean	0. 085* (0.58)	-0.049* (0.43)		
Number of firms	54		66	
Mean	0.051* (0.56)		-0.041* (0.436)	
Number of firms	58			62
Mean	0.069* (0.56)			-0.063* (0.42)

Notes: * indicate significance at 10% level. Figures in parentheses are Standard Deviations

Table 8 – Mean TFP for sub-category of Exporters

Category	Statistics	Continuer	Entrant	Switcher	Exiter
Exporter	Number of firms	31	16	12	16
	Mean	-0.109* (0.293)	0.081* (0.381)	-0.122 (0.53)	0.015 (0.399)
Exporter 1	Number of firms	28	15	9	14
	Mean	-0.122* (0.271)	0.047* (0.368)	-0.059 (0.607)	0.067 (0.399)
Exporter 2	Number of firms	28	13	6	11
	Mean	-0.1221* (0.271)	0.0394* (0.349)	-0.1761 (0.531)	0.0529 (0.413)

Note: Same as Table 7

From Table 7 we can see that Non-Exporters have a higher TFP than Exporters. This is quite surprising. Incidentally, this result is robust as it holds irrespective of how we define exporter in the study. However, when we see the TFP profile across different categories of exporters – continuer, entrant, switcher and exiter, interesting differences emerge (Table 8). Within different categories we find that entrants and exiters have higher productivities than continuers and switchers. This implies that in order to export, firm should have higher productivity, thereby giving support to *self-selection* hypothesis. However, once into export business, there is not much to learn in terms of productivity and if it continues to export, there is a decline in its productivity.

Before we make any firm conclusions that Non-exporters are more productive, we need to look into other measures of productivity as well. This study considers labour productivity and capital productivity as additional measures of productivity. A simple average of these measures across firms and across years for both exporters and non-exporters are given in Table 9.

The table yields a slightly different result. Unlike the TFP case, exporters perform better than non-exporters for both the partial measures of productivity - labour and capital productivity.

The differences are mostly significant in statistical terms. Since the measures of labour productivity and capital productivity are averaged over the entire period, it would be interesting to see how labour productivity and capital productivity have changed over the seven year period. Figures 1 to 3 plot the change in labour productivity profile for three different definitions of exporters. Correspondingly, Figures 4 to 6 give the trend in capital productivity over the period.

Table 9 – Summary of mean of different Productivity Measures

	Non Exporter	Exporter	Exporter 1	Exporter 2
Number of Firms	**45**	**75**		
TFP	0.085* (0.466)	-0.044* (0.381)		
Labour Productivity	9574.05 (9723.85)	10934.08 (15488.24)		
Capital Productivity	1.615* (2.06)	2.02* (1.811)		
Number of Firms	**54**		**66**	
TFP	0.047* (0.458)		-0.035* (0.379)	
Labour Productivity	9173.79* (9259.6)		11445.19* (16305.97)	
Capital Productivity	1.73* (2.19)		1.99* (1.66)	
Number of Firms	**58**			**62**
TFP	0.066* (0.463)			-0.059* (0.362)
Labour Productivity	8929.2* (9025.75)			11814.52* (16728.21)
Capital Productivity	1.71* (2.16)			2.02* (1.652)

