ISID Institute for Studies in Industrial Development
An institution of Indian Council of Social Science Research (Ministry of Education)
Policy Research to Foster India's Industrial Transformation

266
WORKING PAPER

R&D behaviour of Indian Firms: A Case of High-tech Manufacturing

K Seenaiah

March 2023

ISID Working Paper 266

R&D Behaviour of Indian Firms:
A Case of High-tech Manufacturing

K Seenaiah

ISID Institute for Studies in Industrial Development
An institution of Indian Council of Social Science Research (Ministry of Education)
4 Vasant Kunj Institutional Area, New Delhi – 110 070
Phone: +91 11 2689 1111 | *E-mail:* info@isid.org.in | *Website:* https://isid.org.in

March 2023

ISID Working Papers are meant to disseminate the tentative results and findings obtained from the ongoing research activities at the Institute and to attract comments and suggestions which may kindly be addressed to the author.

R&D Behaviour of Indian Firms:
A Case of High-tech Manufacturing

K Seenaiah[*]

[***Abstract***: *Analysis of Manufacturing R&D (research and development) has several implications for firms and policymakers all over the world, particularly in developing economies like India. Given the backdrop of India's weak R&D, this study empirically examines the key drivers of R&D in the case of high-tech manufacturing firms, using panel data spanning from 2001 through 2020. We implement Heckman's two-stage procedure to account for the endogeneity and correct the likelihood of biased estimates due to the sample section criteria. Findings show that the firm size a has traditional "non-linear relationship", and the impact of outward orientation is significantly positive. The technological efforts of India's high-tech manufacturing firms are increasingly attributed to the external activities of the firms.*]

Keywords: *High-tech manufacturing, R&D, Heckman selection, Panel data, India*
JEL Classification: *L25, L60, O32*

1. Introduction

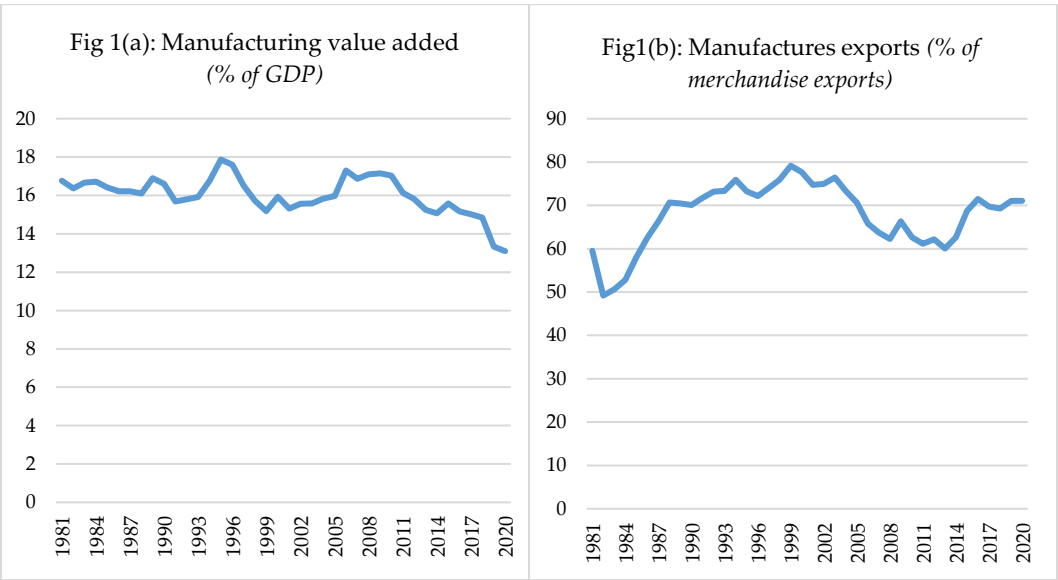
The significance of innovation in the growth process is well established (Aghion & Howitt, 1992; Schumpeter, 1942; Solow, 1957). Particularly, R&D expenditure – a key input to innovation— plays a vital role in promoting manufacturing led-growth development. Recent evidence from the East Asian nations had a relevant showcase, showing how these nations made remarkable progress following manufacturing or export-led growth policies[1]. The nexus between industrialization and growth has a positive relationship even in the case of developing economies, as Rodrik (2006) emphasizes that growth acceleration is often associated with a higher share of manufacturing value added. Such evidence is true all over the world (Cantore et al., 2017; Szirmai, 2012; McCausland and Theodossiou, 2012); particularly studies have demonstrated the role of R&D investment is vital to building not only long-term competitiveness, knowledge spillovers and innovation capability but also to make the best use of imported technologies (Raut, 1995; Cohen and Levinthal, 1989).

[*] Assistant Professor, at ISID. Email: seenaiah@isid.org.in, seenueconomiks@gmail.com

[1] The review of the success story of these countries can be found in Stiglitz's paper in World Bank Observer, 1996; Hsiao and Mei-Chu, 2003.

