WORKING PAPER 159/2017

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February 2017

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Price : Rs. 35

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Santosh Kumar Sahu, Sunder Ramaswamy and Abishek Choutagunta

Abstract

This study re-examines the relationship between export performance and productivity in manufacturing firms in India for the period 2003-2015, using firm level information. Departing from the earlier studies on India economy, we argue that product innovations boost export performance of the economy. The hypothesis being that, in the post-economic-reforms era competitive export market scenario, productivity alone, without product innovation and participation in R and D cannot drive export performance. We observe that the argument of highly productive firms entering the export market without reallocating resources towards innovation and R and D seems to be invalid in our sample. Nevertheless, we find in our sample, that productivity as a selection criterion coupled with advertising and marketing strategies explains participation in R and D in boosting exports.

Keywords: *Export Performance, Innovation, Productivity, Manufacturing firms, India*

JEL Codes*: D20, D24, L16, L6, L60*

INTRODUCTION

A large amount of empirical literature exists which documents the positive relationship between exporting and productivity at different levels – from the firm level right up to industry level aggregates. Firm level increases in productivity may, at an aggregate level, show that there are boosts in exports which usually result in rationalization of productivity aiding reallocation of assets (Greenway and Kneller, 2007). A universal finding is that, on average exporting firm is more productive than the non-exporter, reflecting at least partly, the self-selection of more productive firm into the export market. Theoretical studies like those of Aw et *al.* (2008) have measured the inter-temporal correlations between exporting and productivity in an attempt to determine if firms that participate in the export market have higher productivity growth rates. The empirical evidence on this point is less uniform, with some studies finding higher productivity trajectories for firms after they begin exporting, and others finding no effect.

One element that is missing from this literature is the possibility that firms undertake other investments that lead to both higher productivity and a higher propensity to export. Several authors measured the potential role of the firm's own investments in R and D or technology adoption as another component of the productivity-exporting link. For example; Aw et *al.* (2008), and Lileeva and Trefler (2010) found evidence that exporting is also correlated with firm investment in R and D or adaption of new technology. One of the papers in this line has formalized the potential linkages between a firm's productivity and its choice to export and/or invest in R and D or new technology using dynamic industry models. The model developed by Atkeson and Burstein (2010) stylizes interdependence between firm's productivity and export behavior in explaining productivity as the underlying state variable that distinguishes heterogeneous producers. Productivity evolution in this case is considered endogenous, affected by the firms' innovation decisions,

and contains a stochastic component. There are possibly two pathways - one is that investment in innovation, results in future productivity improvements which then results in a higher probability of the firm being competitive in international markets; and the second is firms that export have larger markets in which to operate which, in turn, results in a higher return to any cost-saving or demand-inducing innovations and raises the firm's probability of undertaking R and D investments. These mechanisms do not require that exporting has a direct effect on future productivity, what is often termed, "learning-by-exporting", but generate an effect of current exporting on future productivity through the innovation linkage.

Developments in industrial organization and international trade literature have employed different methods to understand the decision of a firm to export - this, in literature, seems to be characterized by studies closely linked to a combination of new economic geography (NEG)[1] theory and the structure-conduct-performance (SCP) paradigm. The study by Bernard et *al.* (2003) examines firm level data on how exporting firms are geographically scattered and evaluates their export decisions through market power, productivity and entry barriers. A domestic firm's decision to export requires the augmentation of the productive capabilities of domestic firms in an efficient manner. This has been observed through the theoretical framework of (Bernard and Jensen, 1999; Melitz, 2003) and tested in a variety of conditions by Cirera et *al.*, (2015) in the case of the Brazilian manufacturing industry. The decision of a firm to diversify to export has been conjectured to be dependent on several factors which mainly revolve around reducing risks and volatilities, entrepreneurship and development of human capital. Another major determinant of export diversification of firms is related to

[1] Firms which exist within similar and/or narrowly defined industrial sectors are highly heterogeneous in nature. There exists a relationship between their location, firm level characteristics and export participation since agglomeration can be a driver for the realization of economies of scale. The works of Eaton and Kortum (2002); and the Bernard et *al.* (2003) give a clear indication of this phenomenon and a mode to empirically estimate the same.

innovation. This plays a major role in helping bring about growth in the productive capacity of a firm leading to the decision to export to a foreign market (Becker and Egger, 2013). There could also be a reversal of effects, namely, the process of exporting to a foreign market leads to an efficient augmentation of productive capacities within firms which becomes one of the arguments of this paper.

This strand of research also unilaterally accepts that new and old firms which newly enter into the export market face significant investment costs in the acquisition of knowledge to engage in trade. The knowledge can be in the form of developing technological and productive methods, investing in learning new marketing channels and other preferences influencing the marketability of a good in the foreign market. This might point to the existence of *hysterisis* in the total exports of a nation. Baldwin and Wu (2003) affirm that export participation is induced through higher productivity, higher efficiency, and superior technology which mostly rest with the larger sized firms. The study by Aw et *al.* (2007) and subsequently by Bernard et *al.* (2009) who point towards exporting firms invariably being larger and more productive than non-exporters and is an argument which this study strives to challenge. The fact that a country's export market has been contributory to its economic growth is also well documented. This phenomenon takes a bigger role in emerging markets where the potential to export and diversify the mix of products being exported is large (Agosin, 2009). The literature existing on export diversification from a macroeconomic perspective have been quite widespread over the past two decades, most of which takes root from the ideological debates on import substitution and export promotion policies (for details see Saleem, 1992; Amsden, 2004, and Aditya et *al.*, 2013). In terms of firm level decisions on export diversification, there seems to be a large amount of focus on the impact of minimizing export risk and volatility (Caselli et *al.*, 2015) but questions on their veracity (Vannoorenberghe et *al.*, 2016).

The other stand of firm level studies looks at the determinants leading to the decision of diversification which mostly concentrate on the performance and technological growth parameters of firms measured through efficiency, innovation and R and D behavior of firms (for details see Basile, 2001; Rodriguez-Duarte et *al*., 2007). Similarly, Cirera et *al.* (2015) provide a case for the Brazilian manufacturing firms where they find firms that are successful in exports are those which have invested before-hand in innovation, and are heavily concentrated in the domestic market. For the Indian case, we see that there have been studies (Kumar and Siddarthan, 1994; Narayanan, 1998; Sahu and Narayanan, 2015) that observe innovation, productivity and efficiency of firms significantly determine firm performance that is participating in the export market. Kumar and Siddarthan (1994) found a positive relationship between R and D intensity and export behavior; classified on the technological classifications of firms. However, relationship between R and D and export behavior might be affected by simultaneity bias – since a firm with high R and D intensity may tend to export more. There are mixed results for the Indian case itself. A related issue as described in Narayanan (1998) looks at the automobile segments of the Indian economy and relates technology parameters with export behavior. An updated exercise for the automobile segment of Indian manufacturing sector is documented in Sahu and Narayanan (2015). They empirically investigate the relationship between R and D, productivity and export in terms of export participation and export intensities. This study concludes that firms in the automobile segments in the Indian manufacturing increase export intensity through R and D and multinational affiliations.

Some other studies in the Indian case are that of Mitra et *al.* (2014) who indicate that most augmentations towards trade through the process of production have not benefitted India in the best possible manner; They suggest that many facilitators of trade which should have come together in a specific way, did not; and this might have manifested in the long run persistent underperformance of Indian firms both in terms

of overall productivity and in terms of participation and performance in the export market. Upon observation of the study by Thomas and Narayanan (2016) on the heterogeneity of productivity and export market participation in Indian firms, one can find that self-selection vis-à-vis the Bernard and Jensen (1999) framework may not hold well with the Indian case, and that the "*learning-by-doing*" hypothesis through the Van Biesebroeck (2005) and the De. Loecker (2013) frameworks are probably the better fit, where persistent export market participation and R and D investments have positive effects on productivity. It needs to be noted however, that the determinants of export participation may be different from the determinants leading to sustained export efforts of firms. Some firms which might lead into the export industry through catalysts such as adverse market conditions or high demand from importing clientele; others however, take up exporting deliberately without any exogenous catalysts. Distinguishing between the two can be very hard, since there needs to be a generic trigger variable which would have to be common between the two strands of exporters. Most studies attribute these decisions to firm size, but, the many studies have been critical on the view, since the empirical findings do not suggest a unilateral stance on the debate (for details see, Isgut, 2001; Caldera, 2010; Hausman et *al.*, 2007). While this provides for a fairly large amount of literature on the importance of firm level exports that is dependent on R and D and innovation, seems to play an important role in exports diversification. There is a gap which needs to be filled in the integration of performance, productivity and innovations in a firm contributing to decision to export.

