Outward FDI, Exports and Technological Efforts: A Study of Indian Manufacturing Firms

Ronny Thomas[*] and K. Narayanan[+]
Indian Institute of Technology Bombay, Mumbai
October 2013

Abstract

In this study we test the hypotheses that the choice between OFDI and export decision of the firms depends on the firm level productivity. Here, we compare the productivity levels of OFDI firms *vis a vis* exporting (as an alternate mode of internationalization of firms) and the domestic firms. The study employs firm level data obtained from Centre for Monitoring Indian Economy (CMIE) for the period from 1990-2009 for analysis. Two-sided and one-sided Kolmogorov-Smirnov stochastic dominance test is employed to compare productivity distribution of OFDI vs. exporting/domestic firms. The productivity distribution of firms which undertake OFDI stochastically dominates firms which exports for the period from 2004-2009 (later period of liberalization). Results support the theoretical argument that higher productive firms undertake OFDI as a mode of internationalistaion compared to exporting and domestic production. Further, we use Dynamic random effects Probit and Tobit model to examine the complementarity/ substitution between OFDI and exports. Probit model is used to identify the determinants of probability of OFDI and Tobit model is used to study the determinants of OFDI share. Our findings suggest complementary relationship between export and OFDI. R&D investment and Import of technology in the form of capital goods plays an important role in both probability of undertaking OFDI and OFDI share. The results of the study suggests the need for investment in technology enhancing measures like R&D and import of technology to support OFDI activity of Indian manufacturing firms.

JEL Classification: F14, D21, F10, D24,F23
Keywords: Exporting, Productivity, FDI, Trade, Indian manufacturing

To be presented at:
VIII Annual International Knowledge Forum Conference October 25- 27, 2013
Indian Institute of technology Bombay, Mumbai

[*] PhD candidate (Economics), Department of Humanities and Social Sciences, Indian Institute of Technology Bombay, contact: ronnythomas@iitb.ac.in
[+] Professor and Head, Department of Humanities and Social Sciences, Indian Institute of Technology Bombay, contact: knn@iitb.ac.in

1. Introduction

Foreign Direct Investment (FDI) and Exports as alternative modes of internationalistaion of firms has already been highlighted by the international trade and investment literature. Based on this evidence, theoretical literature in recent years accommodated formal models in which primary motivation for internationalization choices are not industry characteristics like transport costs, trade barriers and exchange rates but the heterogeneity in firm level productivity (see, for example, Melitz, 2003; Helpman et al., 2004)[1]. These theoretical studies are based on the major reasoning that exports and production abroad incur additional fixed cost compared to production in the home country (production for domestic market). The additional fixed costs involved in entering trade are in connection with learning and research on foreign markets, setting of new distribution channels abroad and up gradation of domestic production plants Melitz (2003). Again, fixed costs are higher for engaging direct production abroad than for exporting but foreign production permits the firm to curtail transportation costs (Brainard, 1997; Helpman et al. 2004). In this context, only most productive firms are able to manage production abroad and firms with lesser productivity export and least productive firms operate in the domestic market. Hence, there exists a positive relationship between firm productivity and the degree of participation in international markets. Firms with low productivity serve only the home market, while better performers will be able to succeed in export markets and firms with highest productivity will establish production plants in foreign markets, and engage in horizontal foreign direct investment (FDI).

Studies also indicate that Outward FDI from home country and exports can be complementary and substitutes to each other (see for details, Brainard, 1993; Head and Ries, 2003; Helpman et al., 2004). One argument is that investment by multinationals in other countries would substitute for their exports and therefore, reduce employment and income growth in the home country over a period of time (Brainard, 1997). Contrary to this, trade and outward FDI are found complementing each other having a positive relationship (Lipsey and Weiss, 1984). The

[1] Models of industry dynamics proposed by Javanovic (1982), Hopenhayn (1992) and Ericson and Pakes (1995) discuss in detail the extent of productivity heterogeneity which decides the entry, exit, growth and failure of firms in the market. Empirical review of this productivity studies are provided by Tybout (1993), Caves (1998), Bartlesman and Doms (2000) and Syverson (2011). Melitz (2003) introduced Hopenhayn type industrial dynamics to explain the dynamics of firm level participation in international trade. Following this study, Helpman et al. (2004) based on firm heterogeneity incorporated a model to explain the choice between export and FDI as alternative modes of internationalisation firms.

substitution/complementary relationship between OFDI and export depends on the nature of FDI undertaken by countries (Horizontal vs vertical FDI). Helpman et al. (2004) highlight a complementary relationship between exports and FDI in the case of vertical FDI and substitution in the case of horizontal FDI activity. Again, detailed examination of FDI and exports depends highly on the intervening factors and firm level characteristics (Brainard, 1997). In this context, technology acquisition efforts at the firm level plays an important role in determining firm level heterogeneity and henceforth internationalization activity (see, for example, Yeaple, 2005; Baldwin and Gu, 2004; Girma et al., 2008; Aw et al.,2011; Bustos, 2011). Therefore, a study on the relationship between OFDI, exports and technological efforts in an emerging country like India remains highly relevant.

Although, there exists a number of studies pertaining to various economies, attempt to address the issue in the context of India is limited. India adopted product market liberalisation as early in 1990s. The tariff rate liberalisation and equity ownership liberalization resulted in the growth of exports as well as change in the composition of export in the case of Indian manufacturing industries. In addition to this, worldwide liberalisation of FDI norms encouraged Indian firms to undertake investment abroad. As a result of this the nature of outward orientation of firms underwent changes during the liberalization phase. Firms generate revenue from the foreign market not only through exports but by investing in the foreign markets in the form of Outward foreign direct investment (OFDI)[2]. In the case of India outward investment started increasing in the later half of 1990's and maintained a phenomenal growth after 2000. In 2009, manufacturing accounted for almost 60 per cent of the cumulative stock of outward foreign direct investment from India. Whereas, in the same period, the share of manufacturing in the stock of outward foreign direct investment from developing countries was just 13.5 per cent. Indias total stock of outward FDI increase from 0.01 to 0.41 of the world total. For the same time period the FDI inflow increased from 0.08 to 1.01 (See, Appendix. A., Table. 1) In the case of destination, a large chunk of manufacturing outward FDI from India concentrates mainly in industrialized countries.

Based on this background, main objectives of our study are *first*, whether the choice between OFDI and export decision of the firms depend on the firm level productivity *second*, to test

[2]The nature of outward investment in India is in sharp contrast with other developing countries terms of; (i) sectoral imposition and, (ii) geographical destination (see Pradhan, 2007) .

whether exports and OFDI are complements or are they substitutes to each other in the case of Indian manufacturing industry *third*, to analyse the role of technological efforts in the form of R&D and import of technology on determining Outward Foreign Direct Investment. Our paper is an improvement over the past studies in two aspects. *First*, In contrast to previous work the empirical framework in this paper explicitly control for unobserved heterogeneity and allow for endogenous initial conditions simultaneously by using Dynamic Probit and Tobit models. *Second*, we include the technology efforts (in terms of R&D and import of technology) as a heterogeneity factor other than firm level productivity to determine complementarity and substitution between exports and OFDI in the context of Indian manufacturing firms.

The paper is organized as follows section 2 discuss the theoretical reasoning and empirical literature in this area. In section 3 we discuss the methodology. Section 4 discusses the descriptive statistics. Section 5 and 6 put forward results from stochastic dominance test and regression analysis. Section 7 Summarises and concludes the study.