However, R&D undertaking is costly for the firms particularly in developing countries due to the involved risk and uncertainty along with the economic environment firms operated in. For instance, countries like India confronted several challenges due to ineffective capital and financial markets. Eventually, since the 1990s, with the adoption of open economic policies, firms have been getting exposure to foreign markets and advanced technologies. The changed policy environment gave the momentum to increase the outward orientation of Indian firms (Nayyar, 2008), such rapid internationalization of Indian firms can be noticed through the expansion of investment outflows rose to US$64000 million by 2020 from a mere US$1000 million in 1994 (See, UNCTAD)[2]; however, the evidence on the impact of internationalization on R&D has no clear direction[3] (Feinberg and Majumdar, 2001; Wang and Kafouros, 2009; Salomon and Shaver, 2005).

Figure 1: Share of Manufacturing, value-added and exports



Source: World Development Indicators (World Bank).

Literature shows that the growing role of (high-tech intensive) manufacturing in the growth process, in terms of positive externalities, economies of scale and ability to drive technological progress (Baumann and Kritikos, 2016; Marjit and Mukherjee, 2008; Lee, 2005; Katrak,1989). But the performance of India's manufacturing is not robust despite the sequential priorities and incentives provided by the policy[4]. Manufacturing share at the

[2] https://unctad.org/data-visualization/global-foreign-direct-investment-flows-over-last-30-years

[3] R&D and outward orientation have a bi-directional relationship theoretically; however, the firm-level evidence is not clear from outward orientation to R&D undertaking.

[4] Make in India, a flagship program of the govt of India launched in 2014 with the aim of transforming the economy into a global design and manufacturing hub. Another recent initiative is the production-linked incentive (PLI) scheme, which gives huge priority to expanding the manufacturing units and promoting the quality and competitiveness to improve the (global) performance of Indian firms.

aggregate level has remained stagnant over the decades. Figure 1 shows that manufacturing value added even further declined in recent decades (1981-2020) from 17 to 13%; whereas the East Asian counterparts contribute the lion's share around 30% of GDP. Manufacturing share in terms of merchandise exports also stagnated during the same period of the last four decades (see, Fig1b). The lower share in terms of value-added and exports may be attributed to the poor performance of aggregate R&D as a percentage of GDP, which stagnated around 0.7% during the last decade[5]; whereas it is high and increasing sizably in other parts of the world across the Europe, OECD, and East Asia – averaged above 2% in GDP. Given the backdrop of weak manufacturing, it is imperative to increase the R&D outlays for the following reasons: *first*, to improve the firm's competitiveness by developing high-quality innovative products, addressing global demand, and gaining market share. *Second*, to abate the notion that domestic firms only undertake R&D to modify imported technologies and perform reverse-engineering and incremental innovation, but to achieve the policy goals such as '*making India a manufacturing hub*' to attract global investors India must facilitate and enable the innovation ecosystem. *Third*, given the dual role of R&D—innovation and imitation—undertaking R&D is an essential component of firms' survival and growth and success (Czarnitzki and Thorwarth, 2012).

Given the nature of R&D data of Indian manufacturing (see, section 3), the study examines the determinants of R&D of high technology-intensive manufacturing firms. The study considers high-tech firms for not only to minimise the zero reporting of R&D but also to focus on the R&D concentrated firms, where the technological content and scope of R&D are high, which provides a strong theoretical standpoint. High-tech firms are likely to conduct R&D more frequently to develop new technologies and high-end innovations. Therefore, the present study focuses on high-tech manufacturing firms[6]. This study contributes to the literature on firm-level R&D in a developing country context in the following form: *one*, preliminary analysis shows that R&D undertaking is relatively consistent in high-tech manufacturing firms, and 83% of manufacturing R&D comes from high-tech firms (see, Figure 2). The character of the sector's innovation and technological capability substantially superior. *Two*, given the nature of the data, we implement Heckman criteria to correct the potential selectivity bias. *Three*, results reveal that the impact of outward orientation on R&D is changing over time and playing an active role. The findings are helpful in related debates in academia and policy circles.

---

[5] However, Manufacturing R&D increased over the years; Indian firms realized the fact that R&D role in their business functioning. The data show that (see: Column D of Table A2) R&D expenditure increased from Rs. 32, 421 million to Rs. 3,34,805 million over the last two decades from 2001 to 2020. But, as a matter of fact, it is not enough to carry out larger innovative projects to gain from foreign markets. To come out of the incremental nature of R&D Indian firms must aggressively undertake R&D investments.

[6] Appendix Table A1 provides the classification of the different sectors, present study's focus is on the firms covered under the high technology-intensive categories, i.e., NIC two-digit codes 20, 21, 26, 27, 28, 29 and 30.

The remaining paper is organized in the following form: Section 2 reviews some of the studies and shows the theoretical relationships among the variables, with R&D. Section 3 will go through the data, sample firms and estimation procedure. Section 4 discusses the estimated results and section 5 concludes the paper.

2. Brief Review of Literature

Firms try to improve R&D efforts through internal mechanisms and interactions with external markets. Different channels incentivize to innovate—firm size, rate of profitability, demand conditions and learning through trade channels, and technology acquisition—all such factors affect the performance and the direction and rate of the innovation effort. Following Shi and Wu (2017), Seenaiah and Rath (2018) and Kumar and Aggarwal (2005), we develop two hypotheses that affect the R&D behaviour of the firms, internal and external activities. On the one hand, internal factors such as firms' ability to sell more and generate profitable income to reorient them into strategic areas such as R&D and technology development. On the other hand, firms' outward orientation may improve firm's ability to learn and innovate more. This section reviews these two aspects of firm-level literature to understand the firm behaviour of R&D, technology development and innovation.

