R&D investment, productivity heterogeneity and export market participation: A study of Indian manufacturing firms

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Abstract

The study is an attempt to understand the nature of R&D investment, productivity heterogeneity and firm level export market particpation in the Indian manufacturing industry. We test two alternative hypothesis *first*, self selection of most productive firms into the export market and *second*, learning by exporting, where firms become more productive once they enter the export market. In both the hypothesis we observe the role of R&D investment on export market participation. The study employs firm level data obtained from Centre for Monitoring Indian Economy (CMIE) for the period 1990-2009 for analysis. Firm level Total factor productivity is estimated using Levinsohn and Petrin (2003) method. Preliminary analysis indicates that exporting firms are more productive than the non exporting firms in the Indian industry. However, the extend of this productivity difference is not very large compared to other countries. Exporting firms tend to be more R&D intensive compared to the non-exporting firms. Study reports self selection of more productive firms into the export market for the period from 1990 to1999. Investment in R&D is important for the decision of the firms to enter the export market from 1990-2010. Continued participation in the export market and the intensity of exporting is associated with growth in productivity, indicating the presence of learning by exporting for the period from 2000 to 2009. R&D investment has a positive effect on the future productivity growth of firms. Since R&D investment is undertaken by fewer firms compared to exporting, productivity effect of R&D is found to be larger.

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1. Introduction

Exports play a major role in sustaining economic growth in both developed and emerging economies. Among different channels that connect a country with others, export to foreign markets attracts most attention in the literature studying the sources for productivity growth in an economy. Recent studies indicate that the exporting may result in reallocation of scarce resource towards industries which have comparative advantage, popularly known as trade induced reallocation of resources[1]. However, a large number of scholars provide explanation of reallocation as trade-induced within-firm productivity improvements. Because the firms engage in international trade are heterogeneous in terms of productivity and size (Melitz, 2003). Studies based on this context reveal superior firm performance of exporting firms as compared to the non-exporting ones. The premise of such argument is based on the hypothesis that exporters at the outset tend to be more productive than the non-exporting firms. Two explanations for this phenomenon have been proposed. First, *self selection* of most productive firms to the export market Second, *learning by exporting* where firms become more productive once they start export[2].

Further, the said differences in export performance may be attributed to the other investments undertaken by the firm. Among these investment in technology and R&D is important in augmenting productivity and thereby exporting. Although, there exist a number of studies pertaining to various economies, attempt to address the issue in the context of India is rare. Some of the recent studies indicate that the effects and nature of trade and FDI liberalization in India brought significant changes in firm level productivity[3]. Hence, a detailed analysis on R&D investment, productivity heterogeneity and firm level export market participation in the context of liberalized regime is necessary to understand the linkages. In addition to this, the nature of variables pertaining to capture industrial structure, technical change and policy environment are different in the case of different sub-sectors of the manufacturing

[1] See Melitz(2003), Bernard et al (2003)

[2]Roberts and Tybout (1997) shows that firms the entry decision of a firm into the export market largely depends on the ability to cover the sunk cost of exporting. In the case of learning by exporting, one view is that exporters acquire knowledge of new production methods, inputs, and product designs from their international contacts, and this learning induces higher productivity for exporters relative to their more insulated domestic counterparts. See Clerides, *et al*. (1998) for more discussion on this.

[3] See Topalova(2011) and Sivadasan (2009) for detailed discussion

sector in India. Hence, a detailed empirical analysis of the manufacturing sector which underwent these changes would provide valuable insights about the dynamics of firm level export market participation in an emerging economy like India.

Based on this the major objective of this study is *firs*t, to estimate productivity at the firm level for the Indian manufacturing industry using Levinsohn and Petrin (2003) method *second*, test the alternative hypothesis of self selection of more productive firms into the export market vis a vis learning by exporting (Whether firms boost their productivity once they enter the export market) *third*, we analyse the role of firms R&D investment on the export market participation.

The paper is organized as follows: the section 2 discusses the motivation and background for the study. Section 3 provides an overview of the theoretical and empirical literature on exporting, R&D investment and firm productivity. Section 4 describes data, outlines the empirical model and discusses the variable construction. Section 5 summarises the preliminary analysis. Section 6 discusses the results and section 7 concludes the paper.

2. Motivation and background

Primary motivation for this study on India is the progressive external sector liberalization adopted by the country since early 1990 and the associated productivity reallocation within the narrowly defined manufacturing industries[4]. Product market liberalization has been carried out through two simultaneous routes *first*, the reduction of trade barriers by liberalizing tariff rates and *second*, increasing FDI inflow into the country by liberalizing the foreign capital requirements. As a part of trade liberalization, tariff rates fell from 87 percent points to 34 percentage in 1996 with similar drop in standard deviation of tariff. FDI liberalization eased the entry of foreign firms in the domestic market. As an immediate response to these measures exports as a percentage to GDP increased from 7 to 13 percentage from 1990-2000 with drastic changes in the direction and composition of trade from the country. Studies carried in the context of Indian manufacturing sector document for reallocation of market share, changes in the

[4] See Sivadasan (2009), Topalova(2011), Harrison for detailed discussion on the trade liberalization in India

availability of intermediate inputs and an increase in the product mix produced by firms in different sub sectors[5].

Based on these evidences and on account of liberalization episodes in other countries it is evident that trade liberalization is a potential policy tool which can provide better export performance in terms of reach to different markets and number of products exported. One reason for this phenomenon is that trade liberalization increases the competition firms face by reducing market access cost to foreign firms[6]. As a result domestic firms must become more productive in order to survive the new import competition. Studies carried out on Indian manufacturing sector (aggregate and firm level) highlight the extent of productivity difference and the nature of reallocation of productivity across firms within and between industries after 1990 due to trade liberalization. On the other side of the argument liberalization can make existing inputs cheaper for both foreign and domestic firms and can provide access to previously unavailable inputs (Goldberg et. al. 2009). The imported intermediate inputs would help in the production of export goods. Trade liberalization also resulted in the growth of extensive product margin at the firm level (Goldberg et. al. 2010). This may be due to the declining trade cost due to trade liberalization as postulated by the theoretical models of multi product firms. Hence, it is clear that the trade liberalization induced widening of heterogeneity across firms in the form of reallocation of productivity, availability of intermediate inputs for production and an increase in the product mix produced by firms in different between sectors.