2. Theoretical reasoning and literature review

Helpman (1984) in his theoretical model identified a complementary relationship between exports and FDI in the presence of Vertical FDI. The complementarity arises because of the trade flow of final goods from the foreign affiliate to the parent firms and the flow of intermediate goods for production from parent firm to foreign affiliate. Markusen (1984) predicts a complementary relationship between export and vertical FDI. By using a general equilibrium model they predicts that if identical countries are involved in producing identical bundles of goods then direct investment could act as a complement to commodity trade. Brainard (1997) proposed a model of trade with differentiated goods to identify the tradeoff between proximity to customers in terms of direct manufacturing abroad and concentration of production based on scale economics. The findings indicate proximity- concentration tradeoff between exports and horizontal FDI. The basic assumption of the model is that firms are likely to choose FDI over exports in the context of higher transport cost and trade barriers and low scale economics at the plant level. Transportation cost implies exports are more costly and investment barriers imply FDI is costly. In this case, firms gives up concentration of production at one plant, as the foreign plant is an affiliate of the domestic one and reap the advantages of proximity to the foreign market by setting up foreign production facility. Scale economics at the plant level gives advantage to concentration of production at one plant and subsequently choose to export to other

locations. In this case, production is concentrated in one plant and the firm gives up the proximity of the producing plant and foreign market. Markusen and Venables (2000) following Hecksher- Ohlin structure, with the presence of iceberg trade cost demonstrate how the presence of trade cost and factor mobility decides the internationalization of firms. Technology and factor endowment were identified important determinants of domestic production and MNE activity. In their model technology and factor endowment differences leads to the agglomeration of production and MNE activity in the host country. The important reasoning is that 'multinationals displace trade but also creates intra firm trade in addition to goods trade, which, in turn reduce factor price differences between countries'. Melitz (2003) identified that firms are heterogeneous in terms of productivity. This in turn causes the more productive firms to self select into the export market. Helpman et al. (2004) developed a model on firm's choice between export and horizontal FDI. They are the first to consider the productivity heterogeneity at the firm level as a key determinant of export/FDI decision. The theoretical model predicts least productive firms serve only the domestic market, relatively more productive firms serve the foreign market through exports and the most productive firms engage in FDI. Head and Ries (2004) indicate that an industry comprising of many firms or firms which makes many products chose both exports and FDI. However, they stated that 'the theory predicts exports and FDI are substitutes but empirical work finds out they are complements'. Hence, they concluded 'the analysis of whether to serve foreign market through export or FDI has been hampered by paradox'.

The empirical results on complementarity and substitution between OFDI and exports remains mixed. Based on the level of aggregation and methods used empirical studies can be classified into country level, industry level and firm level. Country level studies reports a dominant complementary effect between OFDI and exports. Clausing (2000) investigated in the case of US examined Multinational firms (from 1977-1994) and found a strong positive relationship between exports and OFDI. Subsequently, they concluded a complementary relationship between OFDI and exports. Pfaffermayr (1994) also reports similar result in the case of Austria using time series econometrics for the period from 1969-1991. They found a two way causality between exports and FDI. Again, the empirical studies on the industry level have produced mixed results. Lipsey and Weiss (1981) show a positive relationship between US exports and FDI for the period 1970 in the case of 14 sample industries. The results indicate that

the higher a firms output in the foreign market, higher they export form the home country. Brainard (1997) validated her theoretical proposition based on 'proximity-concentration trade-off' by using bilateral trade and investment information obtained from USA. The study considered bi-lateral trade and investment information from US for the period 1989 disaggregated at country and industry level. The evidence in the study suggests that the multinational activity is more likely in the presence of transport cost and trade barriers. Hence, concluded a substitution between trade and FDI. Blonigen (2001) reports a substitution effect between the production of Japanese automobile parts in the USA and the Japanese exports of automobile parts to the USA. However, they also found complementary relationship in the case for final good which are vertically linked. At the firm level, Lipsey and Weiss (1984) reports strong complementary effects between the US production of intermediate goods in the host country and the US exports in the same region for the period 1970. Oberhofer and Pfaffermayr (2012) using probit model identified a complementary relationship between exports and OFDI for Austrian firms. Pradhan (2007) employing data from Indian manufacturing firms for the period 1991-2000 explains complementary between export intensity and OFDI. Further, firm level studies also identified the role of firm size, age of the firm and R&D in determining the outward FDI of the home country firms. Narayanan and Bhat (2011) studied the technology sourcing and outward FDI in the case of 130 firms in the high- tech information technology industry in India. The findings of the study indicate that in-house R&D efforts, import of capital goods and technology are important determinants of outward investment for the IT industries in India. Sasidharan and Kathuria (2011) for Indian manufacturing industry found positive association between FDI and R&D for the period from 1994 to 2004. Using a Heckman two-step procedure to correct for self selection problem they identified that FDI and R&D are complementary. The study reported FDI inflow induces foreign firms in high tech industries to invest in R&D. Goldar (2012) investigated exporting decision of pharmaceutical firms in India for the period 2000-2011 using Tobit model. The study reported a substitution relationship from OFDI to exports. The empirical evidence comparing productivity levels of exporters and multinationals firms mostly supports the theoretical model proposed by Helpman et al. (2004). Studies in this category follows two streams of analysis; first, follows Head and Ries (2003) in comparing mean values (see for example, Castellani and Zanfei, 2004; Kimura and Kioyata, 2004) The second category follows Girma, Kneller and Pisu (2005) in using Kolmogrov-

Smirnov tests of stochastic dominance, (see, for example, Delgado et al., 2002; Girma, Gorg and Strobl, 2004; Wagner, 2006; Arnold and Hussinger, 2010).

3. Methodology

3.1 Method for comparing TFP between OFDI firms and other firms(exporting, domestic)

Theoretical and empirical literature discussed in section 2 highlights that the choice of firms to undertake OFDI and exports depends on the firm level productivity. For comparing the productivity levels of different groups we estimate firm level productivity using the Levinsohn and Petrin (2003) method. To examine this we have to compare and rank/order the productivity levels of Domestic, Exporting, OFDI firms. As a first step we use t- test to compare the mean productivity levels of firms (along with other firm characteristics). Mean comparison of firm productivity in terms of t-test exclude the evidence of dominance of the cumulative distribution of productivity for the comparing group over the other. To test for the difference in all moments of the conditional distribution, we use Kolmogorov-Smirnov (K-S) test of stochastic dominance. We use the concept of first order stochastic dominance of one distribution over the other. Similar method has also been adopted by Delgado et al. (2002). Given, two independent random samples of productivity realizations. One sample, $X_{1,\ldots\ldots\ldots,}X_{n,}$ is drawn from a distribution function 'F' and the other sample is drawn from 'K' on same firm level productivity. F corresponds to the group of interest, for example the firms which undertake OFDI, and K to the comparison group, for example Indian exporters. First-order stochastic dominance of F with respect to K is defined as: $\mathrm{F}(x) - \mathrm{K}(x) \leq 0$ uniformly in x, with strict inequality for some x .If the hypotheses holds, and the inequality is strict for at least some $x \in \Re$, we say that S stochastically dominates F[3]. We use two-sided and one-sided Kolmogorov-Smirnov stochastic dominance tests. The two-sided Kolmogorov-Smirnov statistic tests the hypotheses that both distributions are identical, the null and alternative hypotheses are stated below:

$$H_0 : F(x) - K(x) = 0 \ \textit{for all}\ x \in \Re$$
$$H_1 : F(x) - K(x) \neq 0 \ \textit{for some}\ x \in \Re \qquad (1)$$

[3] In other words the cumulative Distribution function of a variable, for example *x*, in the first random sample lies entirely to the right of the corresponding cumulative distribution function in the other random sample. For detailed discussion see Delgado et al (2002)