2.1. Internal Factors

Firm size has long been investigated as a determinant of innovation since the time of Joseph Schumpeter, which influences it through two channels: (1) large firms may have huge resources to carry out these costly and risky projects whereas smaller ones would find it difficult to carry the innovative projects. (2) Economies of scale would preferably favour large firms in marketing or advertising innovative products. However, firm size has mixed effects on R&D undertaking, several studies find a non-linear relationship with the firm size, such relationships commonly observed in Scherer, (1965) and Audretsch and Acs (1991). Using German and French data on the size and innovation Bertscheck and Entorf (1996) did not find supporting evidence for the Schumpeterian hypothesis of the advantage of large firms. Further, mixed empirical evidence supported by Arrow's preposition that competition could be the real source and generate better innovation capability among smaller ones, whereas the larger monopolies may not lead the direction of innovation and technological change (Arrow, 1962), such evidence is documented in Cohen (1995), Kumar and Siddharthan (1994). Given this evidence, we hypothesise firm size has a non-linear relationship with the R&D behavior of the firms under the study.

Profit margin is another area that affects re-investments, particularly the R&D investments to improve strategic areas and focus on product differentiation which further improves revenue channels and higher performance. However, literature pertinent to India shows that profitability has a mixed effect on R&D behavior due to different tax regimes over time and firms' nature of profitability (Goldar and Renaganathan, 1998). The impact of

profitability of a firm further not only depends on the activities within the firm, for instance: Audretsch (1995) finds that profitability favors innovation where firms operate in an environment where technological opportunities are high, it has an insignificant effect in an environment of low technological opportunities. Therefore, profit might affect R&D under different circumstances differently.

2.2. External Factors [from here]

Firm-level R&D depends on several factors, which can be categorized into internal and external. External factors, mainly international trade through exports and import channels, affect the R&D undertaking of manufacturing firms. To effectively use these two – broad openness channels – firms need to understand the demand patterns and level of competition they face from their rivals. The literature emphasizes that trade impact is obvious on innovation (Kiriyama, 2012). Studies such as Bratti and Guilia (2012), Cassiman and Golovko (2011), Salomon and Shaver (2005) show that learning by exporting (from export to R&D and innovation) has evidence that needs complementary effort to enter the export markets with an advantage of learning possibilities (with the exposure of knowledge-intensive products) and improve the ability to bear the involved risks and associated costs. Evidence shows that Indian firms experience these learning channels through trade linkages (Parameswaran, 2010; Nayyar, 2008).

For the effective involvement of trade, firms require the quality of R&D to increase their competitiveness and gain a larger market share. It is also noted that imported inputs can substitute the local R&D but contrarily it promotes innovation due to the ability to create new knowledge with the support of internal R&D capabilities (Lie and Qiu, 2016). The channel of import, particularly the import of capital goods and intermediaries plays a critical role in promoting quality through the absorptive capacity of internal R&D (Mo et al., 2021); trade effects on R&D in the case of India shown in Parameswaran (2010), this link prominently matters for promoting R&D, leaning capabilities to the effective use of imported capital equipment (Cohen and Levinthal, 1989). Import channel of trade captured, through the import of capital goods and expenses on technology know-how and other expenses on the patent process, licensing etc. Considering this evidence, we posit a positive association with outward orientation (different categories of import and export activities), where firms are likely to improve the R&D performance of the firms under investigation.

Multinational affiliations may have different impacts on R&D behaviour. Local firms may find difficulty in getting access to foreign technologies and therefore depends on indigenous technological improvement. A large body of growing literature emphasizes that the internationalization of R&D through MNE activity has become more prominent than a few decades ago. These firms increasingly locate R&D centres across the world given the region-specific advantages such as being characterized by weak protection of intellectual property rights (IPR), and other subsidiary spillovers effect (Anand et al., 2021).

Contrary to local firms, foreign affiliates import technologies developed by their parent firms from abroad without needing their own R&D efforts and may access better technologies and knowledge applications. Therefore, we hypothesize that MNE affiliation improves technological access and innovative inputs and methods from parent firms. To understand the role of foreign affiliation, we use a dummy variable with having a foreign share, more than 25%, otherwise treated as a local firm. However further we study separately domestic firms; we split firms into domestic and foreign affiliates.

3. Data and Preliminaries: The Case of High-tech Sectors

What is technology-intensive firms, and how do they differ from non-R&D or non-technology-intensive firms? Hitech firms tend to invest more in technology due to much business activity linked to the element of science and technology. The technology intensity of the firm can be captured through its ability to undertake knowledge-intensive projects or products that have sophisticated capital or knowledge content. We select these sectors in line with the classification of OECD[7], which pertains to having the high capability of technological content in the production process and thus the ability to produce technologically superior or innovative products.

Table1: Description of the variables

Acronym	*Description of the variable*
R&D	Research and development expenditure of the firm
SIZE	Net sales of the firm
PBT	Profit before tax
RYLTKHW	Expenses on royalty, technology-know
IMPCG	Expenses on capital goods imported
EXPMG*	Earnings from exports of manufactured goods
EXPER*	Earnings from exports of non-manufactured goods*
FSHARE	Dummy variable for foreign ownership (1 >25%, otherwise 0)

Note: Data were converted to real series using appropriated indices, data were collected from Prowess IQ, CMIE.
*Prowess IQ provides data related to trade variables. Earning from different categories of exports captures the sum of the earnings of a company, in terms of foreign exchange under the following heads: (a) Export of Goods, (b) Export of Services, (c) Forex earning - Dividend (d) Forex earning – Interest, (e) Others.