However, some of the issues remains relatively unexplored in the Indian context that F*irst*, whether the liberalization induced the reallocation of productivity between export and non-exporting firms *Second,* the linkage between productivity and exports i.e., whether the productivity improvements helps firms to self-select into the export market (self-selection effect) or export market participation leads to productivity improvement once the firm starts exporting (learning by exporting effect). The export responsiveness of firms to trade liberalization may be also different depends on the intensity of exports with these firms (less export intensive and most export oriented firms). Evidences on other countries highlight that pre-entering firms became

[5] See Goldberg et. al.(2009)
[6] Which is in fact discussed in the trade literature as import effect. Topalova(2011)

more export oriented due to liberalization[7]. Further, in the context of India most of the studies were being carried out using the aggregate data. Therefore, in order to analyse the dynamics of firms response to product market liberalization micro level foundations of exporting and productivity needs to be analysed. Hence the present study is an attempt to fill the gap in the literature by investigating in detail the firm level export market participation and the link between productivity in the context of emerging country- India.

3. Theory and empirical evidence

The earliest study analyzing the causal relationship between exporting and productivity at the firm-level in the recent literature was on the U.S. economy (Bernard et al. 1995, 1999). Study found strong self selection effect and very little evidence of any learning-by-exporting effect. Based on this Melitz (2003) pioneered a model linking heterogeneous firms and industry productivity, with firm level exporting behavior. He created a dynamic industry model in a general equilibrium frame work and incorporated firm level heterogeneity into the model propounded by Krugman (1979). The major difference is on the cost of exporting. Firms face fixed cost to export. However they differ from each other in terms of productivity. Every firm has to make a productivity choice from an exogenous distribution which in turn determines whether they do actually produce and export and endogenously determined productivity threshold which determine who does and does not participate in the export market[8]. The interaction of these raises industry productivity. There are two effects due to to increased export market participation *first*, there is a rationalisation effect. Exporting increases expected profit, which in turn increases the entry of firms in the market results in augmenting the productivity threshold for survival and causes the least efficient firms to exit. *Second*, exporting allows the most productive firms to expand into more market and causes less productive firms to contract, which is known as realization effect.

Bernard and Jensen (1999) find no evidence of strong self selection of firms in the case of USA for the period 1984-92. Study employed a linear probability framework with plant fixed effects and also finds substantial sunk costs in export entry. Export experience in the previous year increases the probability of exporting by 40 percent, although the entry advantage depreciates very quickly. Study identifies that least productive firms exit from the export market. However

[7] See Bernard and Jensen(1999)
[8] See Melitz(2003) for detailed discussion

the benefits of exporting for firms are unclear from this study. Clerides, *et al*. (1998) highlight the importance of self selection in international trade. The model shows that more productive firms with lower marginal costs earn higher gross profits from producing, but not all firms export. Only those with sufficiently high profits to cover the sunk costs of entering export markets do so. They find strong evidence for self -selection and learning by exporting. Aw, Chung and Roberts (2000) used micro data collected from the manufacturing censuses in South Korea (1983-93) and Taiwan (1981-91) to study the linkages between producers total factor productivity and choice to participate in the export market. Study identified differences between the countries in terms of importance of selection and learning by exporting. In Taiwan, the participation of plants in the export market are due to the productivity as predicted by self-selection models. Plants with higher productivity, ex ante, tend to enter the export market and exporters with low productivity tend to exit. Moreover, in several industries, entry into the export market is followed by relative productivity improvements reinstating the effect of learning-by-exporting. However, the evidence of self selection on the basis of productivity is much weaker in the case of South Korea. In addition, study explicated no significant productivity changes following entry or exit from the export market that are consistent with learning from exporting.

Baldwin and Gu (2003) examined how Canadian manufacturing plants has responded to reductions in tariff barriers between Canada and the rest of world over the past two decades. The study brought out three main conclusions. Study found that trade liberalization was a significant factor behind the strong export growth of the Canadian manufacturing sector. As trade barriers fell, more Canadian plants entered the export market and existing exporters increased their share of exports. Export-market participation was associated with increase in a plant level productivity growth. They found the effect is much stronger for domestic-controlled plants than for foreign-controlled plants and for younger businesses than for older businesses. Study reported strong learning effect in terms of export market participation.

Girma et al (2004) reported the presence of learning and self selection for a sample of matched firms from UK for the period 1990-1996. Study find exporters are larger and more productive than non exporters and reported evidence of self selection of more productive firms in the export market. Further they found significant productivity improvements through exporting due to learning effect. Biesebroeck (2005) reports positive self selection and learning effect for a

sample of firms from 9 countries in Sub-Saharan Africa for the period from 1992-1996. Study employed GMM-system, MLE method to identify possible learning effect. The results indicate that exporters in these countries are more productive compared to non-exporting firms. Further, exporters increase their productivity advantage after entry into the export market. The results are robust when unobserved productivity differences and self-selection into the export market are controlled for using different econometric methods. International Study Group on Exports and Productivity (ISGEP, 2007), found that the 30 to 60 percent productivity differential between exporters and non-exporters is attributed to the selection of more productive and faster growing firms into exporting. Having gained a productivity advantage prior to the entry into foreign markets, exporters do not experience additional productivity gains from the exporting activity per se. Moreover, exporters who fail to survive in foreign markets lose this productivity advantage and end up being worse off than the firms who never export.

Aw et al. (2012) developed a dynamic structural model of a producer's decision to invest in R&D and export. They permitted both the choices of the firms affect the future path of productivity. Study employed plant- level data for the Taiwanese electronics industry. Export and R&D investment found to have a positive effect on the plant's future productivity. This in turn attracts more plants to self-select into exporting and R&D, contributing to productivity growth. Study showed that expansion into extensive margin of exporting increases both exporting and R&D investment and gradually generate within- plant productivity growth.

Yang and Chen (2012) studied the relation between productivity and exports in Indonesian manufacturing firms by taking account the endogenous choice of R&D. They reported the determinants of R&D activity in the Indonesian manufacturing firms and identified exporting activity contributes positively to plants R&D activity. The estimates on the interrelation of R&D, productivity, and export show that R&D has a positive impact on both productivity and exports, suggesting the importance of R&D to Indonesian economic growth. They cocluded a two-way relationship between productivity and exports, implying the coexistence of self-selection and learning-by-exporting effects in Indonesian manufacturing sector.