Note: same as Table 7

Trends in Labour and Capital Productivity

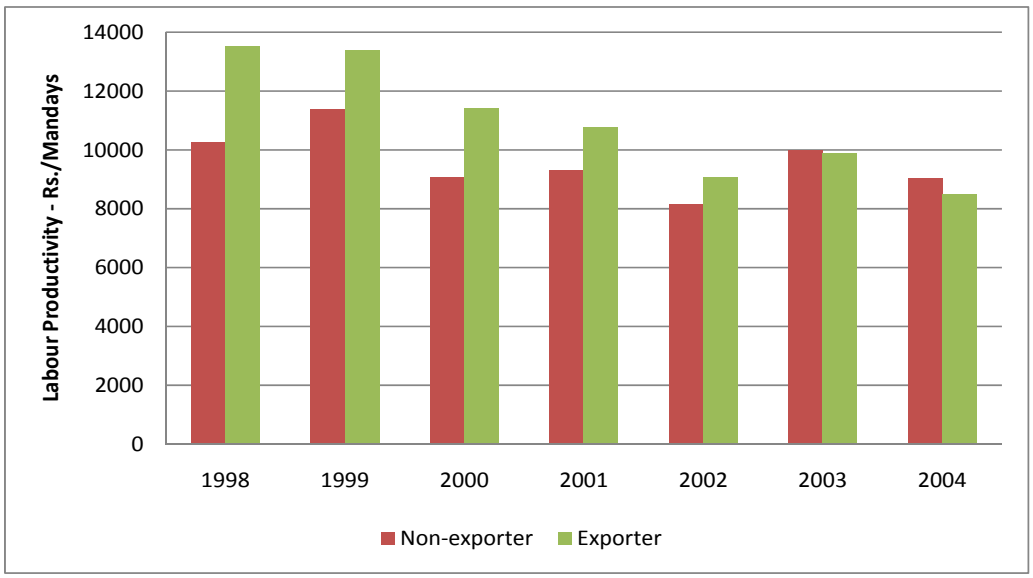

Figure 1 – Labour productivity for Non-Exporters Vs. Exporters

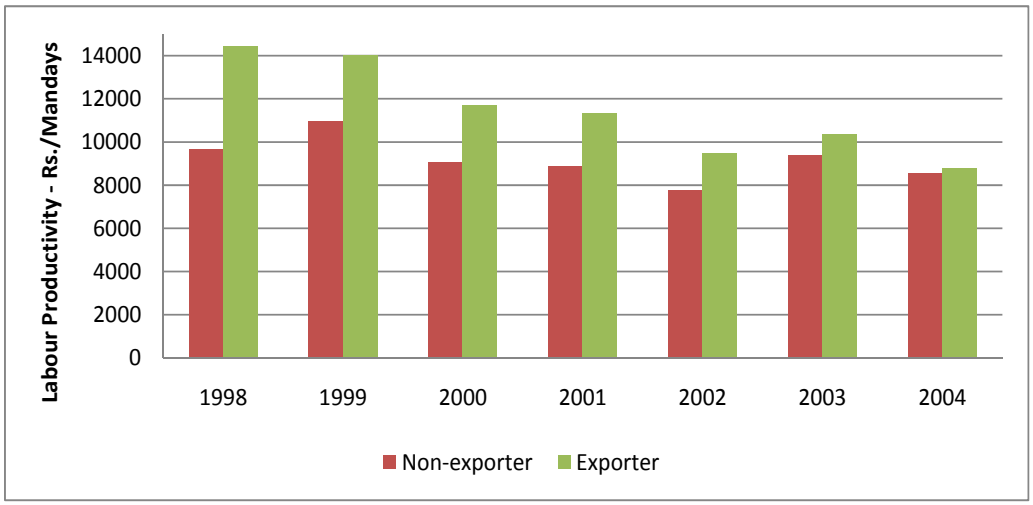

Figure 2: Labour Productivity for Exporter1 vs. Non-exporters1

Figure 3 – Labour productivity for Non-Exporters Vs. Exporter2

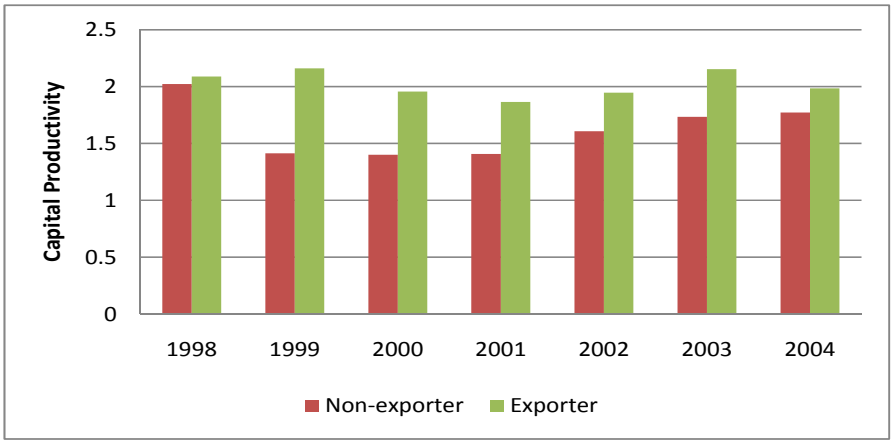

Figure 4 – Capital productivity for Non-Exporters Vs. Exporters

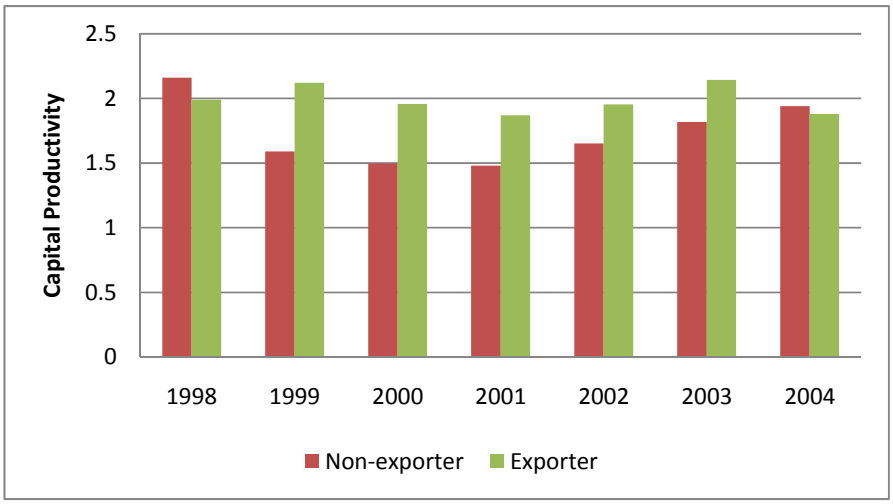

Figure 5 – Capital productivity for Non-Exporters Vs. Exporter1

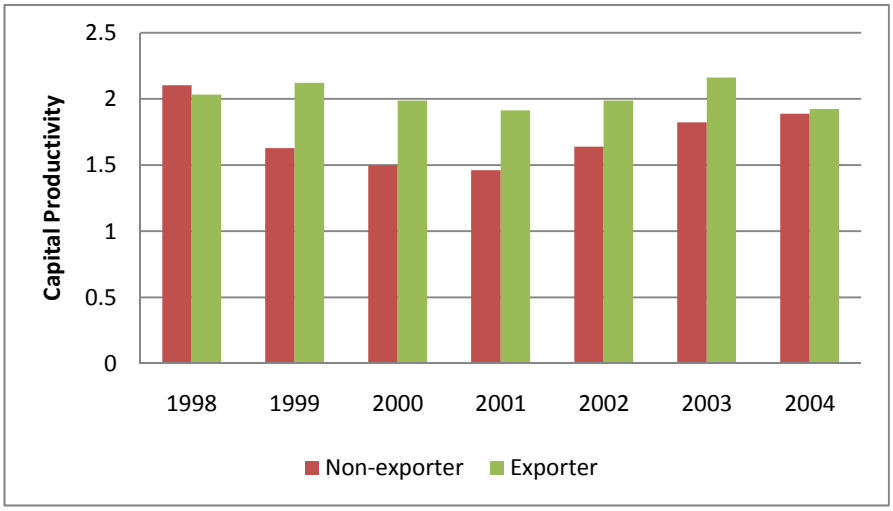

Figure 6 – Capital productivity for Non-Exporters Vs. Exporter2

Figures indicate interesting patterns. From the graphs, we can say that starting from much higher labour productivity levels, the labour productivity for exporters in all the categories has been reducing over time and is converging to the level of Non-Exporters. For Non-Exporters, this value has remained more or less constant over time. Capital productivity for Non-Exporters has been increasing and has become greater than that of exporters. This could imply that exporters are becoming less productive than Non-Exporters. One possible explanation for this is that post 1991 liberalisation, competing in the domestic markets has become tough leading to increased productivity of the firms.