In comparison to two sided test, hypotheses for one-sided Kolmogorov-Smirnov test of the dominance of F(x) with respect to K(x) can be formulated as

$$\begin{aligned} &H_0 : F(x) - K(x) \le 0 \ \textit{for all } x \in \Re \\ &H_1 : F(x) - K(x) > 0 \ \textit{for some } x \in \Re \end{aligned} \tag{2}$$

For the one-sided test the Kolmogorov-Smirnov statistic or D-statistic is given by $\delta_N = \sqrt{(n.m)/N} \max_{1 \le i \le N} \left| F_n(x_i) - K_m(x_i) \right|$ and for two sided test it is given by $\eta_N = \sqrt{(n.m)/N} \max_{1 \le i \le N} \left| F_n(x_i) - K_m(x_i) \right|$ where n and m are the sample sizes from the empirical distributions of F and K respectively, and N = n + m. Acceptance of the null hypotheses (2) implies that the distribution of F dominates K. To establish stochastic dominance of the distribution of F with respect to K requires the rejection of the null hypotheses in the two-tailed test in equation (1) and not in one tailed test in equation (2)

3.2 Method for identifying the determinants of probability of OFDI and OFDI share

One way to capture the extent and nature of complementarity and substitution between exports and OFDI is by modeling the determinants of OFDI of firms. By this way, we could also capture the role of technology in determining OFDI activity. Based on the literature discussed in section 2 we examine the determinants of probability of OFDI and OFDI share separately. We use dynamic Probit model to estimate the determinants of the probability of OFDI and Tobit model for OFDI share ($OFDI_{share}$). We use dynamic random effects Probit method proposed by Wooldridge (2005) for our analyses. By using this method, we take care of two problems, *first*, the treatment of the unobserved heterogeneity especially in relation to the covariates and *second*, the initial condition of the OFDI status. The decision of the firms to invest abroad may depend on its past OFDI status. Several approaches are proposed to deal with this problem. Heckman (1981) considered the initial values as endogenous variables with a probability distribution conditional on the exogenous variables and unobserved heterogeneity. The method is to approximate the conditional probability of initial values with reduces-form equations using the available pre-sample information. The main problem of this method in practice is that the approximation of the conditional probability of initial values leads to simultaneous estimation problem of the reduces-form and structural model and create computational burden (for

discussion, see, for example, Wooldridge, 2005). Wooldridge (2005) method has two advantages compared to the approach proposed by Heckman (1981). *First*, in Wooldridge (2005) observed covariates and the initial condition determine the unobserved firm specific heterogeneity. Where, unobserved heterogeneity follows a specific distribution and *Second*, it takes into account the problem of attrition bias where attrition is made to depend on the initial condition[4]. Therefore, we use Wooldridge (2005) method and assume a distribution of the unobserved heterogeneity that allows unobserved time invariant firm level heterogeneity to be correlated with the initial condition and moments of the covariates[5]. We use the following specification of the model:

$$OFDI_{it} = \begin{cases} 1 & \beta_1 EXP\,\text{int}_{it-1} + \beta_2 TFP_{i,t-1} + \beta_3 OFDI_{it-1} + \beta_4 Z_{it} + u_i + \varepsilon_{it} > 0 \quad i = 1,\ldots..,N, \\ 0 & otherwise \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad t = 1,\ldots..,T. \end{cases} \quad (3)$$

Here the dependant variable $OFDI_{it}$ is a value 1 if the firm Undertakes OFDI in period t and 0 otherwise. EXPint is the variable capturing export intensity. X captures the technology efforts [this includes the R&D intensity(RDint), Import of technology- capital(Impcint) and technology know-how(Imprint). Z_{it} a set of firm specific characteristic which includes firm size (Size), age (Age), ownership (FP). μ_i is unobserved time invariant firm heterogeneity and ε_{it} is an idiosyncratic error that is assumed to be normally distributed and uncorrelated with the regressors. In our model we assume that EX_{it}, X_{it}, Z_{it} are strictly exogenous conditional on μ_i.

In other words, we assume that unobserved heterogeneity can be expressed as a liner combination of firm-specific time averages of the regressors and the initial condition of the dependent variable as follows:

$$\mu_i = \alpha_0 + \alpha_1 OFDI_{i0} + \alpha_2 \overline{EXP\,\text{int}_i} + \alpha_2 \overline{X_i} + \alpha_2 \overline{Z_i} + a_i \quad \text{and} \quad \left(a_i \mid OFDI_{i0,} \overline{EXP\,\text{int}_{i,}}, \overline{X_{i,}}\ \overline{Z_{i,}}\right) \sim N\left(0, \sigma_a^{\,2}\right) \quad (4)$$

Where, it is assumed that $(\varepsilon_{it} \mid OFDI_{i,t-1,} EXP\,\text{int}_{it-1}, X_{it-1}, Z_{it}, \mu_i) \sim N\left(0, \sigma_a^{\,2}\right)$ (5)

Hence, for example, in our model the probability of OFDI at time t is given by:

[4] This has a major advantage because a lot of observations have to be deleted as the estimation techniques do not allow the use of panels with gaps. See for details (Wooldridge, 2005).

[5] One solution to this problem is to use 'fixed-effects approach'. The conditional distribution of unobserved heterogeneity does not play an important role in the estimation process of this approach. However, the fixed-effects approach may lead to biased results as it suffer from the so called 'incidental parameter problem'. See for detailed discussion, Hanore (1993), Arellano and Hanore (2001), Orme (2001)

$$\Pr(OFDI_{it} = 1/OFDI_{io},....,OFDI_{i,t-1,},EXP\text{int}_{it-1},X_{it-1},Z_{it},\overline{EXP\text{int}_i},\overline{X_i},\overline{Z_i})$$
$$= \varphi\left(\beta_1 OFDI_{i,t-1},\beta_2 EXP\text{int}_{i,t-1}+\beta_3 X_{it}+\beta_4 Z_{it}+\alpha_0+\alpha_1 OFDI_{i0}+\alpha_2\overline{EXP\text{int}_i}+\alpha_2\overline{X_i}+\alpha_2\overline{Z_i}+a_i\right) \quad (6)$$

Estimation can be carried out by standard random effects Probit model with $OFDI_{10,}\overline{EXP\text{int}_i},\overline{X_i},\overline{Z_i}$ as additional regressors. We use Tobit model to examine the determinants of OFDI share (OFDI divided by total assets). Here, a lot of firms reports zero value of OFDI, hence left censoring has to be taken into account. The OFDI share is modeled by the following random effects tobit specificaton:

$$OFDI_{Share\,it} = \max\left[0, \alpha_1 OFDI_{i,t-1}+\alpha_2 EXP\text{int}_{it-1}+\alpha_3 X_{it}+\alpha_4 Z_{it}+u_i+\varepsilon_{it} \;\; if \;\; OFDI_{share}>0\right] \quad (7)$$

The rest of the specification remain similar to the Probit model.