What needs to be noted in this study, is that, although, the export markets present small revenues for firms, there is a considerable push-pull factor coming from the international economy. Also noted is that there is a high level of heterogeneity in the processes employed by firms to enter or exit from the world trade market. In this paper, we develop and estimate an empirical model of export behavior and technological related investment that incorporates these key features. We

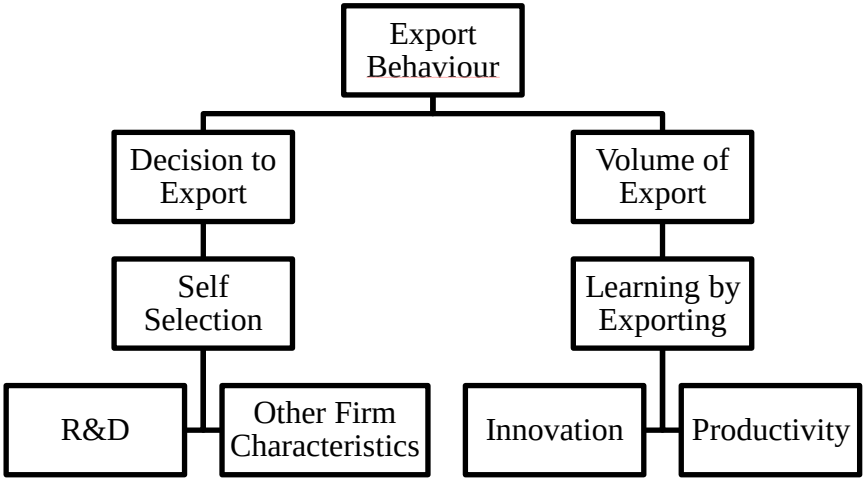
allow both the firm's R and D investment and export status to affect the distribution of its productivity. Further, a firm decides to treat R and D and exporting as discrete choices. These decisions depend on the expected future profits, and current fixed or sunk cost of a firm. After estimating productivity, we then explain the relative importance of R and D investment, product innovation, and exporting, as the source of productivity change. For the empirical analysis, data among Indian manufacturing firms are used for the period 2003-2015. The sample is characterized by high rates of productivity growth, significant export market participation, and R and D investment by firms. The evolution of firm productivity differs significantly across firms, which undertake the different combinations of R and D investment, product innovation, and exporting. Based on the review of literature, and the Indian economy in context, the next section describes a model of export performance, innovation and productivity for the manufacturing industries in India.

MODEL OF EXPORT PERFORMANCE AND PRODUCTIVITY

Based on the theoretical and empirical literature on export behavior, it is understood that export behavior can be divided into two components. First, whether or not to export and second, the volume of exports. This goes hand in hand with an increase in economies of scale, higher profitability, higher productivity, and technological change. The characteristics of developing economies may therefore, allow firms to participate in the export market first, and then increase export volume. Two distinct characteristics of why firms behave as stated above for the export participation can be derived either from *self-selection* or by *learning-by-exporting*. A major component that drives a firm to export can be classified as 'other firm characteristics', R and D behavior, pattern of innovation, and most importantly the production behavior of the firm. Firm characteristics other than R and D, innovation and productivity follow from the SCP literature, whereas R and D and innovation comes from the theory of firm growth. We emphasize on innovation, which we

argue drives firms into *self-selecting* to export market given the inter-country and inter-industry trade, which helps firm become globally competitive, and hence, reallocate their resources based on their productivity.

Chart 1: Determinants of Export Behavior
(Authors' representation)



A graphical representation of such behavior is presented in Chart 1 and our theoretical model is based on the inter-linkage of firm characteristics and production behavior i.e., similar in several ways to the models of exporting developed firstly by Aw et *al.* (2007) and then by Das et *al.* (2007). We abstract from the decision to enter or exit, and focus on the investment decisions and process of productivity evolution. Firms are recognized to be heterogeneous in their productivity and the export demand curve they face. Together these determine each firm's incentive to invest in R and D and to export. In turn, these investments have feedback effects that can alter the path of future productivity for the firm. We divide the firms' decision making into a static component,

where the firms productivity determines its short-run profits from exporting, and a dynamic component where the firm makes optimal R and D investment and export-market participation decisions. We begin with a model of the firms' revenue in the domestic and export market. Firm *i*'s short-run marginal cost function is written as:

$$\ln c_{it} = \ln c(k_{it}, w_{it}) - x_{it} = \beta_0 + \beta_k \ln k_{it} + \beta_w \ln w_{it} \pm x_{it} \qquad (1)$$

Where, k_{it} is firm capital stock, w_{it} is a vector of variable input prices common to all firms, and x_{it} is firm productivity[2]. The firm is assumed to produce a single output, which can be sold in both domestic and export markets and marginal cost that is identical across the two markets for a firm. There are two sources of short-run cost heterogeneity, capital stocks and firm productivity. Marginal cost does not vary with the firms' output level, which implies that demand shocks in one market do not affect the static output decision in the other market. Both the domestic and export market are assumed to be monopolistically competitive and segmented from each other. These rule out strategic interactions among firms in each market, but allow firms to charge markups that differ across markets. The demand curves faced by firm *i* in the domestic and export markets are assumed to have the Dixit-Stiglitz (1977) form. In the domestic market it is:

$$q_{it}^{DOM} = Q_t^{DOM} \left(\frac{p_{it}^{DOM}}{P_t^{DOM}}\right)^{\eta_{DOM}} = \frac{I_t^{DOM}}{P_t^{DOM}} \left(\frac{p_{it}^{DOM}}{P_t^{DOM}}\right)^{\eta_{DOM}} = \phi_t^{DOM} \left(p_{it}^{DOM}\right)^{\eta_{DOM}} \qquad (2)$$

Where, Q_t^{DOM} and P_t^{DOM} are the industry aggregate output and price index respectively, I_t^{DOM} is total market size, and η^{DOM} is the constant elasticity of demand. The firm's demand depends on the

[2] Other firm-level cost shifters can be included in the empirical specification. In this version we will focus on the heterogeneity that arises from differences in size as measured by capital stocks, productivity and net assets.

industry aggregates, represented by ϕ_t^{DOM}; its price p_{it}^{DOM}, and the constant demand elasticity. In the export market we allow the firm's demand to depend on a firm-specific demand shifter z_{it}. By including this term, we incorporate an exogenous source of firm-level variation which will allow a firm's relative demands in the domestic and export market to vary across firms and over time. The firm is assumed to observe z_{it} when making its export decision and this can be tested in the empirical model. DOM represents the domestic market and EXP represents export market conditions. The demand curve that firm *i* faces in the export market is:

$$q_{it}^{EXP} = \frac{I_t^{EXP}}{P_t^{EXP}} \left(\frac{p_{it}^{EXP}}{P_t^{EXP}}\right)^{\eta_{EXP}} z_{it} = \phi_t^{EXP} \left(p_{it}^{EXP}\right)^{\eta_{EXP}} \exp(z_{it}) \qquad (3)$$

Given its demand and marginal cost curves, firm *i*, chooses the price in each market to maximize the sum of domestic and export profits. The first-order condition for the domestic market price p_{it}^{DOM} implies that the log of domestic market revenue r_{it}^{DOM} is:

$$\ln r_{it}^{DOM} = (\eta_{DOM} + 1) \ln\left(\frac{\eta_{DOM}}{\eta_{DOM} + 1}\right) + \ln \phi_t^{DOM} + (\eta_{DOM} + 1)(\beta_0 + \beta_k \ln k_{it} + \beta_w \ln w_{it} - x_{it}) \qquad (4)$$

Specifically, the firm's revenue depends on the aggregate market conditions and the firm specific productivity and capital stock. Similarly, if the firm chooses to export, export market revenue is equation (5) depending on the aggregate export market conditions, firm productivity, capital stock, and the export market demand shock and can be presented as:

$$\ln r_{it}^{EXP} = (\eta_{EXP} + 1) \ln\left(\frac{\eta_{EXP}}{\eta_{EXP} + 1}\right) + \ln \phi_t^{EXP} + (\eta_{EXP} + 1)(\beta_0 + \beta_k \ln k_{it} + \beta_w \ln w_{it} - x_{it}) + z_{it} \qquad (5)$$

Equation (4) and (5) show the information on firm domestic and export revenue where, domestic revenue will provide information on marginal cost, in particular the productivity level x_{it}, for all firms in production. And the export market revenue will provide information on the export demand shocks, but only for firms that are observed to export. Given these functional form assumptions for demand and marginal cost, there is a simple link between firm revenue and profit in each market. The firm's profit in the domestic market is:

$$\pi_{it}^{DOM} = -(\frac{1}{\eta_{DOM}}) r_{it}^{DOM}(\phi_t^{DOM}, k_{it}, x_{it}) \qquad (6)$$