Table 10 gives the different productivity measures for various sub-categories of exporters. The table yields interesting differences. Among the four categories, entrants are found to have highest TFP and capital productivity. This indicates that to enter export market firms need to be more productive. Though these firms are managing their capital better, and have overall productivity, results do not indicate high labour productivity for the group. Surprising, it is the exiters that have highest labour productivity. We do not have any explanation why a group of firms, whose labour is yielding more output per unit of labour has to exit the export market.

Similarly, firms which are continuing to export have not only low capital productivity vis-à-vis entrants but also a negative TFP. Some of these results can be answered when we have more disaggregated that indicating the direction of exports. This is because our conjecture is that to enter export market, firms need to be more productive but once they have entered, there is not much to learn from the export market, if their entry is into countries having same factor proportion as that of India.

Table 10 - Mean of Different productivity measures for various exporter sub-classification

	Continuer	**Entrant**	**Switcher**	**Exiter**
Exporter				
Number of Firms	31	16	12	16
TFP	-0.108* (0.293)	0.081* (0.381)	-0.122 (0.530)	0.015 (0.398)
Labour Productivity	12403.637 (15838.87)	8902.996 (6549.58)	5762.180 (3619.85)	13679.027 (22999.18)
Capital Productivity	1.999 (1.98)	2.264* (1.71)	2.082 (1.84)	1.857 (1.55)
Exporter 1				
Number of Firms	28	15	9	14
TFP	-0.122* (0.271)	0.046* (0.368)	-0.059 (0.607)	0.067 (0.399)
Labour Productivity	12585.471 (16071.03)	7513.647 (4612.37)	5654.131 (3737.12)	14280.811 (24410.12)
Capital Productivity	2.056 (1.98)	2.185 (1.65)	2.090 (1.81)	1.924 (1.61)
Exporter 2				
Number of Firms	28	13	7	12
TFP	-0.122* (0.271)	0.039* (0.348)	-0.176 (0.531)	0.052 (0.412)
Labour Productivity	12585.471 (16071.13)	7456.555 (4736.57)	5477.189 (3714.62)	14628.398 (26320.56)
Capital Productivity	2.056* (1.98)	2.062* (1.67)	1.697* (1.88)	1.915 (1.62)

Note: Same as Table 7.

The results thus differ from what has been obtained by a number of researchers elsewhere. Exporters are not as productive as Non-Exporters. There could be a number of reasons for these results. One reason could be that the Indian market is a more lucrative option for firms. Hence firms that are more productive, exit the export markets and cater to the domestic markets. Over the past 15 years several multinational companies have started participating more aggressively in the Indian market, which has increased the contestability of Indian industry (Kathuria, 2002). Hence it is possible that the benefits from greater productivity lie within the domestic economy.

Also, there may be some government policies that might have made chemical industry less productive in the world markets. For example switchers must be those who are making use of the government incentives by exporting in a few years when government policy is favorable and leaving when it is not. Hence they are least productive under most cases. We, however, need data to substantiate this. In addition, the direction of exports is not known. If exporters have been exporting only to developing countries where price rather than quality decide the amount of sales (Kathuria, 2001), there may be negative spillovers from these countries into the export market. Cost and quality may not be major considerations and hence Indian exporters are getting away with being less productive.

Lastly, there is no disaggregated data on how much the chemical exports contribute to the total exports in diversified firms. Hence though the firms may look less productive in this segment, it could well be that they are more than making up for the inefficient exports in other sectors or industries. For this a lower disaggregation is required but this study does not have access to such data.

5.2 Testing for Self Selection Hypothesis

Table 11 gives the results for the model testing for self-selection hypothesis (equation 4). The study tests for three different variants of the model. In model 1, lagged values of both the partial measures are included, whereas models 2 and 3 include each measure separately.