Given the requirement of business operations and opportunities, these sectors demand higher R&D investment than those of low or non-technology-intensive sectors, therefore, the likely to invest in R&D is high. As mentioned previously, our sample shows that around 80% of R&D expenditure is carried out by high-tech manufacturing firms in India

[7] Classification of technology intensity is based on the National Industrial Classification - 2008, Ministry of Corporate Affairs, Government of India. The broad technology segments are based on OECD technology categorisation. (See: note 6).

(see Figure 2). Improvement in technological prowess depends not only on the ability to import from foreign companies but also on the internal capability to undertake its own R&D, depending on the firm's category of tech intensity.

3.1. The Data

Firm-level data has been used for the analysis, extracted from Prowess IQ, provided by the Centre for Monitoring Indian Economy (CMIE), which is an independent corporate database of Indian firms, the data are reliable and were used previously in the literature (Kale and Rath, 2018; Bhattacharya et al., 2021).

Table 2: R&D Behaviour and Outward Orientation of High-tech Firms (2001-2020)

Year (a)	*No. of firms (b)*	*No. of R&D-oriented firms# (c)*	*Total R&D (Rs. Million) (d)*	*Net sales (Rs. Million) (e)*	*Total forex earnings (Rs. Million) (f)*	*% of R&D oriented firms (g)=(c/b*100)*	*% of R&D in total sales (h)=(d/e*100)*	*% of exports in total sales (i)=(f/e*100)*
2001	1532	512	22979	3451732	342723	33	0.7	10
2002	1538	551	26519	3435978	373643	36	0.8	11
2003	1817	614	31574	3704569	452810	34	0.9	12
2004	1936	636	40544	4124308	585862	33	1.0	14
2005	2058	633	53001	4919517	727022	31	1.1	15
2006	2107	641	63155	5391347	817068	30	1.2	15
2007	2098	532	58022	9976591	1205547	25	0.6	12
2008	2245	699	86823	7042919	1175209	31	1.2	17
2009	2343	682	102896	7752779	1410462	29	1.3	18
2010	2404	701	101045	8306233	1318159	29	1.2	16
2011	2424	696	113448	9429804	1476184	29	1.2	16
2012	2473	721	128277	10734872	1699674	29	1.2	16
2013	2487	769	151377	11054240	1897297	31	1.4	17
2014	3385	915	170652	13715104	2681704	27	1.2	20
2015	3842	956	204346	15397258	3735451	25	1.3	24
2016	3983	980	237385	16319499	3439926	25	1.5	21
2017	3984	982	258535	17115428	3062392	25	1.5	18
2018	3997	923	246955	18763105	3415659	23	1.3	18
2019	3928	933	253012	21375936	4053145	24	1.2	19
2020	3719	916	274874	19843238	4012725	25	1.4	20

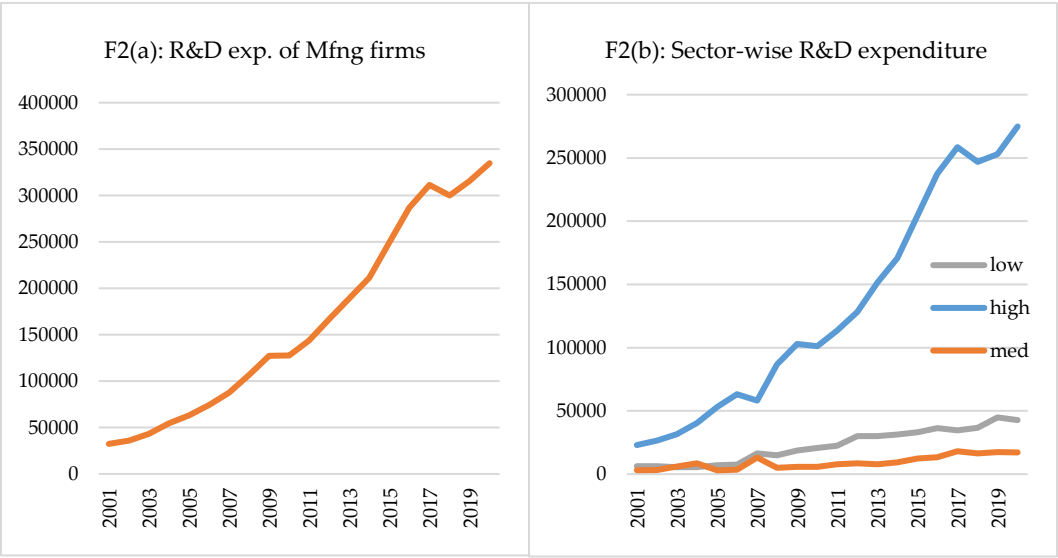
Source: Authors compilation from CMIE.