Similarly, if the firm chooses to export, the profits they will earn are linked to export market revenue as:

$$\pi_{it}^{EXP} = -(\frac{1}{\eta_{EXP}}) r_{it}^{EXP}(\phi_t^{EXP}, k_{it}, x_{it}, z_{it}) \qquad (7)$$

These equations (6 and 7) will allow us to measure firm profits from observable data on revenue in each market. These short-run profits will be important determinants of the firms' decision to export, and to invest in R and D and innovation activities in general and for the product innovation in particular. The next step of our analysis is to identify firm characteristics that make a firm more likely to export. In the absence of sunk costs, a rational profit maximizing firm exports if the current expected revenues from foreign sales exceed the cost of production and shipping for the foreign market. Whether or not, this is the case for an individual firm that is assumed to depend on a vector of firm specific characteristics $F_{C,}$ among other things. In any period, a firm will export whenever exporting carries an additional positive net profit for the export market:

$$EXP_{Pit}EXP_{Qit} - P_{Cit}(F_{Cit}, EXP_{Qit}) - S_C(1 - F_{EXPit}) > 0 \qquad (8)$$

Where, EXP_{pit} is the export price, EXP_{Qit} the exported quantity, P_{Cit} are additional production costs of producing EXP_{Qit}, S_C are sunk costs of exporting and F_{EXPit} is a binary variable indicating whether a firm exports or not. If there are sunk costs involved in taking up export activities, a dynamically maximizing firm will look beyond the present period when deciding whether to export. The presence of sunk costs makes the decision rule dynamic, because exporting today carries an additional option value of being able to export tomorrow, without paying the sunk costs of exporting. The value function of this dynamic problem can be expressed as:

$$V_{Fit} = \max_{F_{EXPit} \in \{0,1\}} \left(EXP_{Pit}, EXP_{Qit} - P_{Cit}(F_{Cit}, EXP_{Qit}) + \delta E(V_{Fit+1}) \right) \qquad (9)$$

Where, δ is a discount factor. The solution to this problem is the decision rule, and

$$Y_{it} = \begin{cases} 1: \\ 0: \end{cases} EXP_{Pit}EXP_{Qit} - P_{Cit}(F_{Cit}, EXP_{Qit}) + \delta \begin{bmatrix} E(V_{it+1} \mid F_{EXPit} = 1) - E(V_{it+1} \mid F_{EXPit} = 0) \\ otherwise \end{bmatrix} > 0 \qquad (10)$$

The last term of this expression represents the option value of exporting. In this decision rule, the firm and time-specific realizations of the vector F_{Cit} determine different decision outcomes across firms and time. In other words, we are explaining different export decisions by firms with observation-specific firm characteristics. Particularly, we are interested in the effect of firm productivity as one element of F_{Cit}. In response to the empirical evidence related to heterogeneity of firms' trade orientations within sectors, a new theoretical strand of literature on international trade has begun to focus on the export behavior of firms within sectors. One crucial assumption of this literature is that high-productivity firms self-select themselves into export markets. This

assumption implies a link between firm productivity to exporting, for which this paper provides an empirical test. The measure for total factor productivity (TFP) used is estimated from firm input and output data, taking into account some econometric difficulties that arise in TFP estimation. Since, firms observe their respective productivities that are unobserved there is likely to be a correlation between the error terms and the explanatory variables in the estimation of the production function.

Least-squares estimation procedures would produce biased coefficient estimates in this situation. Therefore, following Levinsohn and Petrin (2003) we estimate total factor productivity at firm level in a way that is robust to simultaneity bias from endogenous input choice, by using a semi-parametric estimation technique for the production function. There is an extensive debate on the relationship between openness and productivity growth using aggregate, economy-wide data. Edwards (1998) and Sachs and Warner (1995) provide empirical evidence for a positive correlation of trade and growth. Marin (1992) finds a causal link from exports to higher productivity growth for four industrial countries. Such a causal relationship on the aggregate level can work through two channels: either firms become more productive as they export, or increased openness initiates a process in which resources are re-allocated in favor of exporting firms that are more productive than non-exporters. In order to estimate the export decision, we translate the theoretical model into an empirical probit model in which export behavior depends on a variety of observed, firm-specific characteristics:

$$P(Y_{it}) = \phi\left(FA_{it}, FS_{it}, ADVT_{it}, RD_{it}, PINV_{it}, TFP_{it}, PAT_{it}, OECD_{it}, RES_{it}, FDI_{it}\right) \quad (11)$$

Where, ϕ is a normal cumulative density function, and the independent variables, definition and data sources are presented in Appendix Table (T1). The dynamic process of firm formation, growth, prospering, or failure generates a great amount of heterogeneity in firm

performance, not only across industries, but more interestingly, also within industries (Bartelsman and Doms, 2000). Most of the theoretical models on industry dynamics assume that firms are born with an inherent ability, their productivity. Efficient firms survive and grow in the market, while inefficient firms, with productivity below a certain threshold, decline and fail (Hopenhayn, 1992). These models, however, assume that the productivity distribution across firms is exogenous to firms, thus relating firm survival to luck-of-draw. Firms with low productivity exit, while "lucky" firms with high productivity survive and continue growing. Little room is left for firm decisions, except for the decision on exiting, which is endogenized. The model of Pakes and Ericson (1995) improves on these models by introducing investment decisions that can potentially enhance survival chances. But endogenizing such decisions severely complicates solving these theoretical models. While theoretically, such heterogeneity and dynamics is difficult to handle, empirically it provides a wealth of interesting observations. One of the basic empirical facts related to productivity is a strong positive association between productivity and exporting activity at the firm level. Most of the studies explain this pattern by *self-selection* of more efficient firms into the export market (Clerides et *al.* 1998; Bernard and Jensen 1999), confirming the sunk cost hypothesis that only those firms who are efficient enough to bear entry costs and intense competition of the export market will start exporting. This suggests that a closer examination of prior firm decisions might be needed to understand this important selection[3].

[3] The basic mechanism generating selection bias is a correlation between the unobservables determining selection and the un-observables determining the outcome variable of interest. Considering the following binary response model with sample selection: $y_1=1\left[x_1\beta_1+u_1>0\right]$, $y_2=1\left[x\delta_2+v_2>0\right]$. Where, y_1 is observed only if $y_2 = 1$, and x contains x_1 and at least one more variable. In this case, probit estimation of β_1 based on the selected sample will generally lead to inconsistent results, unless u_1 and v_2 are uncorrelated. Assuming that x is exogenous in the population (uncorrelated with u_1 and v_2), we can use a two-stage procedure where we obtain $\hat{\delta}_2$ by estimating the export participation

DATA, VARIABLES AND THE SAMPLE

The empirical estimation uses data from the Centre for Monitoring of Indian Economy[4] – Prowess online corporate database from 2003-2015. This sample covers all manufacturing firms in the database at the 2-digit National Industrial Classification[5] 2008 (NIC-2008). Around 55 percent of the firm-year observations got deleted because of non-reporting or misreporting of major variables of interest which include age of incorporation, net-sales, R and D Expenditures etc. The number of firms which we have in the final dataset is 6726 firms from 2003-2015. The sample includes 344 unique categories at 5–digit classification of NIC-2008. The data from the CMIE prowess database is further used to compute derived variables that are presented in Table T1 in the appendix.

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equation using a probit model. Constructing $\hat{\lambda}_{i2}=\lambda(z\hat{\delta}_2)$ and estimating structural equation using probit with $\hat{\lambda}_{i2}$ added to the set of regressors. Hence, we get; $\Pr(y_1|x_1,y_2=1)=\Phi\left(x_1\beta_1+\rho_1\hat{\lambda}_{i2}\right)$. Where, ρ1 measures the correlation between the residuals u_1 and v_2. This is the heckprobit estimator.

[4] Centre for Monitoring Indian Economy or the CMIE, is a leading business information company. Established in 1976, it straddles the entire information food-chain from primary data collection through analytics and forecasting. It provides services to the entire spectrum of business information consumers that includes governments, academia, financial markets, business enterprises, professionals and the media. CMIE produces economic and business databases and develops specialized analytical tools to deliver these to its customers for decision making and for research (for detail see http://www.cmie.com)

[5] The National Industrial Classification (NIC) is an essential Statistical Standard for developing and maintaining comparable data base according to economic activities in India. Comparability of statistics available from various sources, on different aspects of the economy, and usability of such data for economic analysis, are prerequisite for standardization of a system of classification. For details, see http://udyogaadhaar.gov.in/ua /Document /nic_2008_7apr09.pdf

Table 1: Description of the Sample

NIC-2008 2-digit classification	Continuous Exports (0-2 years)	Continuous Exports (2-4 years)	Continuous Exports (4-6 years)	Exporters in Sample	Total firms in Sample (2003-2015)
10 to 19	234	57	0	291	18132
20 to 29	286	66	6	358	31417
30 to 39	55	3	0	58	6315

Source: Authors calculations from CMIE Prowess database.