4. Data, methodology and construction of variables

We use firm level data from Prowess Database. The sample period is from the year 1990 to2009. The Data is collected by the Centre for Monitoring Indian Economy (CMIE) from the company balance sheets and income statements and covers both listed and unlisted firms from a wide cross section of manufacturing, services, utilities and financial industries. Prowess covers 60-70 percent of organized sector in India, 75 percent of corporate taxes and 95 percent of excise duties collected by the government of India (Goldberg et al. 2010). In our study we use only manufacturing firms – an average of 2481 firms spread across the 20 years. It includes the data on exporting, non-exporting, foreign and Indian firms investing abroad. The data is curled out based on the National Industrial Classification (NIC) provided by the Central Statistical Organization. After editing the data for possible erroneous observations, the sample consists of 45394 observations on 5154 firms spread across different years(2541 on an average for 20 years). The sample firms covers around 50 percent of output in a year reported in Annual Survey of Industries (ASI). We use an unbalanced panel, where the observations vary across time and firm characteristics. Since it is not mandatory for firms to report their balance sheets to the data collecting agency, firm entry and exit from the sample is primarily related to reporting rather than their actual entry and exit from the industry. Apart from firm level data, we also use data obtained from Annual Survey of Industries and National Sample Survey Organization (NSSO). Out of 45394 total observations 24721 cater to the exporting firms which enter and exit out of the export market during the study period and 20673 non-exporting firms.

4.1 *Method for Productivity Estimation*

In recent years great attention has been paid on the measurement of total factor productivity. The estimation of production function using Ordinary Least Squares (OLS) gives inconsistent and biased estimates of explanatory variables (Levinsohn and Petrin, 2003). There are likely to be a host of firm, industry, time, and region-specific influences that are unobservable to the econometrician but are known to the firm. These unobservables might influence the usage of production inputs and usage of inputs thus determined endogenously. Since OLS technique assumes production inputs are uncorrelated with omitted unobservable variables, it fails to address this endogeneity issues and thereby results in inconsistent and biased estimates of production function, which is otherwise known as ‘simultaneity or endogeneity problem’. To

solve these issues semi parametric method by Olley and Pakes(1996) and Levinsohn and Petrin(2003) has been used in many studies. Both these methods takes into account the simulataneity bias(and selection bias attrition bias in the case of OP). For the use of OP method investment is used as a proxy for controlling bias (unobservable productivity shocks). However in this study OP method cannot be used due to the large number of zero observations on investment. It will cause a large truncation of the dataset.

Hence, in this paper we use Levinsohn and Petrin (2003) (LP) methodology to estimate firm level production function. Levinshon – Petrin method uses energy as the proxy for controlling unobservable productivity shocks. The detail of the estimation is as follows. We assume a production function of the form:

$$y_t = \beta_o + \beta_k k_t + \beta_l l_t + \beta_m m_t + \beta_e e_t + \omega_t + \eta_t \qquad (1)$$

Where y_t, k_t, l_t, m_t, and e_t are the ln of output, capital stock, labour input, material, and energy of firm respectively, ω_t denotes productivity of the firm and η_t stands for measurement error in output, which is uncorrelated with input choices.

To control for unobservable productivity shock, in this study we take energy as proxy to take care of the endogeneity bias. LP assume that firm's energy demand function as, $e_t = e_t(\omega_t, k_t)$ is monotonically increasing in productivity given its capital stock. This allows inversion of energy demand function as $\omega_t = \omega_t(e_t, k_t)$. Thus the unobservable productivity term (ω_t) depends solely on two observed inputs, e_t and k_t. Rewriting equation (2) gives us:

$$y_t = \beta_l l_t + \beta_m m_t + \phi(k_t, e_t) + \eta_t \qquad (2)$$

Assuming the monotonocity condition this can be rewritten as

$$\phi(k_t, e_t) = \beta_o + \beta_l l_t + \beta_k k_t + \beta_i m_t + \omega_t(k_t, e_t) \qquad (3)$$

Here the error term (η_t) is not correlated with the inputs[9]. The final estimation requires several steps[10]. The value of the statistic is computed for each of these samples and the distribution of estimates so generated provides the bootstrap approximation to the sampling distribution of the

[9] See Levinsohn and Petrin(2003) for detailed derivation.
[10] See Levinsohn and Petrin(2003) for detailed discussion of the estimation of production function.

statistics. Using the estimated coefficients of production function $\hat{\beta}_l$, $\hat{\beta}_m$, $\hat{\beta}_k$ and $\hat{\beta}_e$ productivity is estimated as follows.

$$TFP_{ijt} = y_{ijt} - \hat{\beta}_l \; l_{ijt} - \hat{\beta}_m \; m_{ijt} - \hat{\beta}_k \; k_{ijt} - \hat{\beta}_e \; e_{ijt} \qquad (4)$$

In our study we use the following functional form

$$\ln y_t = \beta_o + \beta_k \ln k_t + \beta_l \ln l_t + \beta_m \ln m_t + \beta_e \ln e_t + \omega_t + \eta_{it} \qquad (5)$$

Total Factor Productivity is calculated as

$$\ln TFP_{ijt} = \ln y_{ijt} - \hat{\beta}_l \; \ln l_{ijt} - \hat{\beta}_m \; \ln m_{ijt} - \hat{\beta}_k \; \ln k_{ijt} - \hat{\beta}_e \; e_{ijt} \qquad (6)$$

4.2 *Method for the estimation of performance differential between Exporters and Non-exporters*

In this section we try to document the difference between exporters and non-exporters. Many studies found significant productivity differential between exporters and non-exporters. Following Bernard and Jensen (1999) we estimate the OLS regression.

$$\ln x_{it} = \alpha_{it} + \beta E_{it} + \chi Z_{it} + \sum_t \delta_t Time_t + \sum_k \lambda_k Ind_k + \varepsilon_{it} \qquad (7)$$

where x_{it} refers to the characteristic of firm *i* at time *t* in the industry *k*. E is a dummy variable equal to one if the firm is an exporter and zero otherwise. The coefficient on the export dummy E measures the percentage difference of a performance characteristic between exporters and non-exporters. Z_{it} is the set of control variables of firm *i* at time *t*. We control for size, age and ownership of the firm. To find out the difference in firm performance for exporters based on the level of participation of firm in the export market, we classify firms into four categories.