Note: The table shows the trends in R&D and exports over the years. Overall growth is observed in both the aspect, R&D and outward orientation. Total R&D outlays, net sales and foreign exchange earnings are increased over the years (see, columns d,e,f). However, the growth was not robust, close observation reveals

that (see column c, g and h), R&D orientation and R&D intensity is fragile; and export intensity is also weak (see, column i). (Similar statistics are provided in Appendix Table A2 for overall manufacturing).
R&D-oriented means the firms undertaking R&D in a particular year.

CMIE provides time series data on firm-level activities related to financial statements, balance sheets of companies, internal business and trade-related variables such as exports and imports, R&D and on other key inputs. However, several variables are not available consistently. Particularly (in the case of India), the inconsistency of R&D was quite common due to several reasons, nature of the R&D activity of firms and the level of economic development (associated technologies involved) could be a prime reason in developing economies like India.

Figure 2: R&D in High-tech Manufacturing Sectors (Rs. in Million)



Source: Authors compilation from CMIE.
Note. The figure shows the dominant R&D undertaking by high-tech-intensive firms. R&D of low and medium-tech firms is negligible. The association of high-tech-intensive firms and R&D investment are closely connected.

As we notice from Table 2, the proportion of R&D-oriented firms is not even 40% (column-g), similarly R&D intensity (R&D to total sales) is highly negligible, below 1.5% (column-h). Firms in India do not undertake R&D consistently, further corporate R&D is highly concentrated, 50% of R&D comes from the top 100 R&D performing firms even in the case of high technology-oriented firms[8]. Table 2 shows the sample data over time. In the initial year, 2001, we have 1532 firms and gradually sample size increased over time and reaches close to 4000 firms. The number of R&D-oriented firms over the years also increased from

[8] This is further negligible for overall manufacturing. R&D in Indian manufacturing is highly concentrated, 90% of R&D comes from the top 100 R&D performing firms and 99% of R&D from the top 300 R&D oriented firms. Appendix Table A2 provides a quick overview of manufacturing R&D and other key activities over the period of 2000-2020.

512 (33%) in 2001 to 982 (25%) by 2017 and thereafter slight decline was noticed in the number of firms that undertake R&D.

Table 3: Descriptive Statistics, High, Low and Medium tech firms (Rs. in Million)

	All firms *Mean (SD)*	*Local firms* *Mean (SD)*	*Foreign affiliates* *Mean (SD)*
Full sample	26.71 (394.23)	24.75 (388.42)	112.63 (589.99)
High-tech	51.66 (547.47)	47.96 (540.13)	154.71 (715.00)
Mid-tech	5.78 (74.43)	5.34 (67.90)	33.14 (252.32)
Low-tech	11.00 (290.49)	10.71 (292.06)	35.12 (77.22)

Source: Authors' calculation based on prowess IQ, CMIE.

Table 3 provides the mean value of R&D manufacturing including different groups of categories: local, foreign; high-tech, low and medium-tech categories. The mean value of R&D of high-technology intensive sectors is high, 51.66 (547.47) among the technology segments, including the full sample, 26.71 (394.23). Differences were also observed among the ownership structures, foreign firms witness higher R&D volumes as compared to their local counterparts. But in both cases, high-tech sectors performed higher R&D, local and foreign affiliates with the mean of 47.96 and 154.71 respectively. The value of standard deviations shows the variability (inconsistency of R&D undertaking) among the firm R&D observations over the years. The preliminary view indicates that technology intensity and R&D are closely related. Overall, high-technology-intensive sectors perform higher R&D irrespective of ownership structure.

Even some of the large and innovative firms do not report R&D data. To consider such firms in the empirical analysis, we include firms with and without R&D during the sample period. However, if a firm does not report any sales, we exclude that entry from the study sample. However, firms belonging to high-tech sectors recognize the strength of R&D and carry out some form of R&D. Therefore, we included all the firms who do not disclose or report or do not undertake R&D in some years or the whole sample period. Our data is unbalanced in nature, the data selection process was restricted to sales variable, study consider the data with positive sales; observations with zero and negative sales were dropped from the analysis. Since R&D is the dependent variable, if this exceeds the sales value, such abnormal observations also dropped from the analysis, which may create a cumbersome R&D intensity value, but such cases were very few. Explanatory variables other than the firm size entered regression as lagged values to address the issue of causality; also, the variables related to trade and internal firm-level activities may not spontaneously impact the R&D behaviour but are expected to influence with lag. Following the data cleaning procedure, we left with 54, 592 firm observations for the emperical analysis.

3.2. The Model

With the aim of understanding the determinants of R&D of sample firms, given the nature of data, it is feasible to conduct panel data analysis (such as probit and tobit type regressions) following previous studies (see, Majumdar, 2011; Bhattacharya and Bloch, 2004). But, since the dependent variable has several missing values, the response on whether the firm's undertaking R&D in the particular year during the sample period is not convincingly available, therefore traditional OLS and probit, tobit type regressions ruled out due to the likelihood of biasedness in the estimated coefficients. The Heckman selection simultaneously builds both the equations for selection and outcome equations, which is suitable to describe the *likelihood of R&D investment* (R&D Dummy) and *R&D intensity* (R&D as % of sales) of sample firms. The Heckman procedure (1976) is a two-stage implementation. The model in the first stage estimates the likelihood of undertaking R&D investments by the sample firms, through the following probit regression:

$$y_i^* = X_{it}\beta_{it} + \varepsilon_{it}, \varepsilon_i \sim N, (0\ \sigma^2)\ (1)$$

$$y_i = 1\ if\ y_i^* > 0 \text{ firm undertakes R\&D}$$

$$y_i = 1\ if\ y_i^* \leq 0 \text{ firm does not perform R\&D}$$

where, Xi is the vector of independent variables that have theoretical relationships to explain the likelihood of R&D, i.e., *yi*, βi is the vector of coefficient parameters and ε is the vector of error terms.