Table 1 describes the sample in terms of export participation. As mentioned before, the National Industrial Classification (NIC-2008) is the index of classification. The two digit classification gives us the class, the sector of manufacturing industries to which the firms belong (for details see: MoSPI[6], 2008). We observe that the sample contains 291 exporters from the divisions 10 to 19 of the NIC which is about 1.6 percent of the total number of firms in the particular classification. In total, the sample contains 1.26 percent of exporting firms of manufacturing sector in India. This proportion of exporters to total number of firms could be regarded as insignificant, but we hypothesize in the later parts that they do have a sizeable contribution to output in the manufacturing sector as a whole. This is also because the export-behavior of firms are heterogeneous, mapping these firms based on classification-year basis over three categories based on the years of continuous exports give us a better sense of observing their behavior. A similar exercise by Sahu and Narayanan (2015) find high levels of export participation in the motorcycle manufacturing sector, they attribute this to low sample size of the number of firms which are in the automobile sector as a whole. As can be observed from the above, there are only six firms that are exporting continuously from four to six years. This is quite low because once all firms in the manufacturing sector are filtered and deleted over the variables of interest and hence, the sample is reduced to a mere 16 percent of the original sample set. Hence, statistically – the significant

[6] www.mospi.gov.in/

change in the sample behavior may be attributed to bias in sample selection. Therefore, estimation of such a sample should preferably use a selection model compared to limited dependent or censored regressions (Heckman, 1979).

From Table 2 it's evident that the 13 years mean from 2003 to 2015 of export intensity is about 0.43 but when measured year wise, we see a gradual fall in export intensity from 0.67 in 2003, to 0.13 in 2015; also, a similar trend is observed in R and D intensity, and technology imports. Productivity is the only case, where there is a clear trend observed in growth, although – when examined further, we see that the average growth rate of TFP is stagnant over the 13 years period at 3.6 percent. This can be corroborated by observing the Index of Industrial Production (IIP) series of the Indian manufacturing industry as observed from Figure 1 in the appendix.

Table 2: Exports, R and D, Technology Imports, Productivity and Product Innovation

NIC-2008 2-digit classification	Export Intensity		R and D Intensity		Technology Import Intensity		Productivity (LP)		Product Innovation	
Year	2003	2015	2003	2015	2003	2015	2003	2015	2003	2015
10 to 19	0.67	0.13	0.11	0.11	1.60	0.01	1.84	2.84	1.60	0.01
20 to 29	0.67	0.17	0.15	0.01	0.62	0.03	1.75	2.70	0.62	0.03
30 to 39	0.33	0.15	0.01	0	0.61	0.93	1.74	2.70	0.61	0.94

Source: Authors calculations from CMIE Prowess database.

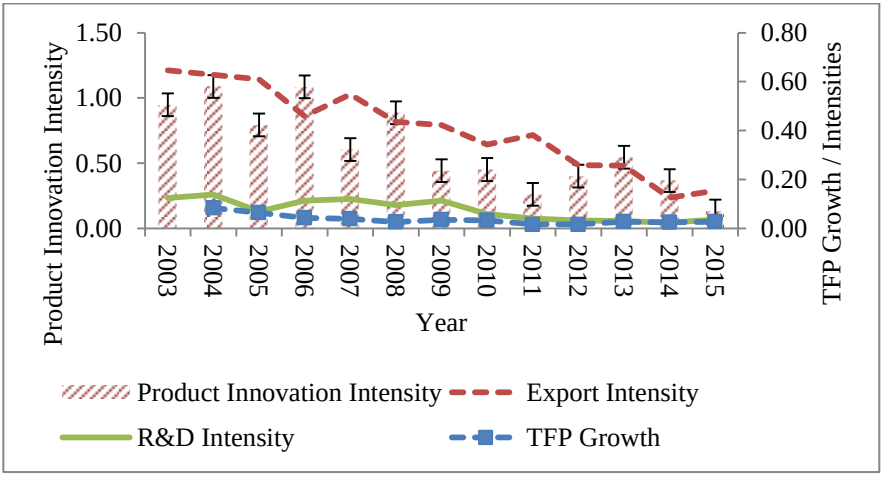
Table 3 explains the descriptive statistics of firms broadly classified in innovative and non-innovative subsamples based on the National Industrial Classification at two digits from 2003-2015. From the table, we can observe that innovative firms are export intensive, spend more in R and D, depend on higher technology import. However, in terms of productivity, both the subsample classified in innovative and non-innovative has similar levels of productivity.

Table 3: Descriptive Statistics of Select Indicators across Industry Groups

NIC-2008 2-digit classification	Export Intensity		R and D Intensity		Technology Import Intensity		Productivity (LP)	
	Non Innovative	Innovative	Non Innovative	Innovative	Non Innovative	Innovative	Non Innovative	Innovative
10 to 19	0.03	0.56	0.05	0.08	0.01	0.86	2.38	2.32
20 to 29	0.07	0.40	0.01	0.10	0.01	0.57	2.03	2.28
30 to 39	0.18	0.34	0.02	0.03	0.01	0.58	2.27	2.17

Source: Authors calculations from CMIE Prowess database.

Figure 1: Trends in Export Intensity, Product Innovation, R and D Intensity and Growth in Productivity (Full Sample)

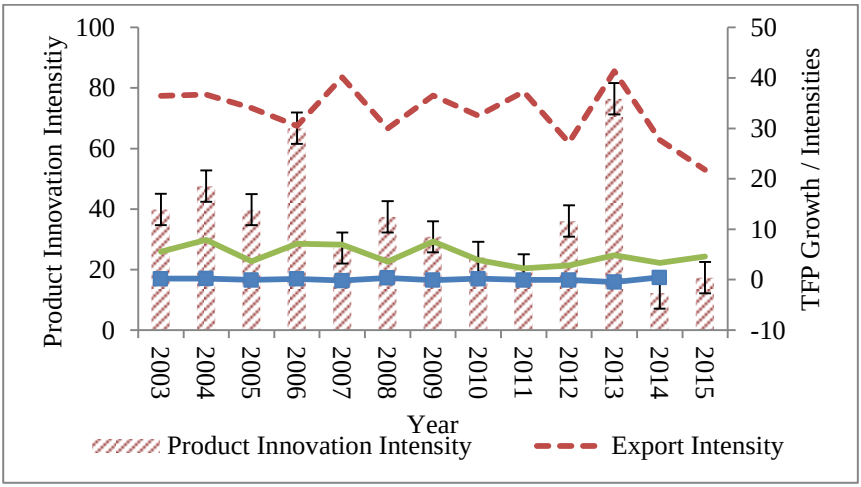


Source: Authors calculations from CMIE Prowess database.

Further, the series behavior of firms in the sample in terms of export intensity, product innovation, R and D intensity and growth in productivity is presented in Figure 1. From the figure, we can observe that export intensity has gone down drastically as compared to R and D intensity and TFP growth, while expenses related to product innovation intensity has a up and down movement from 2003-2015. While R and D

intensity and TFP growth moves similarly, export intensity of the manufacturing sample has come down from about 70 percent in 2003 to 18 percent in 2015. This needs to be looked at carefully to see if there is any new evidence of productivity and export intensity can be established for the Indian case using an updated firm level data.

Figure 2: Trends in Export Intensity, Product Innovation, R and D Intensity and Growth in Productivity (Exporters Only)



Source: Authors calculations from CMIE Prowess database.

As compared to the initial results of Figure 1, we moved further in explaining the behavior of firms that are exporters. The earlier case is a representation of manufacturing firms, whereas; Figure 2 explains the behavior of the exporters. In this case, export intensity has not drastically fallen as explained earlier, but has peaks and falls, and moves around 20 percent to 40 percent. However, parallel to the earlier explanation of Figure 1, in Figure 2 we also find similar movements for R and D intensity and TFP growth. The narratives from both the figures explain that there is possibility of co-movement in R and D and TFP growth which may or may not be associate with export intensity, but dependent on product

innovation at firm level. These findings further support our model for exports, productivity, and product innovation as explained in section 2. Section 4 explains the empirical results of relationship between exports, productivity and product innovation.