Continuous non-exporter = if the firm does not export (export =0) throughout the period of study

Enter = if firm do not export at the beginning of the period but starts export in between
eg:export =0 in t and export >0 in t+1

Switch = if the firm switches its export position in between. eg: if export is >0 in t , =0 in t+1, >0 in t+2

Continue = if firm continuously export during all years or it export continuously for 5 years in a row

Exit = if the firm export for at least 3 years and exit out of the export market. eg: export>0 in t and exp=0 in t+1

4.3 *Method for Estimation of Self- Selection*

Following Bernard and Jensen (1999) Probit model is used to test the self selection hypothesis. To understand the nature of export market participation and productivity in the liberalization phase we divide the sample into two sub-samples (1990-1999 and 2000-2009). The dependent variable in the case of Probit model is binary type depending upon the export market participation of the firm. Firms enter into the export market only if the profits from doing so are enough to cover the sunk cost of exporting. we use the following function.

$$\text{Prob}\{EXP_{ijt}\} = \alpha_{it} + \beta_1 EXP_{ijt-1} + \beta_2 TFP_{ijt-1} + \beta_3 R\&D\ int_{ijt-1} + \beta_4 Z_{ijt} + \sum \beta_5 Time + \sum \beta_6 Industry + e_{ijt} \quad \text{..... (8)}$$

Exp = 1 if EXPINT (Export intensity) > 0, and
= 0 otherwise

Where EXP_{ij}=1 if firm is an exporter and 0 otherwise. E_{ijt-1} is the export status of the $_i$th firm of $_j$th industry at t-1. Z_{ijt-1} is the vector of firm characteristics. The various characteristics that are used as independent variables and influence the decision to export are lagged productivity, age of the firm, size of the firm, R&D intensity and ownership. Productivity is measured in terms of TFP (using the Levinsohn- Petrin (2003) method). A strong positive association between a given firm's characteristics and its participation in export markets could reflect self selection of better firms into the export market. The variant of the above model with additional productivity lag is used for detailed examination.

The main issue in identifying an exporter is that there are several firms with negligible exports (in Rs. Crores) but are exporting at least one year. It is very difficult to classify these firms as exporting firms. In addition there are large firms with large export revenue but the export intensity of these firms are very small. Hence, for detailed investigation and to take care of this problem we classify our sample into four categories:

Exporter 1- if the export intensity is greater than 5% in the firms export history

Exporter 2- if the export intensity is greater than 10% in the firms export history

Exporter 3- if the export intensity is greater than 20% in the firms export history

Exporter 4- if the export intensity is greater than 25% in the firms export history

4.4 *Method for the estimation of Learning by exporting*

To account for the simultaneity of input choices and unobserved productivity we apply the system GMM approach proposed by and Blundell and Bond (1998), Arellano and Bover (1995) and Blundell et al. (2001). This estimation procedure is appropriate when N is large, but T is small and the explanatory variables are endogenous. Unobserved firm characteristics may affect both firm performance and exports, which can lead to spurious correlation between productivity level and past exporting status. For example, certain firms might have more energetic managers who run efficient operations with low unit costs than their competitors and also aggressively seek out foreign markets, while other firms might run by more conservative managers who are unwilling to implement efficiency-enhancing reforms and also prefer to rely on traditional domestic markets. Such unobservable firm characteristics may give rise to spurious correlations between lagged exports and current firm performance. Further, this method provides more appropriate estimates when unobserved firm-specific effects are correlated with other regressors. Firm performance may be serially correlated over time and if jointly determined by exports. For example, if firms self –select into export market and the positive productivity shock is serially correlated, current productivity will also be correlated with previous export experience without any learning by exporting. We estimate the equation of the following form.

$$\ln TFP_{it} = \alpha_{it} + \beta_1(\ln TFP_{it-1}) + \beta_2(\ln TFP_{it-2}) + \beta_3(\ln EXP_{it}) + \beta_4(\ln EXP_{it-1}) + \beta_4 Size_{it} + \beta_5 Age_{it} + \beta_6 R\&D_{it} Int + \sum_t \delta_t Time_t + \sum_k \lambda_k Ind_k + \mu_i + \varepsilon_{it}$$

Where TFP is the total factor productivity. Exp is the export intensity. We use the variants of the equation (7) to study the dynamics of exporting and productivity by introducing the growth rates of TFP and Exports(EXP) .

The GMM system procedure allows us to examine the cross-sectional relationship between the levels of exporting and productivity since the firm-specific effect is not eliminated but rather controlled by the lagged differences of the dependent and independent variables as instruments. Here, the assumption is that the differences are not correlated with a firm-specific effect compared to levels. For checking the validity of the instruments we use two the specification tests f*irst*, we apply the Sargan test, a test of over identifying restrictions. This is to determine any correlation between instruments and errors. For an instrument to be valid there should be no correlation between the instrument and the error terms. *Second*, we test whether there is a

second-order serial correlation with the first differenced errors. The GMM estimator is consistent if there is no second-order serial correlation in the error term of the first differenced equation Productivity changes are associated with entry, continued stay, switching export positions and exit out of the export market. Hence, to study this we divided the sample into two periods(1990-1999 and 2000-2009) to identify the nature of the productivity change during the immediate years of liberalisation We follow Bernard and Jensen(1999) and estimate the below model.

$$\Delta TFP_{it} = \alpha_{it} + \beta_1 entering_{it} + \beta_2 continue_{it} + \beta_3 exit_{it} + \beta_4 switch + \chi controls_{it} + \varepsilon_{it} \quad (10)$$

Where, ΔTFP_{it} is the growth in productivity. The coefficients, $\beta_1, \beta_2, \beta_3, \beta_4$ give the differential in productivity growth rates for entering, continuing, switching and exiting firms for the full sample and the sub-sample. Firm level controls include age, size and ownership. The classification on the exporting history followed here is the same as in the other sections.

4.5 Construction of Variables

Capital stock

Measuring the capital stock of the firm this study follows the methodology of Srivastava (1996) and Balakrishnan et al (2000) which revalues the capital given at historical cost to a base year. The PROWESS database provides the information on Gross Fixed Asset (GFA) at historical cost, its two components –land & building and plant & machinery. Actual invest for the present period is estimated by taking the difference between GFA for current year and last year. The real investment value is expressed in the base price of 1993-94 =100. This enables us to use the perpetual inventory method to construct capital stock by Srivastava (1996). The capital stock has to be converted into an asset value at replacement cost using a revaluation factor. For estimating of the revaluation factor first we have chosen a base year having maximum number of observations[11]. Thus, in our case, year 2004-2005 has been selected as the base year. The

[11] The estimation of revaluation factor involves following three underlying assumptions. *First, g*iven the 25 years life duration of capital and the selected base year 2004-05(maximum number of observation), it is presumed that the no firm has the capital of vintage earlier than 1980-1981 and firms incorporated this year have employed the capital of vintage of the same year. We take the life tenure of capitals employed in mining sector published by in the 'National Accounts Statistics-Sources & Methods, 2007' by the Central Statistical Organisation (CSO) New Delhi. *Second*, Price of capital is also assumed to have changed at a uniform rate from 1980-81 or the year of incorporation, whichever is latter, up to 2004-05 for all the firms. This value is estimated by constructing a price index for the Gross Capital Formation for

revaluation factor obtained is used to convert the capital in the base year into capital at the replacement cost at current prices. We then deflate these values to arrive at the values of capital stock in constant prices for the base year. The deflator used for the purpose in constructed from the series on gross capital formation. Subsequent years' capital stock is arrived by using the sum of investment using the perpetual inventory method by assuming a depreciation of capital 7% following Srivastava (1996). In this study we have used gross fixed asset of the firm rather than net fixed asset.