To check the robustness of the finding obtained from Tobit (OFDI share) estimates we use System - GMM method proposed by Blundell and Bond (1998) method to estimate the determinants of OFDI share. Here, we use the following specification:

$$OFDI_{Share} = \beta_1 EXP\text{int}_{it-1}+\beta_2 EXP\text{int}_{it-2}+\beta_3 TFP_{i,t-1}+\beta_4 TFP_{i,t-2}+\beta_5 OFDI_{it-1}+\beta_6 X_{it}+\beta_7 Z_{it}+u_i+\varepsilon_{it} \quad (8)$$

This estimation technique produces appropriate results when *Number of observations*(N) is large and *Time period*(T) is small and takes care of endogeneity. Managerial efficiency, experience and skill of workers employed by the firm remains unobserved over time (unobserved firm characteristic) and may affect the OFDI decision of the firm. This would lead to spurious correlation between current OFDI and past OFDI status and other firm characteristics. GMM method provides more appropriate estimates when unobserved firm-specific effects are correlated with other regressors (Blundell and Bond, 1998). Further, firm level variables may be serially correlated over time and jointly determined by OFDI. In our analysis, we use one step GMM method where, lagged levels of independent variable and dependent variable is instrumented for regression at differences and lagged difference as instruments for the regression in levels. Thus it allows us to examine the cross-sectional relationship between the levels of OFDI and firm characteristics without discarding the firm-specific effect. Here, the assumption is that the differences are not correlated with a firm-specific effect compared to levels. Following (Blundell and Bond, 1998) we check the validity of the instruments using 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.

4. Data and construction of variables

We use firm level data from Prowess Database. The sample period is from the year 1998 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 large cross section of manufacturing, services, utilities and financial industries. In our study we use only manufacturing firms – an average of 4000 firms. It includes the data on exporting, non-exporting (domestic), foreign and outward investing firms. The data is curled out based on the National Industrial Classification (NIC-2008) provided by the Central Statistical Organization. We use an unbalanced panel, where the observations vary across time and firm characteristics. In the case of few missing data and cross checking we accessed the company website and online sources. Apart from firm level data, we also use data obtained from Annual Survey of Industries and National Sample Survey Organization (NSSO) for the construction of variables.

4.1 Construction of variables:

(a)Firm specific variables:

Outward Foreign Direct Investment (OFDI) :

Investment by Indian Multinationals in their overseas subsidiaries divided by the total asset. We include only those firms which undertakes OFDI in manufacturing activity.

Import of Technology

We use two channels of import of technology by manufacturing firms. Technology imports in the form of capital goods import embodied technology import) and technology imports in the form of Know-how i.e., imports payments made in terms of royalties and fees (dis-embodied technology imports). Capital goods import intensity **(Impcint**) (is the ratio of value of import of capital goods to the sales turnover and import of dis-embodied technology import intensity is the ratio of value of total import payments on royalties and fees etc to sales turnover **(Imprint).**

Export Intensity (Expint)

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

Firm Size (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 of the firm (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 (FP)

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 (RDint)

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

(b) Variables used for production function estimation

Capital stock

To construct capital stock at the firm level, 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 investment* for the current 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. Thus, in our case, year 2004-2005 has been selected as the base year. The 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 purpose. Hence we subtracted purchase of finished goods from

sales to arrive at the firms manufactured output at a given time. 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 (Ministry of Statistics and Programme Implementation).

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

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.

5. Descriptive statistics

Table 1 reports the summary of key firm characteristics for the study period (total sample). In our study, the dataset includes hundred percent export oriented firms as well as firms which cater to the domestic market (export intensity range from 0 to 100). The average age of the firms in the sample is 27 years which indicates that on average, firms in the sample are fairly

experienced. Average value of Import of technology in terms of capital goods import (embodied) and import of technology through payment of royalties (dis-embodied) shows capital goods import is more preferable means of technology import. We include only those firms which report capital, raw material expense and energy (indicated by electricity expenses) of a minimum of one crores (Rupees).

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Size	164.79	1353.22	0.0031	86865.86
Output	168.65	1042.85	4.014	57608.37
Labour	750.10	3277.11	10	180648
Energy	7.02	30.89	1.00	1527.24
Rme	74.91	530.40	1.00	35933.35
Capital	104.89	686.48	1.00	57562.54
Age	26.69	19.40	1.00	121
Expint	12.64	26.44	0	100
R&D int	0.16	1.20	0	54
TFP	1.18	1.30	0.02	3.14
Impcint	0.98	5.09	0	79.30
Imprint	0.22	26.16	0	10.78
OFDI	0.78	5.01	0	48.20

Note: Rme- Raw material expenses. Rme, energy, capital and output in Rupess crores. Impcint – import of capital good intensity (import of capital goods / sales turnover). Imprint- import of technology knowhow intensity (dis-embodied technology import /sales turnover). R&D int (R&D expenses as percentage of sales). Total number of observations- 44421.

Table. 2 compares the mean between different types of firms: *domestic*, *exporting and OFDI.* We use t-test to find out if the mean difference is significant (the comparison groups for exporting firms are domestic firms, and OFDI firms are exporting firms). On an average, exporting firms are more productive compared to the domestic firms but this productivity difference is not significant enough to reach a conclusion. However, it turns out that OFDI are more productive than exporting and domestic firms. OFDI firms on an average produces more output, labour and capital intensive compared to exporting firms. It is clear that on average OFDI firms are bigger in size compared to the exporting firms. Further, OFDI firms pay higher worker compensation. Age of the firm indicate that OFDI firms are far more experienced in the market compared to exporting in the market.

Table 2: Comparison of means between different types of firm (firm charecteristics)

	Domestic		Exporting		OFDI	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
TFP	1.097	1.228	1.164328	1.271	2.345 *	1.193
Size	43.018	4411.435	263.2181*	1817.035	826.292*	4203.265
Output	51.041	3286.369	263.5751*	1389.509	800.450*	3136.415
Labour	295.578	6131.487	1120.639*	4273.273	2517.774*	5905.354
Energy	3.368	84.008	9.505*	39.911	24.024*	81.152
Rme	25.896	1752.106	115.148*	704.524	356.131*	1670.393
Capital	33.922	2193.812	162.908*	916.446	515.777*	2094.452
Age	25.878	19.87843	27.470*	18.914	31.237*	19.830
OFDI	-	-	-	-	29.935	741.413
Expint	-	-	23.187	32.222	-	-
Impcint	.512	5.760	1.367	5.567	1.734	5.649
Imprint	0.053	0.400	0.365	35.418	0.090	0.420
R&D int	0.110	2.392	0.241*	1.094	0.646	2.335
Number of obs		24529	24225			3176

Note : Domestic firms correspond to the firms with no internationalization activity (no export and OFDI). Exporting firms are categorized as firms which are exporting and not involved in OFDI. OFDI firms are the MNEs from india.. Rme- Raw material expenses. Impcint – import of capital good intensity (import of capital goods / sales turnover). Imprint- import of technology knowhow intensity (dis- embodied technology import /sales turnover). * indicates mean difference is significant at 5 percent level. The comparison group is exports for OFDI firms and domestic for exporting firms.

6. Results and Discussion

6.1 Comparing productivity between OFDI and other firms (Exporting and Domestic)

Table. 3 reports one sided and two sided K-S test of stochastic dominance (D- statistic and P-values in parenthesis). The comparison group column provides the names of the groups under comparison (for example, 'F vs. K'), while the comparison is of the TFP distributions of each group. In group 1, we compare the TFP between exporting and domestic firms. In the case of two sided test we reject the null hypotheses of equality of productivity distribution for exporting and domestic firms expect for the years 2002 and 2004. Corresponding one sided test indicate the acceptance of null hypotheses for almost all years. Hence, the results indicate a clear stochastic dominance of exporting firms over domestic firms. Based on the results reported for group 2, we strongly reject the null hypotheses of equality of the cumulative distribution in all the two-sided tests for the group OFDI vs exporting group for the period from 2004-2009.