DISCUSSION OF RESULTS

As discussed in the theoretical section, we link productivity, innovation, R and D, and export behavior of firms for the sample of manufacturing firms in India. Several works in identifying the possible links as the determinants of export performance in general and export behavior in particular for the Indian case have extensively used either export through self-selection or learning by exporting. In both the cases, the decision to export remains a puzzle with the firm itself which may or may not govern only through economic indicators as has been deduced through most of the studies. The decision to export and inter-firm differences in export intensity have been worked out with the theoretical foundation new-empirical Industrial Organization, particularly the SCP (Structure Conduct Performance) paradigm. The SCP paradigm and its modification do not necessarily relate productivity as one of the root in explaining firm performance; hence, productivity as a major determinant of export behavior at firm level is scanty. This gives one of the motives to link total factor productivity and export behavior for the sample firms in Indian manufacturing. The channels of export through productivity or production processes can be linked with Hicksian technological change where firms with greater experience in the domestic market tries to establish themselves in the international market in changing the ownership either through FDI or through multinational affiliations.

The international business literature linked with the OLI (Ownership, Location and Internationalization) gives a closer link concluding productive firms may get into exports relatively easier than lesser productive firms (Forsgren, 2002). Hicksian technological change

however cannot explain the dependency on technological shift, technology transfer and resource allocation at firm level that are the major determinants of competitiveness in an economy. Hence, Schumpeterian technology of identifying the innovation capacity and technology progress at a firm level are important factors that may drive the decision to export.

This is where we deviate from the dominant strain of Indian literature. In addition to investigating the decision to export, is worth looking at the quantum of variations of exports as a proportion to sales. For the CMIE database studies have found difficulties in classifying innovation and R and D into different components, this paper develops an index for the product innovation expenses at firm level which is used as a possible route for export behavior. The above discussion drives the issues related to empirical investigation such interdependencies with variables that are driven by the economics of production, SCP, OLI and R and D. The inter-firm heterogeneities in export intensities are modeled using a censored regression technique of Tobit-type; the decision to export is modeled using a Heckman selection model corrected for endogeneity bias and the robustness of these estimates are arrived at using standard econometric techniques such as fixed and random effects. It is important to mention that our study consists of a heterogeneous sample of firms across manufacturing hence one of the fixed effects (FE) estimates captures clustered results based on the National Industrial Classification (NIC- 2008) at 2-digit level.

The baseline estimate of the decision to export function is performed using Ordinary Least Squares (OLS) estimates, and presented in Appendix T2, where firms with medium age are exporting the maximum whereas the medium sized firms seem to export less. Advertisement intensity, R and D intensity, and product innovation intensities, have positive influence on proportion of exports to sales. Where, product innovation also turns to be non-linearly related with

export intensity. Further, firms in the high-tech industry are able to export more than the low tech industries. Sectors that are allowed 100 percent FDI also seem to export more compared to the rest which is captured through a dummy variable. Whereas, profitability and TFP at level have inverse relationships with export intensity. This result is quite confounding and the estimates narrate that lesser profitable and lesser productive firms export more. This result is similar to the explanation in Figure 1 and 2, where the movement in export intensity and productivity was not identified in similar direction. The inclusion of a squared proportion of estimated TFP however confirms that both lesser and highly productive firms are not able to export more as compared to the medium productive firms. This result may be accepted as the level of export intensity varies for medium and high productive firms. Where high-productive firms may not be 100 percent export oriented.

The results of the baseline estimates are presented in Appendix T3 in two different cases; case 1 represented in row 1 is related to the impact of product innovation to export intensity and case 2 in row 2 represents the relation between productivity and export intensity. This result however, suffers from limiting the observations that are not exporting at all; hence, a censored Tobit-type model is required to capture the specifics of this phenomenon. This is presented in Table 4; classified into 4 estimated equations. Deviating from traditional Tobit estimates, that are censored around assumed points, we estimate the baseline Tobit from the distribution of export intensity (percentile distribution) censoring around no-exports, 25th percentile, 50th percentile and the 75th percentile of export intensity. The results do not confirm "firm age" as a major driving factor in determining for export intensity in any of these models consistently. Firm size however, has a consistent and similar relationship across groups explaining that medium sized firms are exporting more, which is in line with the baseline OLS estimates. Similarly, advertisement and R and D intensities are drivers of export behavior coupled with product innovation.

Table 4: Tobit Estimates (Without Dummies)

Variables	(1)	(2)	(3)	(4)
	Dependent Variable = Export Intensity			
	Censor= 0	Censor = 4.23	Censor = 34.20	Censor = 64.11
FA_{it}	-0.059	-0.073	0.034	0.008
	(0.079)	(0.097)	(0.091)	(0.074)
FS_{it}	-51.92***	-54.19***	-39.72***	-15.98***
	(3.694)	(4.739)	(5.046)	(4.223)
FS^2_{it}	2.491***	2.443***	1.618***	0.264
	(0.329)	(0.444)	(0.486)	(0.457)
$ADVT_{it}$	45.25***	47.16***	55.70***	27.62**
	(12.81)	(15.87)	(17.97)	(13.93)
RD_{it}	2.437***	2.708***	1.994***	1.024***
	(0.178)	(0.212)	(0.210)	(0.150)
$PINV_{it}$	0.450***	0.497***	0.601***	0.336***
	(0.040)	(0.048)	(0.094)	(0.066)
$PINV^2_{it}$	-0.0004***	-0.0004***	-0.001***	-0.0006***
	(5.74e-05)	(6.84e-05)	(0.0002)	(0.0001)
TFP_{it}	-17.96***	-21.68***	-18.58***	-9.067***
	(1.341)	(1.696)	(1.909)	(1.427)
PAT_{it}	-0.179***	-0.194***	-0.127***	-0.0567
	(0.038)	(0.044)	(0.044)	(0.039)
Constant	77.56***	72.31***	47.55***	37.44***
	(9.091)	(11.22)	(11.52)	(9.597)
σ_u	42.72***	47.59***	38.42***	22.16***
	(2.464)	(3.114)	(3.799)	(3.517)
σ_e	50.97***	58.58***	54.12***	34.10***
	(1.783)	(2.375)	(3.136)	(2.908)
Observations	55,863	55,863	55,863	55,863
Number of statenum	6,726	6,726	6,726	6,726

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors calculations from CMIE Prowess database.

Technology advancement classified in R and D and product innovations are very important factors may be related to differentiate between non-exporters, low-exporters and high-exporters (intensity-wise). The pooled panel regression cannot explain the movement of export behavior over a period of time and hence, the use of fixed and random effects is appropriate in explaining the movement of the panel. This exercise is presented in Appendix T3 and T4; the consistencies of FE and RE estimators are decided based on the Hausman χ^2 test statistics. Based on the significance of χ^2 we select FE estimates over RE estimates. Given the panel structure that is from 2003 to 2015, a macroeconomic variable capturing the global recession is quite important to understand its impact on firm level export behavior. The estimates of FE are divided into sub-equations; in row 1 of Appendix T3 that can be comparable with Appendix T2 which does not take productivity as one of the variables; in row 3 of Appendix T3, we introduce productivity as a determinant of export behavior.

This allows us to check the consistency of the estimator and the impact of productivity in estimating export behavior function. Including productivity as an indicator of firm heterogeneity does not change the sign and magnitude of independent variables as reported in Appendix T3 which is in line with the results presented in Appendix T2. The robustness check of FE estimates are further coupled with clustering the standard errors for 2 digit NIC-2008 classification. This exercise helps us in making use of heterogeneous firm-level data of the manufacturing sector by grouping it with similar subsectors; and we arrive at similar results. Using fixed and random effects estimates, we are inconclusive about explaining the possible impact of recession given some of the firms do not participate in the export market in the sample, nor are they influenced by external markets; hence, a censoring model is required.