Output

Output is deflated sales adjusted for change in inventory and purchase of finished goods. In Prowess database the purchase of finished goods is defined as finished goods purchased from other manufacturers for resale. Hence we subtracted purchase of finished goods from sales to arrive at the firms' manufactured output. A positive increase in inventory is added to sales to arrive at output and a decrease subtracted.

Materials

We follow Balakrishnan et al. (2000) methodology to construct the materials variable. The materials bill was deflated by a material input-output price index. The input-output coefficients for the year 2004-05 have been used as the weights to combine the whole sale prices of relevant materials. The input-output weights were obtained from the CSO's input-output table for 2004-05 and the relevant whole sale price index is obtained from the "Index of Wholesale Prices in India with base year as 1994=100, provided by MOSPI.

Labour

The PROWESS database provides information on wages and salaries of the firm and provides no information on the number of employees. Therefore, we need to use this information to arrive at the number of person engaged in each firm. Number of persons engaged in a firm is arrived at by dividing the salaries and wages at the firm level by the average wage rate of the industry (at the three digit level) to which firm belongs.

Number of persons engaged per firm =Salaries and Wages/Average Wage Rate

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the mining and quarrying sector compiled from the various volumes of National Account Statistics of India. Third, *Third*, investment is assumed to have changed at a uniform rate during 1980-81 and 2004-05 for the firms incorporated in same years. Here the growth rate of gross fixed capital formation in manufacturing sector at 1993-94 price is assumed to apply to all firms.

To arrive at the average wage rate we make use of the Annual Survey of Industries (ASI) data on Total Emoluments as well as Total Persons Engaged for the relevant industry.

Average Wage Rate = Total Emoluments/Total persons engaged

Energy

Following (Topalova, 2011) electricity expenses incurred by the firm is taken as a proxy for energy input variable. Prowess data reports the electricity expenses incurred by the firms as 'power and fuel expenses' in the database. The electricity expenses incurred by the firms are converted in real terms by the electricity whole sale price index with base 1993-'94.

Export Intensity

Export to sales ratio is used as export intensity of the firm.

Firm Size

Deflated value of sales turnover is taken as the size variable. The value of sales are deflated using appropriate Whole sale price index (1993- '94 base).

Age

Year of incorporation of the firm is used to construct the age of the firm. Studies found a positive relationship between the age of the firm and export market participation of the firm.

Ownership

Based on RBI definition the equity ownership of the firm is used to classify foreign and domestic firms. Firms with foreign promoters share greater than 10 percent is considered as foreign firms

R&D intensity

R&D expenditure of the firm to the sales is taken as R&D intensity of the firm in the year of the study.

5. Preliminary analysis

Table 1 gives the summary of key firm characteristics for the study period (total sample). The mean values of total sample indicate that the mean size of the sample firm is 152.87 (in Rs.crores). Where deflated (base 1993-'94) sales is taken as an indicator of size. On average, the wage bill stands around 8.83 (in Rs. Crores). The firms included in the sample are experienced if we count in terms of age, the average age of the firms is 27 years. Export intensity of the total sample is 13.52 percent of the sales, which indicates that on an average, firms spend 13.52 percent of their sales revenue on exports.

Table 1: Summary Statistics (Full sample)

Variable	Mean	Std. Dev.	Min	Max
Size	152.87	1259	0.89	72386.81
Wage Bill	8.83	38.23	2.17	2189.567
Age	27	20.57	1.00	120
Expint	13.52	24.69	0	100
Impint	11.57	91.3	0	90
R&D Int	0.18	23.4	0	65.12
	Variables used in Production Function Estimation			
Output	155.92	964.32	1.00	47488.23
Labour	764	3527.71	10	140649
Capital	98.23	616.76	1.00	33502.71
Energy	6.93	2.36	1.00	1246.9
Materials	68.19	469.54	1.00	26580.75

Note: Wage bill- deflated value of salaries and wages in Rupees. Crores, Expint- export revenue/sales turnover, Impint-Total import payments/sales, Total number of observations**:** 45394

The range of export intensity is from 0 to 100, which indicates that the sample includes firms which are non-exporting and hundred percent export oriented. On an average, firms spend 11 percent of their sales on import. The sample includes firms which spent 90 percent of their sales on import. Table 2 compares the mean and standard deviation between different types of firms, exporting, non-exporting, foreign and domestic. We use t-test to find out if the mean difference is significant. It shows that exporting firms on an average produces more output compared to non-exporting firms. There is significant difference in the number of labourers employed by exporting firms in comparison with the non exporting firms. In addition to that if we compare

foreign and domestic firms, foreign firms outperform the domestic counter parts in all the variables taken for the study.

Table 2: Comparison of means between different types of firms

Variables in production function estimation					
Variable	Total (1)	Export (2)	Non-Exp (3)	Domestic (4)	Foreign (5)
Output	155.92	293.26*	50.98	143.46	367.33*
	(964.32)	1538.96	210.37	961.81	982.35
Labour	764	1416*	308.45	698	1874*
	(3527.7)	5318.32	1151.05	3498.83	3819.31
Capital	98.23	173.24*	33.53	92.49	195.57*
	(616.76)	753.01	134.01	621.66	517.22
Energy	6.93	10.86*	4.09	6.71	10.75*
	(29.34)	41.37	12.13	28.98	34.78
Materials	68.19	121.11*	25.06	62.75	160.42*
	(469.54)	723.09	127.61	464.49	540.02
Observations	45394	24721	20673	42800	2594

Note: Significant at 5% level (t-test). Comparing group for column 3 is 2 and column 5 is) and Domestic (Column 4) . Standard deviation in parenthesis, Materials- raw material expense, energy – deflated total expense on electricity

Table 3 compares the mean of firm characteristics such as firm size, age, wage bill, export intensity, R&D intensity and import intensity of the firms. It is clear from the table that on an average exporting firms are bigger in size compared to the non- exporting firms. Further, exporting firms pay higher worker compensation. Age of the firm indicate that exporting firms are far more experienced than the non exporting counter parts. Import intensity, import to sales ratio indicate that on an average exporting firm spend more on import compared to the non-exporting firms. When we compare the firm characteristics of domestic and foreign firms (column 4 and 5 of Table 3), we find that foreign firms outperform the domestic firms in almost all firms characteristics except export. This indicate that on an average there is no significant difference between the export intensity of domestic and foreign firms. Exporting firms tend to teake part in R&D more intensively compared to the non- exporting firms. However, the difference is not prominent in the case of domestic and foreign firms.