Table 11 – Testing for Self–selection hypothesis

(Dep. Variable = 1 if exporter and 0 otherwise)

	Variables	Model 1	Model 2	Model 3
1	Export Status$_{i,t-1}$	7.336*** (2.292)	6.922*** (2.375)	6.929*** (2.323)
2	Labour Productivity$_{i,t-1}$	-2.60e-05 (6.74e-05)	-1.80x10^{-05} (6.65x10^{-05})	
3	Labour Productivity$_{i,t-2}$	-5.24e-05 (6.00e-05)	-4.57x10^{-05} (5.30x10^{-05})	
4	Capital Productivity$_{i,t-1}$	0.292 (0.720)		0.324 (0.448)
5	Capital Productivity$_{i,t-2}$	0.223 (0.424)		0.00307 (0.107)
6	Capital Intensity$_{i,t}$	-3.16x10^{-05} (2.20x10^{-05})	-3.40x10^{-05}* (1.74x10^{-05})	-3.09x10^{-05}* (1.79x10^{-05})
7	Age$_{i,t}$	0.293** (0.140)	0.320*** (0.0892)	0.333*** (0.106)
8	Size$_{i,t}$	2.914** (1.451)	2.723** (1.276)	3.245** (1.364)
9	Group Dummy$_i$	8.724*** (2.810)	9.809*** (3.756)	9.210*** (2.676)
10	Constant	-12.19*** (3.473)	-11.68*** (2.796)	-14.25*** (3.281)
11	Observations	510	510	510
12	Number of firms	107	107	107
13	Wald Chi2	38.21*	39.77*	50.09*

Notes: i and t stand for firm and time respectively. Figures in parenthesis are standard errors. *, **, *** indicates significance at 10%, 5% and 1% respectively. Two observations for two different firms had very high Capital intensity – hence had to be dropped.

From the table, we find that both the measures of productivity are not significant irrespective of whether these measures are taken individually or together. This indicates that the productivity is not a consideration for Indian Exporters. On the other hand, exporting in the past induces a firm to export in the current period also. Capital Intensity is significant but with a negative sign. This could be due to overuse of capital by exporters which is causing diminishing returns to this factor of production. Among other variables - Age of the firm, Size of the firm, Group dummy are significant and have expected signs. An older firm is assumed to have more experience and hence a greater confidence to export. Larger firms can share risks from exporting and hence have greater probability of being exporters. The group dummy shows that firms who are owned by groups have a higher probability of exporting. This could be due to group firms having a better ability to share risk from exporting.

To verify the robustness of the results, we test these models for other two definitions of exporters also. Table 12 reports the results. As can be seen from the table, barring results are fairly robust to how we define an exporter. The past productivity is not having any influence on the decision to export for a firm. The results thus indicate that the self-selection hypothesis is not validated for Indian exporters.

Table 12 – Robustness Test for Self–selection hypothesis

(Dep. Variable = 1 if exporter and 0 otherwise)

	Variables	**Exporter1**			**Exporter2**		
		Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
1	Export Status$_{i,t-1}$	3.435*** (1.272)	3.209** (1.374)	4.078*** (0.900)	3.908** (1.748)	2.769** (1.309)	3.384*** (0.940)
2	Labour Productivity$_{i,t-1}$	-1.80e-05 (7.23e-05)	-2.58x10^{-05} (6.20x10^{-05})		-8.76e-06 (7.32e-05)	-2.74x10^{-05} (6.37x10^{-05})	
3	Labour Productivity$_{i,t-2}$	-4.79e-05 (6.15e-05)	-5.65x10^{-05} (6.17x10^{-05})		-5.61e-05 (6.19e-05)	-5.22x10^{-05} (5.66x10^{-05})	
4	Capital Productivity$_{i,t-1}$	-0.570 (0.640)		-0.707 (0.471)	-0.672 (0.814)		-0.679 (0.473)
5	Capital Productivity$_{i,t-2}$	-0.182 (0.555)		-0.337 (0.417)	-0.149 (0.582)		-0.422 (0.409)
6	Capital Intensity$_{i,t}$	-1.55e-05 (1.63e-05)	-1.59x10^{-05} (1.34x10^{-05})	-2.83x10^{-05}** (1.15x10^{-05})	-2.26e-05 (1.59e-05)	-1.12x10^{-05} (1.56x10^{-05})	-6.00x10^{-05}*** (1.08x10^{-05})
7	Age$_{i,t}$	0.0176 (0.0532)	0.0335 (0.0631)	0.0495 (0.0350)	0.0831 (0.0655)	0.0165 (0.0586)	0.0512 (0.0358)
8	Size$_{i,t}$	2.670*** (0.725)	3.157** (1.247)	1.387* (0.782)	2.769** (1.190)	2.556* (1.453)	1.266** (0.534)
9	Group Dummy$_i$	10.22*** (1.620)	9.354*** (1.695)	10.98*** (1.088)	12.29*** (2.001)	10.74*** (1.616)	15.56*** (1.129)
10	Constant	-5.592*** (1.546)	-5.738*** (2.002)	-5.922*** (1.206)	-8.782*** (2.211)	-7.236*** (1.654)	-5.862*** (1.102)
11	Observations	510	510	510	510	510	510
12	Number of firms	107	107	107	107	107	107
13	Wald Chi2	104.81*	59.47*	153.44*	87.59*	70.35*	325.76*