Table 3: K-S test of Stochastic Dominance f TFP (Selected years)

Year	No. of Observations			(F) Exporting vs Domestic (K) *(Group 1)*		(F) OFDI vs Exporting (K) *(Group 2)*		(F) OFDI VS Domestic (K) *(Group 3)*	
	Domestic	Exporting	OFDI	One-sided	Two-sided	One-sided	Two-sided	One-sided	Two-sided
1998	371	339	103	- 0.006	0.353	0.055	0.013	- 0.054	0.273
				(0.91)	(0.00)	(0.07)	(0.87)	(0.87)	(0.00)
2000	1532	1831	122	- 0.031	0.654	0.012	0.654	- 0.043	0.205
				(0.86)	(0.00)	(0.54)	(0.64)	(0.94)	(0.00)
2002	1811	1832	233	0.075	0.129	0.075	0.129	- 0.005	0.378
				(0.44)	(0.35)	(0.14)	(0.09)	(0.96)	(0.00)
2004	1980	2136	275	- 0.019	0.089	-0.002	0.569	- 0.062	0.369
				(0.93)	(0.32)	(0.96)	(0.00)	(0.98)	(0.00)
2005	2115	2441	301	- 0.053	0.325	-0.033	0.220	- 0.032	0.393
				(0.88)	(0.00)	(0.91)	(0.00)	(0.95)	(000)
2007	1969	2546	439	- 0.023	0.187	-0.063	0.195	- 0.043	0.429
				(0.73)	(000)	(0.98)	(0.00)	(0.99)	(0.00)
2009	1942	2513	517	- 0.038	0.214	-0.008	0.190	- 0.543	0.512
				(0.81)	(000)	(0.95)	(0.00)	(0.89)	(0.00)

Note: exact p- values are given in brackets. Domestic firms correspond to the firms with no internationalization activity (no export and OFDI). Exporting firms are categorized as firms which are exporting and not involved in OFDI. OFDI firms are the MNEs from india.

As we never reject the null in the one-sided test for the same comparison group, we can conclude that the ranking of TFP for the firms which undertakes OFDI is higher than the firms which export for the period from 2004 onwards. From this exercise, we could infer results are in support of the model proposed by Helpman et al. (2004) where they proposed that productivity distribution of OFDI are higher compared to the exporting and domestic firms.

6.2 Determinants of probability of OFDI and OFDI share

Table 4: Dynamic Probit model

Pr(OFDI>0)	Full Period		1998-2003		2004-2009	
	Coef.		Coef.		Coef.	
R&D int_{t-1}	0.021**	(0.011)	0.043**	(0.018)	0.024***	(0.003)
$Impcint_{t-1}$	0.022***	(0.005)	0.033***	(0.005)	0.008***	(0.001)
$Imprint_{t-1}$	-0.137	(0.083)	-0.081	(0.157)	-0.013	(0.018)
TFP_{t-1}	0.007**	(0.024)	-0.005	(0.179)	0.049***	(0.030)
TFP_{t-2}	0.005	(0.145)	0.091	(0.182)	-0.019	(0.028)
$Expint_{t-1}$	0.256***	(0.003)	0.007***	(0.002)	0.321***	(0.002)
$Expint_{t-2}$	0.009***	(0.004)	0.011**	(0.021)	0.001***	(0.001)
$OFDI_{t-1}$	0.023***	(0.001)	0.027***	(0.002)	0.056***	(0.002)
FP	-0.028	(0.133)	-0.023	(0.263)	-0.107	(0.044)
Age	0.022***	(0.002)	0.013***	(0.003)	0.027***	(0.005)
Size	0.012***	(0.001)	0.004***	(0.002)	0.062***	(0.000)
cons	-5.403	(0.099)	-6.571	(0.162)	-0.57	(0.081)
Year	Yes		Yes		Yes	
Industry	Yes		Yes		Yes	
Wald chi^2	598.34		102.55		601.08	
Log likelihood	-4160.52		-1137.52		-4151.94	
Number of observations	29089		7363		21726	

Note: ***Significant at the 1% level. **Significant at the 5% level. Standard errors are given in the brackets.

Table. 4 report the estimated results (marginal effects) from the random effects probit model. The results for the subsample for the period form 1998-2003 and 2004-2009 is given separately in the same table. The full period result indicates a complementary relationship between OFDI and exports. The coefficient of lagged value of exports variable is positive and is significant. Lagged values of Total Factor Productivity is significant indicating the OFDI of firms are based on the past productivity levels. R&D and capital goods import intensity indicating the technological efforts undertaken by the firm turns out significant and positive. Following previous studies, here we control for age, size, and ownership. Lagged values of R&D intensity is significant for the full period as well as for the sub-period. This indicates that OFDI highly

depends on firms level efforts to spend on innovative activities. The import of technology through capital goods turns out to be significant determinant of probability of undertaking OFDI compared to import of technology in the form of technology-know how by paying royalties and fees. Further, the probability OFDI is also dependent on the experience of the firm in the market as shown by the coefficient of the variable AGE. The sub- period results also indicate that exports is significant and positive determinant of OFDI of firms in the Indian manufacturing industry. The more experienced the firm in the industry the higher is the chance of undertaking OFDI. Further the OFDI in the current period is also depend on the past OFDI decision. Past experiences in the OFDI market allows firms to reap the economics of scale associated with participating in the FDI. However, the TFP is significant only at the later period of liberalization (2004-2009).

Table 5: Dynamic Probit estimation of OFDI (New firms Vs Established firms)

Pr(OFDI>0)	New firms		Established firms	
	Coef.		Coef.	
R&D int_{t-1}	0.010**	(0.014)	0.040***	(0.008)
$Impcint_{t-1}$	0.022***	(0.008)	0.015***	(0.007)
$Imprint_{t-1}$	-0.699	(0.275)	-0.007	(0.094)
TFP_{t-1}	- 0.263	(0.169)	0.001***	(0.006)
TFP_{t-1}	0.328	(0.185)	0.004	(0.083)
$Expint_{t-1}$	0.013***	(0.004)	0.008***	(0.002)
$Expint_{t-2}$	0.003***	(0.001)	0.018***	(0.003)
$OFDI_{t-1}$	0.114	(0.213)	0.453***	(0.005)
FP	0.791	(0.353)	-0.014	(0.150)
Size	0.003***	(0.001)	0.004***	(0.002)
cons	-6.046	(0.299)	-5.462	(0.136)
Industry	Yes		Yes	
Year	Yes		Yes	
Wald chi^2		231.37		353.75
Log likelihood		-989.28		-2998.90
Number of observations		8337		19813

Note: ***Significant at the 1% level. **Significant at the 5% level. Standard errors are given in the brackets.

Pradhan (2007) and Narayanan (2011) report that the OFDI decision of the firm also depend on the experience of the firms in the market. Hence, we divide the sample based on the level of participation in the market based on the year of incorporation. All firms incorporated after 1990 is taken as new firms and before as established. The results of this exercise are given in Table. 5.

The results indicate export- OFDI complementarity for established firms. However, Productivity turns out to an important element in deciding OFDI only in the case of established firms.

We use Tobit model to identify the determinants of OFDI share. In other words, this explains the question of success of firms in the international market or extent of OFDI undertaken by the firms abroad. Table. 6 report the results from Tobit model. The lagged variable indicating past export status is positive and significant indicating complementary relationship between OFDI and past export performance of the firms. The results are similar to the findings from Probit model. However, in the case of classification based on young and matured firms, the result indicates that TFP is an important determinant only in the case of matured firms in the market as indicated in Table. 7 (similar to Probit results). The decision to invest in OFDI depends on the past OFDI performance of frims only in the case of matured firms. Investments in R&D and technology imports are important determinants of OFDI for both new and established firms in the market. Our result supports the findings reported by Pradhan (2007) for Indian manufacturing firms, Pradhan and Singh (2009) for Indian auto motive industries, Narayanan and Bhat (2011) for Indian IT industries.