Table 3: Comparison of means between different types of firms (other firm characteristics)

Variable	Total	Export	Non-Exp	Domestic	Foreign
	1	2	3	4	5
Size	152.87	312.53*	43.15	140.02	349.24*
	(964.32)	(2293.04)	(183.33)	(1272.48)	(954.3)
Wage Bill	764.39	11.94*	2.10	5.81	16.45*
	(3527.7)	(45.59)	(7.28)	(35.43)	(35.15)
Age	98.23	28.19*	24.94	25.66	31.56*
	(616.76)	(20.11)	(19.78)	(19.22)	(20.8)
Expint	6.93	22.74	0.00	12.99	13.12
	(29.34)	(28.59)	(0)	(23.61)	(21.1)
Impint	68.19	14.59*	10.10	10.04	15.65*
	(469.54)	(115.55)	(101.09)	(93.11)	(21.89)
R&D Int	0.24	1.23*	0.11*	0.17	0.28
	(1.08)	(12.34)	(3.29)	(56.13)	(81.23)
Observations	45394	24721	20673	42800	2594

Note: Significant at 5% level (t-test). Comparing group for Column 3 is exporters (2) and column 5 is Domestic(4) . Standard deviation is reported in parenthesis. Wage bill- deflated value of salaries and wages in Rs.crores. Expint-export/sales turnover, Impint-Total import payments/sales

6. Results and discussion

6.1 *Production function Estimation*

Production function has been estimated separately for 22 industries from NIC 10 – NIC 32. The Results are given in Table 4. Table 5 gives the list of industries used in the study with sector code and sector names. The total number of firms varies across industries and across year of study. The Results in table 4 indicate that the capital and labour coefficients using Ordinary Least square method and Levinsohn- Petrin (2003) method differs across different manufacturing sectors. Capital and labour coefficient are significant at 1 percentage level for all industries studied. Levinsohn and Petrin (2003) highlight that there can be three different biases happen if OLS is used for estimation. Table.4 shows OLS method under estimates labour coefficient and over estimate capital coefficient compared to the L-P method.

Table 4: Production function estimation (Capital and Labour co-efficient by industry)

	OLS			L-P			
NIC code	**Labour**	**Capital**	**R^2**	**Labour**	**Capital**	**Wald *Chi*^{2}**	**NOB**
10	0.178***	0.156***	.70	0.138***	0.406***	5.34	6,615
11	0.245***	0.380***	.75	0.205***	0.630***	8.26	801
12	0.172***	0.090***	.60	0.132***	0.340***	7.13	199
13	0.199***	0.095***	.56	0.159***	0.345***	1.87	6,615
14	0.076**	0.149**	.64	0.036***	0.399***	4.14	901
15	0.404***	0.123***	.74	0.364***	0.373***	3.86	702
16	0.382***	0.071***	.72	0.342***	0.321***	8.18	355
17	0.336***	0.145***	.58	0.296***	0.395***	9.36	1,775
18	0.627***	0.309***	.81	0.587***	0.559***	14.31	205
19	0.371***	0.210***	.74	0.331***	0.460***	16.13	399
20	0.233**	0.202***	.73	0.193***	0.452***	5.67	6,211
21	0.114***	0.317***	.45	0.074***	0.567***	4.14	3,155
22	0.252***	0.160***	.34	0.212***	0.410***	4.51	3,866
23	0.386***	0.160***	.73	0.346***	0.410***	6.67	1,909
24	0.258***	0.143***	.81	0.218**	0.393***	7.17	4,988
25	0.312***	0.164***	.85	0.272***	0.414***	6.15	1,601
26	0.263***	0.318***	.63	0.223***	0.568***	5.14	1,809
27	0.199***	0.216***	.73	0.159***	0.466***	6.43	3,488
28	0.195***	0.239***	.78	0.155***	0.489***	8.19	3,966
29	0.050***	0.065***	.75	0.010***	0.315***	6.17	176
30	0.341***	0.212***	.86	0.301***	0.462***	8.13	3,618
31	0.012***	0.012***	.85	0.002***	0.262***	18.13	166
32	0.305***	0.141***	.92	0.265***	0.391***	12.12	986

Note: *** significant at 1%, ** significant at 5% and * 10%. NOB- Number of observations, L-P levinsohn- Petrin method. OLS- Ordinary least square. Wald's test is Chi-square distributed against the null that the production technology is constant returns to scale

Table 5: Industry classification (Manufacturing sectors included for study

Industry NIC code	Sector
10	Manufacture of food products
11	Manufacture of Beverages
12	Manufacture of Tobacco products
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of wood and products of wood
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemical and chemical products
21	Manufacture of pharmaceutical, medicinal Chemical and botanical products
22	Manufacture of rubber and plastic products
23	Manufacture of other non-metalic mineral products
24	Manufacture of basic metals
25	Manufacture of Fabricated metal products, except machinery and equipment
26	Manufacture of Computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c.
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment
31	Manufacture of Furniture
32	Other Manufacturing

Note: NIC classification 2008 which corresponds to the ISIC rev 4.

6.2 Performance of Exporters Vs Non exporter

Table 6 reports the mean and standard deviation of TFP for exporting, non- exporting, entering, continuing and exiting firms in the sample. Exporting firms tend to be more productive compared to the non- exporting firms. The mean TFP for exporting firms are high compared to entering and exiting firms. R&D investment undertaken by the continuing firms in the export market is much larger than the entering and exiting firms. This indicates that established exporters serving the foreign market invest more in R&D as a means of survival and innovation in the export market.

In Table 7, Column 1 reports the export difference between exporters and non- exporters for the full sample. For the full sample exporters seems to reap. Export coefficient is positive and significant for various firm characteristics if we take the case of full sample. By far the largest difference is found in the case of output. The productivity levels are higher for exporters

compared to the non-exporters in all groups other than entering firms (column 3). The result indicates that the exporters at the outset are more productive than the non-exporting firms. However, when we take the magnitude of productivity difference between exporting and non-exporting, we find it very small. Column 5 reports finding for continuing firms. The continuing firms in the export market are 10% more productive compared to the non-exporting firms. Column 7 reports the findings for firms which exit out of the export market (year prior to exit). Export premium for R&D investing firms are much larger in all cases.