Notes: Same as Table 11.

6. Conclusions

The theory that links explains why exporters and productivity consists broadly of two hypotheses- the 'self-selection hypothesis' and the 'learning by exporting hypothesis'. In the

self-selection hypothesis, firms that are more productive tend to self-select into the export market. The *learning by exporting hypothesis* posits that firms in export markets see an increase in productivity due to the new knowledge they could acquire from international buyers and competitors through contracts and agreements.

Under this backdrop, this study has tried to measure the productivity differentials between exporters and non-exporters for the Indian chemical industry using data from CAPITALINE. Also, it tries to investigate if the self-selection hypothesis holds in the Indian context. After cleaning the data, the final sample consisted of 120 firms in the industry. Exporters consist of a heterogeneous group of firms that are classified as Entrants, Switchers, Continuers and Exiters.

The first objective of the study tests the empirical regularity that exporters are more productive than non-exporters in India. TFP is calculated from the Cobb-Douglas Production function using a fixed effects model. The analysis to measure the productivity differentials between exporters and non-exporters show that Non-exporters have a higher Total Factor Productivity than Exporters. Though labour productivity is higher in exporters than non-exporters, the yearly averages show that the labour productivity of exporters is converging to that on the non-exporters. In terms of capital productivity, overall averages show that exporters are more productive, but yearly trend shows that capital productivity of non-exporters have overtaken that of exporters over the years.

With respect to self-selection hypothesis, the study does not find any evidence for it for the chemical industry. Prior status, size, being part of a group and age to some extent are the only factors that induce a firm to go for exporting.

This study can have important policy implications. If the reason as to why exporters are less productive lies in the current policy scenario of the government, amends need to be made. One of the possible reasons as discussed earlier that can explain the less efficient exporters could be government policy that exporters could avail which is having negative repercussions on the economy. A closer look into the current policy scenario is needed.

Ever since the 1990s liberalization, the Indian markets have warming up to FDI, FII and MNCs the new market to compete has become the Indian Market. Hence Non-exporters are reaping the benefits from a competitive domestic market. The results show that more productive firms are exiting the export market. Hence there seems to be some evidence that there are more benefits from competing in the domestic economy.

If good firms become exporters by increasing their productive activity and innovativeness, a policy can be designed that would reward ex-post those who become exporters. This will encourage other firms to start improving their productivity as well. Also if the study can establish the fact that exporters have a greater probability of survival, further analysis could be carried out as to why they are more capable of surviving a shock. This can help policy makers decide what safety nets to design for the more vulnerable firms.

One of the limitations of the first objective is that the total factor productivity of the firms is assumed to be a constant over the study period. The assumption is not heroic given the short time period of the study. A longer time series could have facilitated the calculation of a time-variant Total Factor Productivity of the firms. Another limitation of this study is that it does not segregate exporters on the basis of the direction of exports. Since exports to OECD countries are to discernable customers (Kathuria, 1999), knowing the direction of exports could have facilitated finding a cause for less productivity of exporters.

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