Table 5: Tobit Estimates (With Dummies)

Variables	(5) Censor = 0	(6) Censor = 4.23	(7) Censor = 34.20	(8) Censor = 64.11
FA_{it}	-0.108	-0.122	0.0129	-0.007
	(0.081)	(0.098)	(0.097)	(0.075)
FS_{it}	-51.28***	-53.63***	-39.37***	-15.81***
	(3.660)	(4.695)	(5.015)	(4.234)
FS^2_{it}	2.379***	2.340***	1.556***	0.226
	(0.324)	(0.438)	(0.482)	(0.459)
$ADVT_{it}$	46.90***	49.20***	57.04***	28.91**
	(12.80)	(15.81)	(17.85)	(13.81)
RD_{it}	2.431***	2.714***	2.011***	1.037***
	(0.177)	(0.212)	(0.211)	(0.151)
$PINV_{it}$	0.444***	0.491***	0.598***	0.335***
	(0.039)	(0.048)	(0.094)	(0.066)
$PINV^2_{it}$	-0.0004***	-0.0004***	-0.001***	-0.0006***
	(5.69e-05)	(6.79e-05)	(0.000295)	(0.000195)
TFP_{it}	-19.46***	-23.02***	-19.05***	-9.199***
	(1.422)	(1.789)	(1.991)	(1.481)
PAT_{it}	-0.170***	-0.184***	-0.122***	-0.0530
	(0.038)	(0.044)	(0.044)	(0.040)
$OECD_{1i}$	42.91***	49.33***	32.23**	16.22
	(10.65)	(12.89)	(12.81)	(10.08)
$OECD_{2i}$	38.79***	41.29***	24.34*	10.62
	(10.84)	(13.18)	(13.22)	(10.37)
$OECD_{3i}$	40.81***	46.79***	31.94**	15.76
	(11.09)	(13.44)	(13.42)	(10.51)
RES_i	14.64***	15.49***	10.04***	5.157*
	(2.751)	(3.431)	(3.770)	(2.942)
FDI_i	30.80***	33.77***	25.76**	10.13
	(8.778)	(10.53)	(10.70)	(8.382)
Constant	34.67**	23.72	14.75	21.75
	(14.08)	(17.17)	(17.48)	(14.28)
σ_u	43.07***	47.97***	38.70***	22.74***
	(2.477)	(3.131)	(3.839)	(3.538)
σ_e	50.46***	57.98***	53.71***	33.62***
	(1.762)	(2.349)	(3.124)	(2.886)
Observations	55,863	55,863	55,863	55,863
No. of statenum	6,726	6,726	6,726	6,726

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors calculations from CMIE Prowess database.

As presented in the baseline OLS and the fixed effects estimates, the Tobit equations are in line with explaining the non-linear relationship of product innovation to export intensity. Similar to the exercise as presented in the baseline estimate, productivity is inversely related to export intensity for all the cases; however, profit margin is not an important indicator of export-intensity when censoring is carried out at the 75th percentile. To relate this exercise with the OLS baseline estimate, we present our first result of how much a firm exports and its determinants in Table 5. The improvement in Table 5 in contrast to Table 4 is due to the inclusion of sectoral dummies that capture technology dependent industries - a recession dummy to capture the short run impact of the financial meltdown on exports, and a dummy related to sectors where 100 percent FDI is allowed. In line with earlier estimates, the results of Table 5 are quite consistent in both magnitude and direction - for example, firm size and product innovations are found to be non-linearly related to export intensity. The decision of a firm to advertise more and invest proportionately higher R and D is those which play a dominant role in exports. Profit margins and productivity are inversely related to export which is consistent with both Appendix T2 and Table 4. The results are quite similar when censoring is done at different levels and thus, a general conclusion comes out that the factors explaining firm heterogeneity in export behavior are similar for different volumes of exports.

The recession dummy that captures the intermittent effect of 2007-08 is positively related to export decision volumes indicating the impact of recession on Indian manufacturing in general, and the sample in particular. This gives an indication from the trade literature where countries are dependent on trade flows and hence, macroeconomic factors related to business cycles have inverse impact on trade volumes. Firms that are associated with sub sectors that are allowed 100 percent FDI are exporting more compared to the rest of the sample. This becomes quite a strong policy instrument to promote firms in making

them competitive to participate in the international market. The general understanding of Table 5 goes in line with the earlier studies such as (for example, Wagner, 1995 and Boeing, 2016) where firm size, R and D and advertising intensities are major factors of firm export behavior but, deviates in explaining the relationship between productivity and export behavior (Kunst and Marin, 1989) for the Indian manufacturing firms.

Results estimated from the censored regression models explain the probability of a firm getting into the export market in general, and the extent of export participation within the exporters. Though we have estimated the Tobit equation with different forms to arrive at the results presented in Tables 4 and 5, there may be two possibilities of revisiting the entire exercise that can be classified either in terms of self-selection or learning by exporting. In the context of self-selection using the CMIE database, Thomas and Narayanan (2016) used self-selection similar to Bernard and Jensen (1999) which essentially indicates that firms in Indian manufacturing may self-select to export, then learning by exporting as explained by De. Locker (2013). The crucial argument here comes from export behavior and productivity linkage which may explain the differences in firm behavior related to productivity and changes in technology investment for the participating firms in the export market. Though the empirics sound favorable for the Indian case, the econometric argument on selection bias is more important as the bias is a correlation between the un-observables determining selection and outcome. From the empirical and econometric standpoint, we estimate the export behavior using a heckprobit model.

We formulate two selection arguments; product innovation coupled with (1) participation in R and D and (2) productivity. Higher product innovation, and R and D capabilities of the firm might increase the profit margin and hence, there is a higher possibility of getting into the export market which is in line with Schumpeterian technological change that firms self-select into the export market. Similarly, increase in

total factor productivity may or may not be associated with direct technological interventions, and this also might make a firm self-select itself into the export market. This paper as an improvement on linking product innovation and export participation also tries to see whether a subsample of firms that are exporting for one to two years also self-select in the export market. Therefore, the variant of self-selection as product innovation and R and D are estimated for the subsample of firms that are exporting between one to two years.

The reduced form of export behavior explains that firm characteristics that allow self-selection through product innovation and participation in R and D are important for firms that are old and bigger in size with low-productivity. Hence, we assume that older and bigger firms with lesser productivity capabilities first invest in product innovation through participation in R and D when they target the export market. Within the set of firms that self-select through product innovation and R and D however, may not participate completely in the export market as – within the older and bigger firms the relatively smaller and younger ones participate in the export market. Similarly, firms that are less productive and select to get into product innovation through participating in R and D become productive and hence, participate in the export market. The selection through innovation and R and D is quite visible as a major determinant of export participation given the statistical significance and positive relationship of product innovation and R and D intensities. Therefore, innovation and R and D as a route to participate in the export market will not only facilitate higher productivity, but also stimulate R and D and innovation activities at firm level.

Table 6: Heckprobit Estimates

	(1) Probit	(1.1) Selection	(2)	(2.1) Selection	(3)	(3.1) Selection
Variables	Export Participation	Product Innovation and Participation in R and D	Export Participation	TFP	Continuous Exporters for 1-2 years	Product Innovation and Participation in R and D
FA_{it}	-0.002**	0.001**	-0.001	0.0007	-0.001**	0.001**
	(0.0007)	(0.0005)	(0.0009)	(0.0007)	(0.0006)	(0.0005)
FS_{it}	-0.111***	0.041***	-0.385***	0.057***	-0.083***	0.041***
	(0.013)	(0.005)	(0.027)	(0.007)	(0.010)	(0.005)
$ADVT_{it}$	-0.094		0.835***		-0.026	
	(0.146)		(0.220)		(0.119)	
TFP_{it}	0.109***	-0.144***	-0.231***		0.122***	-0.144***
	(0.015)	(0.010)	(0.027)		(0.013)	(0.010)
RD_{it}	0.027***		0.068***		0.011***	
	(0.006)		(0.004)		(0.003)	
$PINV_{it}$	0.001***		0.009***	-0.003***	0.001***	
	(0.0002)		(0.0005)	(0.0004)	(0.0002)	
Constant	2.376***	-1.916***	0.251**	1.766***	2.201***	-1.914***
	(0.083)	(0.042)	(0.12)	(0.051)	(0.067)	(0.042)
Observations	55,863	55,863	55,863	55,863	55,863	55,863

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors calculations from CMIE Prowess database.

These results are presented in row 1 and 1.1 in Table 6. A parallel exercise for the subsample can be observed from rows 3 and 3.1 where we arrive at similar results for continuous exporters that self-select through product innovation and R and D. Similarly, firms that would want to participate in the export market to increase productivity may also self-select themselves. In this case, the selection equation is through TFP where bigger firms try to increase productivity to get into the export market. The result of TFP in the export participation equation explains the importance of TFP, as lesser productive firms that self-select through TFP can also participate in the export market. The comparison of selection equations between product innovation and R and D vis-à-vis TFP narrates the differential behavior of advertisement intensity which is captured in the TFP equation significantly and positively but not in the

innovation and the R and D equation. Therefore, export participation is possible either through activities related to technological advancements, new product developments, increased in-house R and D and related technological decisions or increase in productivity linked with higher expenses on advertising and marketing. Given the sample remains the same, the selection equation changes, hence, innovation, R and D, productivity and higher advertisement expenses at firm level explains the inter-firm differences in export participation for the sample of Indian manufacturing firms from 2003 to 2015.