The first step, probit regression estimates the likelihood of R&D undertakings of high-tech manufacturing firms, where *yi* is measured as a dummy if a firm undertakes R&D indicates 1, otherwise 0. The explanatory variables are continuous in nature except for the foreign share dummy. Another dummy variable, the dummy of exporting manufacturing goods is included to fulfil the "*exclusion restriction*" which may affect the decision to undertake R&D in a particular year. The probit estimation produces the inverse Mill's ratio (IMR), which calculates through the standard normal density function to the value of the standard normal cumulative distribution function, in the following form, which is a necessary condition to implement the second stage of outcome equation (the R&D intensity).

$$\lambda = \frac{\emptyset(X_i\beta_i)}{\varphi(X_i\beta_i)}$$

The Heckman model in the next step estimates the relationships between the R&D expenditure undertaken by the firms and the hypothetical relationships placed in section 2, ie, the determinants of R&D by regressing the positive Yi values on Xi by incorporating the IMR obtained from the first stage regression. The second stage basically estimates the behaviour of the outcome variable (R&D intensity) with no selectivity bias. The significance of the IMR coefficient indicates the existence of bias and is corrected automatically by the model. In other words, the outcome equation uses the data available on

R&D to estimate the coefficients of the dependent variables. Unlike the selection equation (probit type equation), the dependent variable in the outcome equation (OLS estimator), uses the amount of R&D spending (R&D intensity) by the firm in the sample. The outcome equation be written as follows:

$$lny_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it} + \cdots + \beta_n X_{it} + \lambda_{it} + \varepsilon_{it} \quad (2)$$

where β_0 is intercept; $\beta_1, \beta_2, \ldots, \beta_n$, are the parameters to be estimated, λi is inverse mill ratio and ε_{it} is a stochastic error term.

The apriori expectations of the covariates on R&D undertakings are provided the in the previous section (section 2), along with the description of the variables in Table 1, applicable to both, domestic and foreign affiliates. We estimate equation (2), fitting with the model to correct the sample selection bias, whereas equation (2) incorporates equation (1) through '*inverse mills ratio (λ)*' to examine the determinants of R&D by considering the above model.

4. Results Discussion

A firm interacts with various players to perform the business activity and understands its reactions and decides what needs to produce and sell. The economic environment is a key player; where firm deals with the complex task of understanding the real world, and producing products accordingly, in this process, as mentioned R&D comes to play a vital role in making different forms of innovation possible.

Table 4: High-tech Indian Manufacturing Firms

	Coefficient	*t value*
First stage: Probit Selection equation		
SIZE	-0.029	-0.28
SIZE2	0.106***	6.02
SIZE3	-0.005***	-5.26
PBT	0.002	0.37
IMPCG	0.002	1.03
RYLTKHW	-0.006	-0.57
EXPMG	-0.009	-0.65
EXPER	0.000	-0.17
EXPGD	0.475***	12.92
FSHARE	0.264**	2.57
_cons	-7.978***	-27.27
Wald	2141.99	
Loglikelihood	-13355	
no obs	54,592	

Second stage: Heckman Outcome equation		
SIZE	-0.500**	-2.09
SIZE2	-0.171***	-2.69
SIZE3	0.012***	3.44
PBT	-0.108***	-8.83
IMPCG	0.019**	2.65
RYLTKHW	0.018	0.20
EXPMG	0.363***	3.56
EXPER	0.017***	3.99
FSHARE	-0.452	-1.00
lambda	-1.618***	-4.16
_cons	14.512***	4.60
Year dummies	Yes	Yes
Sector dummies	Yes	Yes
wald	270.08	
no obs	54,590	

Note: Table reports the estimated results of the Heckman selection, using data of High-tech intensive manufacturing firms, sample includes both the groups: Domestic and foreign affiliated. Data were collected from Prowess IQ; the sample period is 2001-2020.
***and ** indicate the significance level at 1% and 5% respectively.

Our estimated results statistically capture the behaviour of R&D, the internal and external factors that drive the firm level R&D. Results reported in Tables 4 & 5 reports the results of local and foreign affiliates. As mentioned, our focus is divided into internal and external i.e., outward orientation due to the increased globalization and involvement of Indian firms in external markets. Firms not only import technologies from outside but potentially absorb knowledge where it is originally developed. For the viable adaptation of these technologies, a firm needs an internal R&D activity to assimilate them properly in local conditions (Nelson, 2004). We restrict our interpretation to the Heckman procedure, where lambda is significant and negative (*inverse Mills ratio*) indicates the existence of selection bias and corrected by the model and not that of selection (probit) equation, applicable to both Tables 4 & 5[9].