Table 6: Dynamic Tobit estimation results

$OFDI_{Share}$	Full Period		1998-2003		2004-2009	
	Coef.		Coef.	.	Coef.	
$R\&D\ int_{t-1}$	0.003***	(0.012)	0.021***	(0.004)	0.009***	(0.007)
$Impcint_{t-1}$	0.566***	(0.037)	0.022***	(0.002)	0.015***	(0.002)
$Imprint_{t-1}$	0.389	(0.984)	-0.317	(0.371)	-0.451	(0.267)
TFP_{t-1}	0.588***	(0.005)	0.299	(0.322)	0.009***	(0.006)
TFP_{t-2}	0.883***	(0.022)	0.182	(0.287)	0.001**	(0.015)
$Expint_{t-1}$	0.153***	(0.308)	0.004***	(0.006)	0.044**	(0.007)
$Expint_{t-2}$	0.525***	(0.407)	0.003	(0.107)	0.165***	(0.001)
$OFDI_{share\ t-1}$	0.029***	(0.010)	0.017***	(0.001)	0.021***	(0.005)
FP	-0.467	(0.063)	-0.012	(0.084)	-0.556	(0.038)
Age	0.513***	(0.095)	0.012***	(0.008)	0.873***	(0.004)
Size	0.054***	(0.003)	0.003***	(0.000)	0.068***	(0.005)
_cons	-13.567	(0.911)	-10.809	(0.387)	-14.321	(0.151)
Year	Yes		Yes		Yes	
Industry	Yes		Yes		Yes	
LR chi^2	7710.48		11500.92		5790.44	
Log likelihood	-19796.12		-27008.55		-15004.81	
Number of obs	29089		7363		21726	

Note: ***Significant at the 1% level. **Significant at the 5% level. Standard errors are given in the brackets.

Table 7: Dynamic Tobit results (New firms Vs Established firms)

$OFDI_{Share}$	New firms		Established firms	
	Coef.		Coef.	
R&D int_{t-1}	0.005***	(0.079)	0.032***	(0.003)
$Impcint_{t-1}$	0.008***	(0.009)	0.014***	(0.007)
$Imprint_{t-1}$	-0.329	(0.037)	-0.058	(0.423)
TFP_{t-1}	0.023	(0.119)	0.776***	(0.004)
TFP_{t-2}	0.032	(0.134)	0.003	(0.045)
$Expint_{t-1}$	0.011***	(0.006)	0.007***	(0.003)
$Expint_{t-2}$	0.006**	(0.008)	0.003***	(0.009)
$OFDI_{share\ t-1}$	0.132	(0.024)	0.352***	(0.007)
FP	- 0.553	(0.312)	-0.013***	(0.004)
Size	0.015***	(0.123)	0.003***	(0.003)
_cons	-3.887	(1.231)	-13.089	(2.887)
Year	Yes		Yes	
Industry	Yes		Yes	
LR $chi^2(11)$	601.02		898.19	
Log likelihood	-5401.92		-20779.74	
Number of obs	8337		19813	

Note: ***Significant at the 1% level. **Significant at the 5% level. **Significant at the 10%. Standard errors are given in the brackets

We test the robustness of the findings from Tobit and Probit model using the dynamic GMM model proposed by Blundell and Bond (1998). Table. 8 reports the findings from GMM estimation. The lag variable indicating past export status turns out to be significant for the full period as well as for the sub period. This result indicates a complementary relationship between exports and OFDI and supports the findings from the Tobit model. The coefficient values of OFDI lag, indicating past outward investment by firms, is positive and significant. This indicates that already established firms in the foreign market have an added advantage in investing abroad. Firms which invest abroad may be having the advantage of information of the foreign market, distribution channels etc. Hence the prior experience in the foreign market induces firms to invest more abroad to reap the advantages of economics of scale and agglomeration. Here, we control for R&D intensity and technology imports in the form of capital goods are important determinants of OFDI from India. Here, we could infer that the technology efforts undertaken by firms in the home country increases the capability of firms to invest abroad. OFDI participation is highly depends on the experience of the firm in terms of age in the market.

Table 9: Dynamic model on determinants of OFDI share [Robustness check (SYS-GMM)]

$OFDI_{Share}$	Full Period		1998-2003		2004-2009	
	Coef.		Coef.		Coef.	
TFPt-1	0.015***	(0.003)	0.069	(0.582)	0.002***	(0.001)
TFPt-2	-0.011	(0.190)	0.016	(0.398)	- 0.122	(0.008)
EXPt-1	0.034***	(0.005)	0.004***	(0.007)	0.163***	(0.002)
EXPt-2	0.006	(0.886)	0.018	(0.985)	0.012**	(0.009)
$Imprint_{t-1}$	-0.086	(1.522)	-0.160	(0.324)	0.030	(0.838)
$Impcint_{t-1}$	0.013***	(0.003)	0.012***	(0.004)	0.032***	(0.006)
$OFDI_{share\ t-1}$	0.043***	(0.003)	0.034***	(0.076)	0.053***	(0.002)
$OFDI_{share\ t-2}$	0.012**	(0.011)	0.001**	(0.011)	0.017	(0.112)
$R\&D\ int_{t-1}$	0.112***	(0.008)	0.452***	(0.001)	0.002***	(0.000)
FP	- 0.223	(0.071)	0.502	(0.670)	- 0.115	(0.063)
Size	0.023***	(0.000)	0.005***	(0.000)	0.049***	(0.004)
Age	0.032***	(0.003)	0.007***	(0.009)	0.040***	(0.000)
Year	Yes		Yes		Yes	
Industry	yes		yes		yes	
N.Observations	29001		7425		21726	
Sargan Difference test	0.298		0.116		0.372	
Sargan test	0.332		0.423		0.225	
AR(1) p-value	0.574		0.382		0.943	
AR(2) p-value	0.787		0.402		0.866	
Wald Test Chi^2	321.76		211.47		589.872	

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.

7. Summary and conclusion

In this study we examine the relationship between OFDI, exports and technological efforts in the case of Indian manufacturing industry. The three key hypotheses examined are *first*, whether choice between export and outward investment decision of the firms depend on the firm level productivity. We test empirical regularity that more productive firms undertake Outward Foreign Direct Investment (OFDI) compared to firms which chose exports as mode of internationalization (OFDI Vs Exports). *Second*, whether exports and outward investment are complements or are they substitutes and *Third*, to analyse the role of technology enhancing efforts in the form of R&D investment and import of technology (both embodied and dis-embodied technology imports) in determining firm level OFDI. We use firm level data provided by the Centre for monitoring Indian Economy (CMIE) for the period 1998-2009 for analysis. The Preliminary analysis indicate that, on an average, OFDI firms are bigger in size, are more experienced in the market, investment more on technology (high R&D intensity and technology imports) and pay higher wages compared to the exporting firms. In terms of productivity OFDI firms are more productive compared to the exporting firms and non-exporting firms. Following previous studies we examine the stochastic dominance of productivity distribution of OFDI firms compared to exporting firms and purely domestic firms. We use one-sided and two-sided Kolmogorov-Smirnov stochastic dominance tests (K-S test). The results indicate stochastic dominance of productivity distribution for OFDI firms over exporting firms for the periods from 2004-2009. The findings support the theoretical work proposed by Helpman et al. (2004). Similar results are reported by empirical studies by Kimura and Kiyota (2004) for Japan, Wagner (2006) in the case of Germany, Arnold and Hussinger (2010) for Germany.