CONCLUSION

This exploratory study tries to establish the relationship between export performance, innovation and productivity in Indian manufacturing firms from 2003-2015. There is ample evidence in linking export performance and productivity in the case of Indian manufacturing sector, where product innovation is not considered as one of the drivers of export performance. As a contribution to the literature, we conclude product innovation and R and D as *major* determinants of selection to the export market and increasing export behavior. The presence of product innovation and R and D are found to be major drivers of export behavior whereas, productivity is not explained except in the estimated model of heckprobit. Except in the competitive export market scenario, in the post economic reforms era, our results strongly indicate that productivity alone does not drive export performance, without product innovation, and participation in R and D. Arguments in favor of higher productive firms being able to get into the export market seems to be invalid in this case without reallocating resources towards innovation and R and D. Nevertheless, productivity as a selection criterion explains participation in R and D coupled with advertising and marketing strategies for the sample of firms in Indian manufacturing. To conclude, macroeconomic variables such as the impact of recession and policy variables such as possibility of 100 percent FDI in a sector and technology variables such as the OECD

technology classification play important roles in favor of export participation and performance. Therefore, stronger policy is required to make firms technologically sophisticated, increase the FDI caps and drive firms in carrying out R and D related to product innovation, as these measures will help to boost export performance for the Indian manufacturing units. The significant role of recession that affects the export performance implies the dependency of shocks from international business cycles and hence, the government of India must formulate policies that would help firms in reducing possible risks of economic downturns.

REFERENCES

Aditya, A., and R. Acharyya (2013), "Export Diversification, Composition, and Economic Growth: Evidence from Cross-Country Analysis", *The Journal of International Trade and Economic Development*, 22(7), 959–992.

Agosin, M. R. (2009), "Export Diversification and Growth in Emerging Economies", *CEPAL Review*, 115–131.

Amsden, A. H. (2004), "Import Substitution in High-Tech Industries", *CEPAL Review*, 82, 75–89.

Atkeson, A., and A. Burstein (2010), "Innovation, Firm Dynamics, and International Trade", *Journal of Political Economy*, 118(3), 433-484.

Aw, B. Y., M. J. Roberts, and D. Y. Xu (2008), "R and D Investments, Exporting, and the Evolution of Firm Productivity", *The American Economic Review*, 98(2), 451-456.

Aw, B. Y., M. J. Roberts, and T. Winston (2007), "Export Market Participation, Investments in R and D and Worker Training, and the Evolution of Firm Productivity", *The World Economy*, 14(1), 83-104.

Baldwin, J. R., and W. Gu (2003), "Export-Market Participation and Productivity Performance in Canadian Manufacturing", *Canadian Journal of Economics*, 36(3), 634–657.

Bartelsman, E.J., Doms, M. (2000), "Understanding Productivity: Lessons from Longitudinal Microdata", *Journal of Economic Literature*, 38(3), 569-594.

Basile, R. (2001), "Export Behaviour of Italian Manufacturing Firms Over the Nineties: The Role of Innovation", *Research Policy*, 30(8), 1185–1201.

Becker, S. O., and P. H. Egger (2013), "Endogenous Product Versus Process Innovation and a Firm's Propensity to Export", *Empirical Economics*, 44(1), 329–354.

Bernard, A. B., and J. J. Bradford (1999), "Exceptional Exporter Performance: Cause, Effect, or Both?", *Journal of International Economics*, 47(1), 1–25.

Bernard, A. B., J. B. Jensen, S. J. Redding, and P. K. Schott (2009), "The Margins of US Trade", *The American Economic Review*, 99(2), 487-493.

Bernard, A. B., J. Eaton, J. B. Jensen and S. Kortum (2003), "Plants and Productivity in International Trade", *American Economic Review*, 93(4), 1268–1290.

Boeing, P. (2016), "The Allocation and Effectiveness of China's R and D Subsidies - Evidence from Listed Firms", *Research Policy*, 45(9), 1774-1789.

Caldera, A. (2010), "Innovation and Exporting: Evidence from Spanish Manufacturing Firms", *Review of World Economics*, 146(4), 657–689.

Caselli, F., M. Koren, M. Lisicky, and S. Tenreyro (2015), "Diversification Through Trade", *National Bureau of Economic Research*.

Cirera, X., A. Marin, and R. Markwald (2015), "Explaining Export Diversification Through firm Innovation Decisions: The Case of Brazil", *Research Policy*, 44(10), 1962–1973.

Clerides, S., S. Lach, and J. Tybout (1998), "Is Learning by Exporting Important? Microdynamic Evidence from Colombia, Mexico, and Morocco", *The Quarterly Journal of Economics*, 113(3), 903-947.

Das, S., M. J. Roberts and J. Tybout (2007), "Market Entry Costs, Producer Heterogeneity, and Export Dynamics", *Econometrica*, 75(3), 837-873.

De. Loecker, J. (2013), "Detecting Learning by Exporting", *American Economic Journal: Microeconomics*, 5(3), 1–21.

Dixit, A. K., and J. E. Stiglitz (1977), "Monopolistic Competition and Optimum Product Diversity", *American Economic Review*, 67(3), 297-308.

Eaton, J., and S. Kortum (2002), "Technology, Geography, and Trade", *Econometrica*, 70 (5), 1741-1779.

Edwards, S. (1998), "Openness, Productivity and Growth: What Do We Really Know?", *The Economic Journal*, 108(447), 383-398.

Forsgren, M. (2002), "The Concept of Learning in the Uppsala Internationalization Process Model: A Critical Review", *International Business Review*, 11(3), 257-277.

Hausmann, R., J. Hwang, and D. Rodrik (2007), "What You Export Matters", *Journal of Economic Growth*, 12(1), 1–25.

Heckman, J. J. (1979), "Sample Selection Bias as a Specification Error", *Econometrica*, 47, 153-161.

Hopenhayn, H. (1992), "Entry, Exit and Firm Dynamics in Long Run Equilibrium", *Econometrica*, 60(5), 1127-1150.

Isgut, A. (2001), "What's Different About Exporters? Evidence from Colombian Manufacturing", *Journal of Development Studies*, 37(5), 57–82.

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

Kunst, R. M., and D. Marin (1989), "On Exports and Productivity: A Causal Analysis", *The Review of Economics and Statistics*, 699-703.

Levinsohn, J. and A. Petrin (2003), "Estimating Production Functions Using Inputs to Control for Unobservables", *The Review of Economic Studies*, 70(2), 317-341.

Lileeva, A. and D. Trefler (2010), "Improved Access to Foreign Markets Raises Plant-Level Productivity for Some Plants", *Quarterly Journal of Economics,* 125(3), 1051-1099.

Marin, D. (1992), "Is the Export-Led Growth Hypothesis Valid for Industrialized Countries?", *Review of Economics and Statistics*, 74(4), 678-688.

Melitz, M. J. (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica*, 71(6), 1695–1725.

Mitra, A., C. Sharma, and M. A. Véganzonès-Varoudakis (2014), "Trade Liberalization, Technology Transfer, and Firms' Productive Performance: The Case of Indian Manufacturing", *Journal of Asian Economics*, 33, 1–15.

Narayanan, K. (1998), "Technology Acquisition, De-Regulation and Competitiveness: A Study of Indian Automobile Industry", *Research Policy*, 27(2), 215–228.

Pakes, A., R. Ericson (1995), "Markov Perfect Industry Dynamics: A Framework for Empirical Work", *Review of Economic Studies*, 62(1), 53-82.

Rodríguez-Duarte, A., F. D. Sandulli, B. Minguela-Rata, and J. I. López-Sánchez (2007), "The Endogenous Relationship Between Innovation and Diversification, and The Impact of Technological Resources on the Form of Diversification", *Research Policy*, 36(5), 652–664.

Sachs, J. and A. Warner (1995), "Economic Reform and The Process of Global Integration", *Brookings Papers on Economic Activity*, Washington DC., 1-95.

Sahu, S. K., and K. Narayanan (2015), "Technology Import, R and D Spillover and Export: A Study of Automobile Sector in India", *Review of Development and Change*, XX(2), 257-276.

Saleem, H. N. (1992), "*Import Substitution in the Manufacturing Sector*. *Import Substitution in the Manufacturing Sector* (1st ed.)", New Delhi: National Institute of Public Finance and Policy.

Thomas, R., and K. Narayanan (2016), "Productivity Heterogeneity and Export Market Participation: A Study of Indian Manufacturing Firms". In F. De Buele and K. Narayanan (Eds.), *Globalization of Indian Industries,* Springer, 97–120.

Van Biesebroeck, J. (2005), "Exporting Raises Productivity in Sub-Saharan African Manufacturing Firms", *Journal of International Economics*, 67(2), 373–391.

Vannoorenberghe, G., Z. Wang, and Z. Yu (2016), "Volatility and Diversification of Exports: Firm-Level Theory and Evidence", *European Economic Review*.

Wagner, J. (1995), "Exports, Firm Size, and Firm Dynamics", *Small Business Economics*, 7(1), 29-39.