Variable firm size shows the non-linear relationship is consistent with that of earlier studies for the full sample, which is consistent with the stylized fact 3 of Klette and Kortum (2004), "*the R&D intensity is independent of firm size*". SIZE variable (and size2, the square of the size) has a negative impact on R&D behaviour with statistical significance in the case of local firms, but SIZE3 has become positive with statistical significance. The sign confirms the non-linear relationship between firm size and firm behaviour towards R&D in Indian

[9] Lambda is not significant in the case of foreign affiliates (see Table 5 of panel b), indicating that there is no selection bias in this case, therefore we do not interpret these results.

firms, in the case of the full sample and local as well, the relationship is cubic, it is significant. These results are theoretically consistent, suggesting that R&D and firm size has no linear relationship. In both samples, the size variable produced no clear direction in relation to the R&D behaviour of the firms. Much of the interpretation goes in line with earlier studies, particularly with Klette and Kortum (2004). However, such a relationship between size and technological behaviour is not in line with the Schumpeterian hypothesis of large firm advantage, the results show a non-linear relationship. Other studies also find a negative relationship (Scherer, 1965; Mansfield, 1964), as opposed to the large firm advantage of economies of scale (Cohen and Klepper, 1996). Our results fall in line with that of Kumar Aggarwal (2005) and Majumdar (2011) which strengthens the hypothesis made above.

Theoretically, the profit margin has a similar impact to that of size, because of its higher size and ability to generate more resources and finance the costs and handle the involved risk associated with firms. Further, turn the generated profits into strategic investments like R&D. However, the variable PBT (profit before tax) has a negative impact with statistical significance in the full sample as well as in the case of local firms, discouraging R&D behaviour with a negative impact. This indicates that the ability of Indian firms in terms of reviewing R&D decisions is not closely related to internal size and revenue generation mechanisms and probably related to much of other factors.

We turn to import factors: consider two variables *viz*., IMPCG and RYLTKHW for spending on import of capital goods and knowledge assets in terms of spending on royalties, designs, and product licensing etc., the variables show mixed effects. High technology-intensive firms have a significant relationship with the import of capital goods but not with RYLTKHW. This is true in the case of domestic firms also, indicating that Indian firms are dependent on technology acquisition through spending abroad on importing capital goods. Our finding somewhat corroborates with the earlier evidence of Chen et al. (2017), whose study finds that the import of intermediaries increases the R&D intensity; similarly, Rijesh (2015) also finds that the import of capital goods drives the TFP growth of Indian manufacturing significantly.

Table 5: Local vis-à-vis Foreign Affiliates: High-tech Manufacturing Sectors

	Panel (a) Local firms		*Panel (b) Foreign affiliates*	
	Coefficient	*t value*	*Coefficient*	*t value*
First stage: Probit Selection equation				
SIZE	-0.023	-0.21	-1.774	-1.28
SIZE2	0.107***	5.84	0.242	1.32
SIZE3	-0.005***	-5.05	-0.009	-1.16
PBT	0.002	0.37	-1.365**	-2.71
IMPCG	0.002	1.10	1.685	1.00
RYLTKHW	-0.007	-0.57	11.536***	3.63

EXPMG	-0.008	-0.61	-0.358	-0.57
EXPER	0.000	-0.17	0.221	0.21
EXPGD	0.466***	12.53	0.820*	2.25
_cons	-8.060***	-26.95	0.131	0.03
wald	2047.37		104.22	
loglikelihood	-12752.46		-554.70	
no obs	52,607		1,985	
Second stage: Heckman Outcome equation				
SIZE	-0.476*	-1.94	-0.664	-0.96
SIZE2	-0.184**	-2.73	0.024	0.27
SIZE3	0.013***	3.45	0.001	0.19
PBT	-0.108***	-8.67	-0.511**	-2.11
IMPCG	0.019**	2.58	-0.918	-0.86
RYLTKHW	0.018	0.20	-0.635	-0.70
EXPMG	0.362***	3.48	-0.505	-1.53
EXPER	0.017***	3.92	0.630	1.22
lambda	-1.631***	-3.98	0.168	0.87
_cons	14.752***	4.40	3.180	1.40
Year dummies	Yes		Yes	
Sector dummies	Yes		Yes	
wald	259.84		89.06	
no obs	52,605		1,985	

Note: Table reports the estimated results of Heckman selection, using data of High-tech intensive manufacturing firms, Domestic vis-à-vis foreign affiliates. The data source and sample period are the same as above, table 4. ***, ** and * indicates the significance level at 1%, 5% and 10% respectively.

Firm-level export activities are captured through EXPMG (exporting manufactured goods) and EXPER (export of non-manufactured goods along with dividends and other earnings from abroad). The export orientation of firms, particularly from developing countries, could be somewhat different from that of firms operating in industrialized countries. However, firms from these countries under liberalized economic policies play a significant part in global markets. Evidence is growing in support of these aspects of firms' engagement in favour of firm growth (MacGarvie, 2006; Bleaney et al., 2000). Estimated results of outward orientation on R&D, both the coefficients show positive signs with high statistical significance corroborating with theoretical predictions. The form of exportation, particularly, relatively the lower magnitude of EXPER shows that India's earnings from abroad in terms of royalty, technology know-how and dividend earnings impact on R&D are less as compared to the effect of earnings from manufactured exports (EXPMG). This finding indicates that firms have larger incentives to undertake R&D due to the improvement in carrying out the traditional exporting activity which is prevalent in the case of high-tech sectors. The outward orientation of Indian firms gradually improved over the years since the liberalization, where Indian firms took advantage of such policy environment and exporting intensively and doing other activities of business abroad. The impact, particularly the revenue generation in terms of dividends also included in the

sample, which is a desirable indication that Indian firms leveraging the full potential of policies that encourage firms to involve in international trade. This evidence in the case of high-tech industries is worth noting. Overall, outward orientation in terms of imports and exports has become apparent and corroborates with earlier evidence, showing that liberalized firms actively engage in these activities (Bas and Paunov, 2018).