We employ dynamic Probit and Tobit models to anlayse the determinants of probability of OFDI and OFDI share. We use sub-sample of firms divided by the period [(1998-2003) & (2004-2009)] and the experience in the market (young & mature, based on age) for analysis. In the case of probability of undertaking OFDI, full period and sub-period results indicates strong evidence supporting the fact that OFDI and exports are complementary. R&D intensity and technology imports in the form of capital goods are significant determinants of probability of OFDI. Results also support the hypotheses that OFDI decision depends on firm level productivity. However, the sub-period results confirm the fact that this holds only to the later

period of liberalistaion (period form 2004-2009). Matured and more experienced firms have high probability of undertaking OFDI. Results from Tobit model indicates that export intensity is positive and significant in determining the OFDI share, indicating complementary relationship between two alternative modes of internationalization. R&D intensity and import of technology in the form of capital goods import are important determinant of OFDI share. TFP is positive and significant indicating selection of firms into OFDI based on productivity. We test the robustness of this findings using dynamic GMM (sys-GMM) method. The findings remain similar to the Tobit results. Export intensity turned out to be positive and significant in determining OFDI. R&D intensity and embodied technology imports (in the form of capital goods imports) are are strong determinants of OFDI. Similar finds are reported in the context for many other countries. For example, Oberhofer and Pfaffermayr (2012), Lipsey and Weiss (1984) reports similar results.

References

Arnold, J. and Hussinger, K. (2010), 'Exports versus FDI in German manufacturing: Firm performance and participation in international markets', *Review of International Economics*,Vol. 18, No. 4, pp. 595–606.

Aw, B. Y., Roberts, M. J and Xu, D. Y. (2011). 'R&D Investment, Exporting, and productivity Dynamics', *American Economic Review*, Vol. 101, No. 4, pp. 1312–4.

Arellano, M. and Honore, B. (2001), 'Panel Data Models: Some Recent Developments', Handbook of Econometrics', Vol.5, Elsevier Science, Amsterdam.

Balakrishnan, P., Pushpangadan, K and Babu, M. S. (2000), 'Trade Liberalisation andProductivity Growth in Manufacturing: Evidence from Firm-Level Panel Data', *Economic and Political Weekly*, Vol. 35, No. 41, pp. 3679-82.

Baldwin, J. R. and Gu, W. (2004), 'Trade liberalisation: Export-market participation, productivity growth and innovation', *Oxford Review of Economic Policy*, Vol. 20, No.3, pp.372–392.

Bartelsman, E. J and Doms, M. (2000),'Understanding Productivity: Lessons from Longitudinal Microdata', *Journal of Economic Literature*, Vol. 38, No.3, pp.569-594.

Bernard, A. and Jensen, J. B. (1999), 'Exceptional exporters performance: cause, effect or both?', *Journal of International Economics*, Vol. 47,No.1, pp. 1-25.

Bigsten, A., Collier, P., et al. (2002), 'Do African Manufacturing Firms Learn from Exporting?', *The Journal of Development Studies*, Vol. 40, No.3, pp. 115-141.

Bhat, S. and Narayanan, K. (2010), "Technological Efforts and Performance of IT MNCs from India", in Siddharthan, N.S. and Narayanan, K. (eds.): Indian and Chinese Enterprises: Global Trade, Technology and Investment Regimes, Routledge, New Delhi.

Blonigen, B. (2001), 'In search of substitution between foreign production and exports', *Journal of International Economics*, Vol. 53, pp. 81-104.

Blundell, S. and Bond, S. (1998), 'Initial conditions and moment restrictions in dynamic panel data models', *Journal of Econometrics*, Vol. 87, No.1, pp. 29-52.

Blundell, R., Bond, S. R., and Windmeijer, F. (2000), "Estimation in dynamic panel data models:improving on the performance of the standard GMM estimators", *Advances in Econometrics*, Vol.15, No.1, pp.53 – 91

Brainard, S. L. (1993), 'A simple theory of multinational corporations and trade with trade-off between proximity and concentration', NBER Working Paper, No. 4269, Cambridge, MA.

Brainard, S. L. (1997), 'An Empirical Assessment of the Proximity-Concentration Trade-Off between multinational Sales and Trade', *American Economic Review*, Vol. 87, No. 4, pp. 520-544.

Bustos, P. (2011),'Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms', *American Economic Review*, Vol. 101,No.1,pp. 304-40

Caves,R. E.(1998),'Industrial Organization and New Findings on the Turnover and Mobility of Firms', *Journal of Economic Literature*, Vol. 36, No.4, pp. 1947-1982.

Castellani, D. (2002), 'Export Behaviour and Productivity Growth: Evidence from Italian Manufacturing Firms', *Review of World Economics / Weltwirtschaftliches Archiv*, Vol. 138, No.4, pp. 605-628.

Clausing, K. A. (2000), 'Does Multinational Activity Displace Trade', *Economic Inquiry*, Vol. 38, No. 2, pp. 190-205.

Clerides, S., Lach, S. and Tybout, J. (1998), 'Is learning by exporting important? Micro-dynamic evidence from Columbia, Mexico and Morocco', *Quarterly Journal of Economics*, Vol. 113, No.3, pp.903-948.

Delgado, M.A., Farinas, J.C. and S. Ruano (2002) 'Firm productivity and export market: a non-parametric approach', *Journal of International Economics*, Vol. 57, pp. 397—422.

Dunning, J. H. (1977), 'Trade, Location of Economic Activity and the Multinational Enterprise: A Search for an Eclectic Approach' in Ohlin, B., Hesselborn and Wijkman, P. M. (eds), 'The International Allocation of Economic Activity', Macmillan, London, pp. 395-418.

Ericson, R., and A. Pakes (1995), 'Markov-perfect industry dynamics: a framework for empirical work', *Review of Economic Studies*, Vol. 62, pp. 53– 82.

Girma, S., Görg, H. and Strobl, E. (2004), 'Exports, international investment, and plant performance: Evidence from a non-parametric test', *Economics Letters*, Vol. 83, No.3, pp. 317-324.

Girma, S., Kneller, R. and Pisu, M. (2005). 'Exports versus FDI: An empirical test', *Review of World Economics*, Vol 12, pp. 855-866.

Girma, S., Gorg. H. and Hanley, A. (2008),'R&D and Exporting: Comparison of British and Irish firms', *Review of World Economics*,Vol. 144, No. 4, pp. 750-773.

Greenaway, D., and Yu, Z. (2004), 'Firm level interactions between exporting and productivity: industry-specific evidence', *Review of World Economics /Weltwirtschaftliches Archiv*, Vol. 140, No.3, pp. 376-392.

Goldar, B. (2012), 'R&D Intensity and Exports: A study of Indian Pharmaceutical Firms', Proceedings of VII Annual International Knowledge Forum Conference 2012, Symbiosis International University, Pune, India

Goldberg, P., Khandelwal, A., Pavcnik, N. and Topalova, P. (2010), 'Multi-product Firms and Product Turnover in the Developing World: Evidence from India', *Review of Economics and Statistics*, Vol.92, No.4, pp. 1042-1049.

Goldberg,P., Khandelwal, A., Pavcnik, N. and Topalova, P. (2009), 'Trade Liberalization and Imported Inputs', *American Economic Review*, Vol. 99, No.2 , pp. 494-500.

Honore, B. (1993), 'Orthogonality-conditions for Tobit model with fixed effect and lagged dependent variables', *Journal of Econometrics*, Vol.59, pp.35-61

Head, K., and Ries, J. (1999), 'Rationalization effects of tariff reductions', *Journal of International Economics*, Vol. 47, No.2, pp. 295-320.

Helpman, E. (1984), 'A simple theory of international trade with multinational corporations', *Journal of Political Economy*, Vol.92, pp. 451-471.