Appendix T1: Description of Variables

Variable Name	Symbol	Description
firm_age firm_age2	FA_{it} FA^2_{it}	Age of the firm (in years) calculated as the difference between the year of recorded observation and the year of establishment. Subsequently, firm_age2 is the square of firm_age.
ln_assets ln_assets2	FS_{it} FS^2_{it}	Natural log of net assets of the firm. The untransformed variable is measured in millions of rupees. Subsequently, ln_assets2 is the square of ln_assets.
avt_intensity	$ADVT_{it}$	The ratio of marketing and advertisement expenses of the firm to the total sales of the firm.
randd_in	RD_{it}	The ratio of R and D expenditure of the firm to the total sales of the firm
prod_innov_in	$PINV_{it}$	The ratio of product innovation expenses of the firm by the total sales of the firm. Subsequently, inno2 is the square of prod_innov_in
oecd_d1 oecd_d2 oecd_d3	$OECD_i$	Equals 1, if the firm belongs to the "High-Technology Industries" based on the OECD-ISIC Rev 3. classification. Equals 1, if the firm belongs to the "Medium High-Technology Industries" based on the OECD-ISIC Rev 3. classification Equals 1, if the firm belongs to the "Medium Low-Technology Industries" based on the OECD-ISIC Rev 3. classification.
recess_d0	RES_i	Equals 1, if the observation is recorded for the year 2008
fdi_d0	FDI_i	Equals 1, if the firm belongs to the NIC-2008 sector where 100 percent FDI is allowed.
pat_in	PAT_{it}	Ratio of profit after taxes to the total sales of the firm.
prod_LP prof_LP2	TFP_{it} TFP^2_{it}	The productivity of the firm measured through the Levinsohn Petrin production function. Subsequently, prod_LP2 is the square of prod_LP.

Appendix T2: OLS Estimates (Dependent Variable: Export Intensity)

Variables	(1)	(2)
FA_{it}	0.035***	0.045***
	(0.008)	(0.008)
FA^2_{it}	-0.0003***	-0.0004***
	(8.89e-05)	(9.08e-05)
FS_{it}	-2.216***	-2.381***
	(0.107)	(0.108)
FS^2_{it}	0.129***	0.139***
	(0.007)	(0.007)
$ADVT_{it}$	3.026***	2.896***
	(0.471)	(0.477)
RD_{it}	0.634***	0.679***
	(0.011)	(0.011)
$PINV_{it}$	0.092***	
	(0.002)	
$PINV^2_{it}$	-0.0001***	
	(4.07e-06)	
$OECD_{1i}$	2.924***	2.978***
	(0.685)	(0.690)
$OECD_{2i}$	2.387***	2.532***
	(0.683)	(0.688)
$OECD_{3i}$	2.926***	2.958***
	(0.697)	(0.702)
RES_i	0.133***	0.234***
	(0.043)	(0.046)
FDI_i	2.886***	2.830***
	(0.619)	(0.624)
PAT_{it}	-0.005**	-0.01***
	(0.002)	(0.002)
TFP_{it}		-0.586***
		(0.070)
TFP^2_{it}		0.073***
		(0.014)
Constant	5.820***	7.097***
	(0.791)	(0.800)
Observations	55,863	55,863
Number of statenum	6,726	6,726
Overall R^2	0.1433	0.1156

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors calculations from CMIE Prowess database.

Appendix T3: Fixed Effects Estimates (Dependent Variable: Export Intensity)

Variables	(1)	(2)	(3)	(4)
	Dependent Variable = Export Intensity			
FA_{it}	0.057***	0.050***	0.065***	0.060***
	(0.010)	(0.013)	(0.012)	(0.014)
FA^2_{it}	-0.0006***	-0.0006***	-0.0005***	-0.0005***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
FS_{it}	-1.509***	-1.511***	-0.303***	-0.304***
	(0.132)	(0.132)	(0.0416)	(0.0416)
FA^2_{it}	0.087***	0.087***		
	(0.009)	(0.009)		
$ADVT_{it}$	3.758***	3.765***	3.731***	3.736***
	(0.507)	(0.507)	(0.508)	(0.508)
RD_{it}	0.595***	0.595***	0.600***	0.600***
	(0.011)	(0.011)	(0.011)	(0.011)
$PINV_{it}$	0.0852***	0.0852***	0.0858***	0.0858***
	(0.002)	(0.002)	(0.002)	(0.002)
$PINV^2_{it}$	-0.0001***	-0.0001***	-0.0001***	-0.0001***
	(4.31e-06)	(4.31e-06)	(4.31e-06)	(4.31e-06)
PAT_{it}	0.0002	0.0002	4.40e-05	5.82e-05
	(0.002)	(0.002)	(0.002)	(0.002)
RES_i		0.057		0.046
		(0.063)		(0.063)
TFP_{it}			-0.100*	-0.098*
			(0.058)	(0.058)
Constant	5.220***	5.395***	1.262***	1.399***
	(0.460)	(0.498)	(0.208)	(0.280)
Observations	55,863	55,863	55,863	55,863
R^2 Within	0.084	0.084	0.082	0.082
R^2 Between	0.246	0.250	0.224	0.230
R^2 Overall	0.143	0.142	0.126	0.130
Number of statenum	6,726	6,726	6,726	6,726

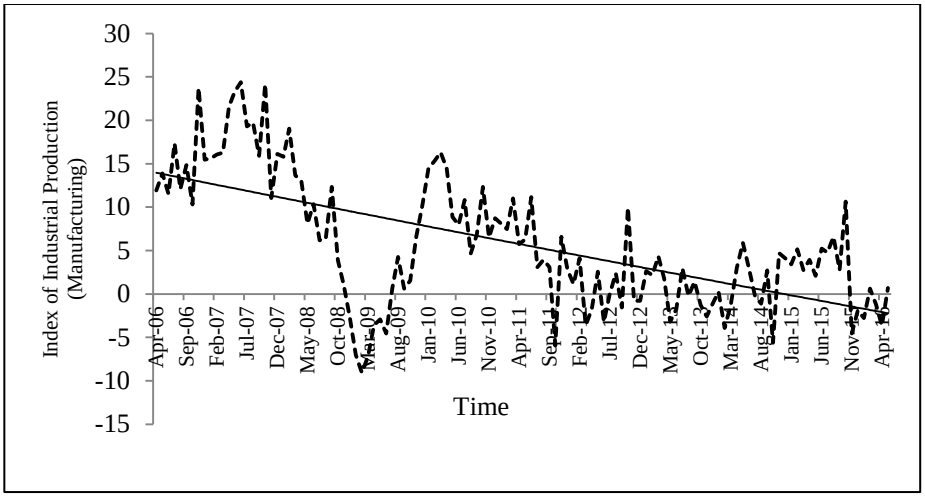
Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors calculations from CMIE Prowess database.

Appendix T4: Fixed Effects (Cluster, Robust) Estimates

Variables	(1)	(2)	(3)	(4)
	Dependent Variable = Export Intensity			
FA_{it}	0.057**	0.050**	0.065**	0.060***
	(0.027)	(0.021)	(0.025)	(0.020)
FA^2_{it}	-0.001**	-0.001**	-0.0005**	-0.0005**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
FS_{it}	-1.509***	-1.511***	-0.303***	-0.304***
	(0.341)	(0.342)	(0.092)	(0.093)
FS^2_{it}	0.087***	0.087***		
	(0.019)	(0.019)		
$ADVT_{it}$	3.758**	3.765**	3.731**	3.736**
	(1.693)	(1.696)	(1.698)	(1.700)
RD_{it}	0.595***	0.595***	0.600***	0.600***
	(0.130)	(0.130)	(0.130)	(0.130)
$PINV_{it}$	0.085***	0.085***	0.085***	0.085***
	(0.022)	(0.022)	(0.022)	(0.022)
$PINV^2_{it}$	-0.0001***	-0.0001***	-0.0001***	-0.0001***
	(2.85e-05)	(2.85e-05)	(2.87e-05)	(2.87e-05)
PAT_{it}	0.0002	0.0002	4.40e-05	5.82e-05
	(0.010)	(0.010)	(0.010)	(0.010)
RES_i		0.057		0.046
		(0.077)		(0.079)
TFP_{it}			-0.100	-0.010
			(0.124)	(0.124)
Constant	5.220***	5.395***	1.262***	1.399***
	(1.067)	(1.138)	(0.249)	(0.348)
Observations	55,863	55,863	55,863	55,863
R^2 Within	0.084	0.083	0.082	0.082
R^2 Between	0.250	0.250	0.224	0.230
R^2 Overall	0.142	0.142	0.126	0.130
Number of statenum	6,726	6,726	6,726	6,726

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors calculations from CMIE Prowess database.

Appendix F1: Trend in IIP from 2006-2016



Source: Authors calculations from Index of Industrial Production, Government of India.

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