Table 6: Mean and standard deviation (based on different exporter category)

	Mean TFP	S.D	Mean R&D int	S.D	Observations
Exporter	1.825	1.262	1.23	1.08	24721
Non-exporting	1.802	1.336	0.11	3.29	20673
Continue	1.813	0.559	0.25	1.11	23112
Enter	1.596	0.588	0.10	0.61	1891
Exit	1.818	1.299	0.11	0.8	1678
Switch	1.224	0.516	0.12	0.44	586

Note: S.D Standard Deviation, TFP is the Total Factor Productivity estimated at the firm level,R&D int indicate R&D intensity.

Table 7: Exporting and firm performance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Output	0.268***	0.72	0.084***	0.71	0.269**	0.009	0.133**	0.020
Capital	0.171***	0.70	0.043***	0.68	0.194**	0.019	0.046**	0.021
Average Wage Bill	0.043***	.003	0.015***	.002	0.025***	.003	0.024***	0.006
TFP	0.017*	0.76	0.001	0.78	0.101***	0.023	0.006**	0.008
R&D Intensity	.23**	.09	.003*	.112	.211**	.011	.54*	0.23
Observations	45394		1891		23112		1678	

Note**:** lnY – ln output, ln TFP- total factor productivity. ***significant at 1% level,**significant at 5%level,*significant at 10% level.. Column 1 provides the exporting premium for the entire sample. Column 3,5,7 premiums for entering(year prior to entry), continue and exiting firms(year prior to exit). Column 2, 4, 6, 8 reports the standard error.

Table 8: Probit estimation of export participation (Full Sample)

	Model 1		Model 2	
	Coef.	SE	Coef.	SE
Expt-1	0.063***	0.004	0.064***	0.007
TFP_{t-1}	0.051	0.007	-0.051	0.008
TFPt-2			-0.015	0.009
$R\&D_{t-1}$			.021**	.004
Size	0.312***	0.008	0.165**	0.008
Age	0.006**	0.004	0.008***	0.011
FP	0.376**	0.012	0.377**	0.022
constant	-0.012	0.024	-0.088	0.038
Time	Yes		Yes	
Industry	Yes		Yes	
NOB	36512		29123	
Log likelihood	-15132.7		-12445.23	
LR chi2	17254.16		13123.18	
Pseudo R2	0.4325		0.4923	

Note: ***Significant at the 1% level. **Significant at the 5% level. **Significant at the 10%. Probit estimates with export dummy as dependant variable. Dependent variable is export dummy 1 if firm exports otherwise 0. Column 2 and 4 gives the standard error.

6.3 *Self selection: Do better firms become exporters?*

Table 8 reports the finding of Probit estimation of export performance. Table 9 highlight the findings for the sub-sample. The decision of the firm to participate in the export market largely depend on the past export performance of the firm. This results are similar to Arnold and Hussinger(2005) for German manufacturing and Baldwin and Gu(2003) for Canadian firms. We find that the TFP measure is not significant in the case of full sample. In the case of sub-sample

(Table 9) TFP measure is positive and significant for the 1990-1999 sub group. This indicate the participation in the export market during immediate years of liberalization largely dependent on Productivivty. However, this is not same for the 2000-2009 time period. One reason could be the immediate productivity change brought by the product market liberalization. Another reason could be the convergence of productivity of exporting firms to the level of non exporting firms over the years. The decision to participate in the export market largely depends on the R&D investment undertaken by the firm.

Table 9: Probit estimation of export participation (Sub-sample)

	1990-1999		2000-2010	
	Coef.	SE	Coef.	SE
Expt-1	0.077***	0.007	0.069***	0.006
TFP_{t-1}	0.298*	0.079	-0.064	0.007
$R\&D_{t-1}$	.023	.002	.023**	.009
size	0.386***	0.031	0.345***	0.005
Age	0.006**	0.005	0.005**	0.006
FP	0.003**	0.225	0.234**	0.042
constant	-0.018	0.048	-0.820	0.034
Time	Yes		Yes	
Industry	Yes		Yes	
NOB	2017		35665	
Log likelihood	-629.83		-15634.89	
LR chi2(5)	578.18		16423.22	
Pseudo R2	0.3123		0 .3187	

Note: ***Significant at the 1% level. **Significant at the 5% level. **Significant at the 10%. Probit estimates with export dummy as dependant variable. Dependent variable is export dummy 1 if firm exports otherwise 0. Column 2 and 4 gives the standard error.

We check the robustness of the result by classifying the exporters into 4 groups. Export participation the previous year is an important determinant in the current export market participation of a firm. However, the Productivity is not an important factor in determining the export market participation of the firm. This indicates there is no self selection of firm based on productivity to the export market. This result supports the findings we discussed in Table. 8. Hence we can infer that the self selection based on productivity happened only in the initial phase of liberalization.

Table 10: Robustness check (Self selection- hypothesis)

	Exporter 1		**Exporter 2**		**Exporter3**		**Exporter 4**	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	Se
Expt-1	0.017***	0.023	0.207***	0.034	0.112***	0.043	0.124***	0.078
TFP_{t-1}	-0.023	0.016	-0.021	0.067	-0.013	0.089	0.009	0.089
Size	0.143**	0.077	0.345**	0.089	0.306**	0.065	0.423**	0.043
$R\&D_{t-1}$	.132	.249	.021	.056	.057**	.063	.056***	.002
Age	0.016***	0.010	0.034***	0.068	0.048***	0.051	0.089***	0.075
FP	0.236**	0.048	0.436***	0.098	0.109**	0.041	0.123**	0.103
constant	-0.123	0.032	0.004	0.016	0.023	0.056	0.467	0.023
Time	Yes		Yes		Yes		Yes	
Industry	Yes		Yes		Yes		Yes	
NOB	15738		12462		8942		7750	
Log likelihood	-15432.8		14226.4		14638.2		15711.4	
LR chi2(5)	18234.16		15324.12		17456.23		15675.17	
Pseudo R^2	0.382		0.346		0.374		0.351	

Note: ***Significant at the 1% level. **Significant at the 5% level. **Significant at the 10%. Probit estimates using export dummy as dependant variable. . Dependent variable is export dummy 1 if firm exports otherwise 0. Column 2, 4, 6 and 8 gives the standard error

6.4 Learning by exporting: Does exporting boost productivity?

Table 11 reports the GMM-system estimation results. Past export performance are not important factor to determine the current productivity of firm. But the growth of productivity largely depends on the intensive margin of exporting. The co-efficient of variable indicating lagged export growth is positive and significant. Further, we examine (column 5, Table. 11) at the factors influencing the growth of export or the intensive margin of exporting. We Found that productivity both at levels and at margins are significant in influencing the margin of exporting. Positive export growth in initial years of exporting adds to the present growth in the exporting. To understand this further we investigate the productivity improvements related to entry, continued stay, switching export positions and exit out of the export market (Table 12). R&D investment is positively influencing the productivity at levels and at margin. This indicate the presence of learning through R&D investment.