Helpman, E., Melitz, M. and Yeaple, S. (2004), 'Export versus FDI with heterogeneous firms', *American Economic Review*, Vol. 94, No.1, pp. 300-316.

Hopenhayn,H.(1992),'Entry, exit, and firm dynamics in long run equilibrium', *Econometrica*, Vol.60, pp. 1127–1150.

Jovanovic, B. (1982),'Selection and the Evolution of Industry', *Econometrica*,Vol.50, No.3, pp. 649-70

Kimura, F. and Kiyota, K. (2004), 'Exports, FDI, and Productivity: Dynamic Evidence from Japanese Firms', *Review of World Economics*,Vol. 142, No. 4, pp. 695-719

Kneller, R. and Pisu, M. (2004), 'Export-oriented FDI in the UK', *Oxford Review of Economic Policy*, Vol. 20, No.3, pp. 424-439.

Levinsohn, J. and Petrin, A. (2003), 'Estimating Production Functions using Inputs to Control for Unobservables', *The Review of Economic Studies*, Vol.70, No.2, pp.317-341.

Lipsey, R. E. and Weiss, M. Y. (1984),'Foreign Production and Exports of Individual Firms', *Review of Economics and Statistics*, Vol. 66, pp. 304-308.

Marchant, M. A., Manukyan, T. and Koo,W. (2002), 'International Trade and Foreign Direct Investment: A Focus on the Free Trade Area of the Americas', *Journal of Agricultural and Applied Economics*,Vol. 34, pp. 289-302.

Markusen, J. R. (1984), 'Multinationals, multiplant economies and the gains from trade', *Journal of International Economics*,Vol.16, pp. 205-226.

Melitz, M. (2003), 'The impact of trade on intra-industry reallocations and aggregate industry productivity', *Econometrica*, Vol. 71, No.6, pp. 1695-1725.

Mundell, R. (1957), 'International Trade and Factor Mobility', American Economic Review, Vol.47, No.3,pp. 321-335.

Narayanan, K. and Bhat, S. (2010), 'Technological Efforts and Export Performance of IT Firms in India', in N.S. Siddharthan and K. Narayanan (eds.), *Indian and Chinese Enterprises: Global Trade, Technology and Investment Regimes*, Routledge, London, New York and New Delhi, pp. 241–269.

Oberhofer, H and Pfaffermayr, O. (2012), 'FDI versus Exports: Multiple Host Countries and Empirical Evidence', *The World Economy*, vol. 35, No. 3, pp 316-330.

Orme, C. D. (2001), 'Two-step inference in dynamic non-linear panel data models', mimeo, University of Manchester

Pfaffermayr, M. (1994), 'Foreign Direct Investment and Exports: A Time Series Approach', *Applied Economics*, Vol. 26, No. 4,pp. 337-351.

Pfaffermayr, M. (1996), 'Foreign Outward Direct Investment and Exports in Austrian Manufacturing: Substitutes or Complements, *Weltwirtschaftliches Archiv*, Vol. 132, pp. 501-522.

Pradhan, J. P. (2007), 'How do Indian Multinationals Affect Exports from Home Country?', Working Paper No. 2007/07,Institute for Studies in Industrial Development, Delhi.

Pradhan, J. P. and Singh, N. (2009), 'Outward FDI and Knowledge Flows: A Study of the Indian Automotive Sector', *International Journal of Institutions and Economies*, Vol. 1, No.1, pp. 155–186.

Narayanan, K. & Bhat S. (2011), 'Technology sourcing and outward FDI: A study of IT industry in India', *Technovation*, Vol. 31, No.4, pp. 177-184.

Roberts, M., Tybout, J.R. (1997), 'The decision to export in Colombia: an empirical model of entry with sunk costs', *American Economic Review*, Vol. 87, No.4, pp. 545–564.

Sauvant, K.P., and J. P. Pradhan (2010), "Introduction: The rise of Indian multinational enterprises: Revisiting key issues." In K.P. Sauvant and J.P. Pradhan (Eds.), The rise of Indian multinationals: Perspectives on Indian outward foreign direct investment (pp. 1-24).Palgrave MacMillan, Newyork.

Sasidharan, S., and Kathuria, V. (2011), 'Foreign Direct Investment and R&D: Substitutes or complements- A case of Indian manufacturing after 1991 Reforms', *World Development*, Vol.39, No.7, pp.1226-1239.

Svensson, R. (1996), 'Effects of Overseas Production on Home Country Exports: Evidence based on Swedish Multinationals', *Weltwirtschaftliches Archiv*, 132(2): 304–329

Syverson, C. (2011),'What Determines Productivity?,' Journal of Economic Literature, Vol. 49, No.2, pp.326-65.

Topalova, P. (2011), 'Trade Liberalization and Firm Productivity: The Case of India', *Review of economics and statistics*, Vol. 93, No. 3, pp. 995–1009.

Tybout, J. R. (1996), 'Heterogeneity and productivity growth: assessing the evidence', In: Roberts, Mark J.,Tybout, James R. (Eds.), Industrial Evolution in Developing Countries: Micro Patterns of Turnover,Productivity and Market Structure. Oxford University Press.

Wagner, J. (2006), 'Exports, foreign direct investment, and productivity: evidence from German firm level data', *Applied Economics Letters*, vol. 13, No.6, pp. 347-349.

Wooldridge, J. M. (2005), 'Simple Solutions to the Initial Conditions Problem in Dynamic Nonlinear Panel Data Models with Unobserved Heterogeneity', *Journal of Applied Econometrics*, Vol. 20,pp. 39–54.

Yeaple, S. (2005), 'A Simple Model of Firm Heterogeneity, International Trade, and Wages',*Journal of International Economics*,Vol.65,pp. 1–20.

Appendix A

Table 1: FDI inflow, OFDI and Trade in India (1990-2010)

Year	FDI inflow/ World Total	OFDI/World Total	Imports/ World Total	Exports/World Total
1990	0.08	0.01	0.65	0.51
1991	0.07	0.01	0.56	0.5
1992	0.08	0.01	0.6	0.52
1993	0.1	0.01	0.59	0.57
1994	0.12	0.01	0.61	0.58
1995	0.16	0.01	0.66	0.59
1996	0.2	0.02	0.69	0.61
1997	0.23	0.01	0.73	0.63
1998	0.24	0.01	0.76	0.61
1999	0.21	0.02	0.8	0.62
2000	0.22	0.02	0.77	0.66
2001	0.26	0.03	0.79	0.7
2002	0.34	0.05	0.85	0.76
2003	0.34	0.06	0.93	0.78
2004	0.34	0.07	1.05	0.83
2005	0.37	0.08	1.33	0.95
2006	0.49	0.17	1.44	1
2007	0.59	0.23	1.61	1.07
2008	0.8	0.38	1.95	1.21
2009	0.94	0.41	2.03	1.31
2010	1.01	0.46	2.27	1.48

Source: UNCTAD database. unctadstat.unctad.org. Accessed on 4/05/2013
Note: FDI inflow, Outward FDI, Imports and exports as a percentage of world total

Table 2: Number of firms included in the sample (year-wise)

year	Domestic	Exporting	OFDI
1998	371	339	52
1999	543	473	58
2000	1532	1831	60
2001	1729	2072	122
2002	1811	2136	233
2003	2033	2384	260
2004	1980	2432	275
2005	2115	2441	300
2006	2072	2508	379
2007	1969	2546	439
2008	1795	2550	483
2009	1942	2513	517

Note: OFDI – outward foreign direct investment. Domestic firms include the firms which produces to cater only for the Indian market.