Table reports the findings for full sample and for the sub-period. The entry into the export market is associated with high productivity for the firm in the initial period of liberalization (1990-1999). Starting to export is associated with increase in productivity during early years of liberalisation. However the productivity increase during the later period (2000-2010) due to entry is less. The continuous participation in the later half (2000-2009) is the associated with positive productivity improvements. The exit from the export market leads to a productivity loss in the initial years of liberalization.

Table 11: Dynamics of exporting, R&D investment and productivity

	Dependant Variables					
	ΔlnTFP		lnTFP		Δln Exp	
	1	2	3	4	5	6
lnTFP(t-1)			0.712**	0.022	0.445	0.131
lnTFP(t-2)			0.051	0.023	0.231	.012
2Δ lnTFP					0.086***	0.216
Δ lnTFPt-1	0.758	0.021			0.0242**	0.104
ln EXP(t-1)			-0.014	0.004		
ln EXP(t-2)			-0.008	0.006	0.61	0.038
Δ ln EXP	0.054***	0.004				
Δ ln EXPt-1	0.078***	0.003			0.02***	0.155
$R\&D_{t-1}$	0.23**	0.23	.017**	.023	.047***	0.023
Size	0.067***	0.036	0.143***	0.012	0.242***	
Age	0.065***	0.022	0.113***	0.071	0.052***	
cons_	0.56	0.31	0.32	1.12	-0.366	2.311
Year	yes		yes		Yes	
Industry	Yes		Yes		Yes	
N.Observations	29854		36645		30023	
Sargan Difference test	0.234		0.241		0.212	
Sargan test	0.321		0.323		0.236	
AR(1) p-value	0.312		0.243		0.344	
AR(2) p-value	0.123		0.527		0.111	
Wald Test Chi^2	211.14		264.5		675.21	

Notes: (1) Asymptotically robust standard errors are reported in column 2, 4 and 6. (2) The Sargan test is a Sargan–Hansen test of over identifying restrictions. (3) AR1 and AR2 are tests for first and second-order serial correlation in the first-differenced residuals. (3) Year and industry dummies are included in each model. ***Significant at the 1% level. **Significant at the 5% level. **Significant at the 10% level. ΔlnTFP- Growth in Total Factor Productivity. Δln Exp – Growth in exports. lnTFP- Total factor productivity at levels.

Table 12: Exporting and productivity by exporter category

	ΔTFP					
	Full sample		**1990-99**		**2000-2010**	
	1	2	**3**	**4**	**5**	**6**
Start	0.023	0.031	0.013*	0.022	0.007	0.051
Continue	0.076*	0.053	0.087	0.001	0.152**	0.016
Exit	-0.026*	0.083	-0.156*	0.025	-0.016	0.013
Switch	-0.002	.0014	-0.156	0.043	0.143	.098
Size	0.059**	0.094	0.048	0.048	0.006**	0.001
Age	0.013**	0.007	-0.082**	0.038	0.012**	0.008
FP	0.025	.0134	067	.003	.189	.098
Year	Yes		Yes		Yes	
Industry	Yes		Yes		Yes	
NOB	39385		2599		36786	
R^2	0.5789		0.7658		0.7258	

Note: ***Significant at the 1% level. **Significant at the 5% level. **Significant at the 10% level Column 1,3 and 4 estimated co-efficients. Column 2,4 and 6 shows the standard error in estimation. Dependent variable is ΔTFP. ΔTFP- Growth in Total factor productivity. FP – ownership dummy.

7. Summary and Conclusion

In this paper we examine R&D investment, productivity heterogeneity and firm level export market participation in the Indian manufacturing sector. The two key questions examined are whether more productive firms export and/or whether exporting improves productivity (testing of alternative hypothesis *self-selection* vis-à-vis *learning by exporting*). We use firm level data provided by the Centre for monitoring Indian Economy (CMIE) for the period 1990-2009 for analysis. Preliminary analysis indicate that , on an average, exporting firms are bigger in size , are more experienced in the market and pay high average wage compared to the non- exporting firms. Exporing firms are found to be more R&D intensive compared to non- exporting firms. As a next step, we test the empirical regularity that exporters are more productive compared to non-exporters. Total Factor Productivity is calculated using Levinsohn and Petrin (2003) method. The results indicate that exporting firms on an average are more productive compared to the non-exporting firms for the full sample. However, the extent of this productivity difference is small compared to other countries. Prior to entry, there are no significant productivity differences between entering and non-entering firms. However, there is positive evidence that the productivity difference between continuous exporters and non-exporters widens over time. In the case of R&D continuing exporters invest more on innovation compared to entering, switching and exiting firms.

we test whether more productive firms self-select into the export market. We found no evidence of self- selection based on productivity in the case of Indian manufacturing firms. These results are similar to the one obtained by Aw, Chung and Roberts (2000) for Korea. To investigate further we divided the sample into two time periods from 1990-1999 (immediate years following liberalization) and 2000-2009. We found positive evidence of self selection for the immediate period following liberalization (1990-1999). However we found positive evidence for self selection based on R&D for the period 1999-2009. We apply the system GMM approach proposed by Arellano and Bover (1995) and Blundell and Bond (1998, 2000) to examine learning by exporting effect. Results indicate no significant evidence of exporting on current productivity level of the firm. However we found evidence of positive productivity growth due to intensive margin of exporting. This is in line with findings by Biesenbroeck (2005) for Sub-Saharan Africa. R&D investment has a positive influence on the productivity of the export market participating firms. One important point worth noting here is that productivity effect of

R&D is found to be larger compared to exporting. Possible explanation is that R&D investment is undertaken by fewer firms compared to exporting. Entry into the export market is a time of productivity growth and improved firm performance for the period from 1990-1999. During the same time firms that stop exporting perform badly. This finding corresponds to the study by Bernard and Jensen (1999) in the case of USA. However, results indicate that continuous exporting during the period 2000-2009 brings positive productivity growth at the firm level.

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