Finally, ownership structure, the coefficient of FSHARE, the dummy variable representing the ownership structure of the firm is not a significant driver of R&D (see Table 4). However, the sample is further divided to investigate closely, the local and foreign affiliates, but the model comprising domestic firms did not show much difference from that of the whole sample. This indicates that foreign affiliation does not have much influence on driving R&D investments. In other words, foreign affiliates are much more dependent on parent firms rather than developing technologies in-house. This appearance shows that the development of completely new technologies is beyond their business horizons. The variable is not statistically significant in explaining the variation due to ownership affiliation.

5. Conclusion

Our study directly contributes to strengthening the evidence on the past literature on Manufacturing R&D. Particularly the understanding of the R&D behaviour of India's high-tech manufacturing firms using data from 2001 to 2020.

Preliminary analysis shows that the concern of declining importance of R&D is not the case, but the concentration of R&D. Firms' ability to undertake R&D has increased but overall, at the aggregated level it is far away from desired level (2% of GDP). Given that, the reprise of the R&D behaviour of Indian firms is done through the sample of high technology-intensive firms. Heckman's two-stage model was applied to correct the sample-selection bias in estimated coefficients. Results indicate a non-linear relationship with the size variable, which shows a mixture of signs but not with a unique positive or negative relationship holds. Profit before tax turns up a negatively significant explanation of R&D behaviour in both the samples, domestic and foreign. Outward orientation treated as a key aspect in this paper has clear implications in driving the R&D behaviour of sample firms. This aspect of firm-level activities is captured through different variables of exports and imports. The export activity allows local firms to engage with foreign markets and learn to innovate and upgrade technologically. The outward orientation, including strategic aspects captured through IMPCG, EXPMG and EXPER has a significant impact in driving firm-level R&D.

The findings of the study have several policy implications in a liberalized economy like India. Having access to foreign technology and capital goods imports is helpful to observe the technologies and imitate the products to compete in foreign markets and grow internationally. It also revealed that the firm's ability to export further gives space to learning capabilities to drive high productivity with better internal technology

management and R&D upgradation (Parameswaran, 2010). The external linkages to improve productivity or innovation through R&D is the key concern of policymakers throughout the developing world including India.

This study has limitations. Further studies need to focus at the disaggregate level at least in three respects: *first*, size: small, medium, and larger size towards R&D and technological capabilities; *second*, technology segment— low and medium technology-intensive firms to be given attention to understand their technological needs and innovation strategies. Due to the pervasive informality and low level of technological development, these two aspects are critical for a middle-income country like India, *Third*, age – younger and matured firms' behaviour of R&D further needs to be explored to understand R&D patterns in greater detail, it is vital to establish a viable '*start-up ecosystem*' in a growing economy like India.

References

Aghion, P., & Howitt, P. (1992). A Model of Growth through Creative Destruction. Econometrica, 60, 323-351.

Anand, J., McDermott, G., Mudambi, R., & Narula, R. (2021). Innovation in and from emerging economies: new insights and lessons for international business research. *Journal of International Business Studies*, *52*(4), 545-559.

Arrow, Kenneth J. (1962). "Economic Welfare and the Allocation of Resources for Invention." In The Rate and Direction of Inventive Activity: Economic and Social Factors, 609–626. Princeton: Princeton University Press.

Audretsch, D. B. (1995). Firm profitability, growth, and innovation. *Review of Industrial Organization*, *10*(5), 579-588.

Audretsch, D. B., & Acs, Z. J. (1991). Innovation and size at the firm level. *Southern Economic Journal*, 739-744.

Bas, M., & Paunov, C. (2018). The Unequal Effect of India's Industrial Liberalization on Firms' Decision to Innovate: Do Business Conditions Matter? *The Journal of Industrial Economics*, *66*(1), 205-238.

Baumann, J., & Kritikos, A. S. (2016). The link between R&D, innovation and productivity: Are micro firms different? *Research Policy*, *45*(6), 1263-1274.

Bhattacharya, M., & Bloch, H. (2004). Determinants of innovation. *Small Business Economics*, *22*(2), 155–162.

Bhattacharya, M., Okafor, L. E., & Pradeep, V. (2021). International firm activities, R&D, and productivity: Evidence from Indian manufacturing firms. *Economic Modelling*, *97*, 1-13.

Bleaney, M. F., Filatotchev, I., & Wakelin, K. (2000). *Learning by exporting: Evidence from three transition economies*. Centre for Research on Globalisation and Labour Markets, School of Economics, University of Nottingham.

Bratti, M., & Felice, G. (2012). Are exporters more likely to introduce product innovations? *The World Economy*, *35*(11), 1559-1598.

Cantore, N., Clara, M., Lavopa, A., & Soare, C. (2017). Manufacturing as an engine of growth: Which is the best fuel? *Structural Change and Economic Dynamics*, *42*, 56-66.

Cassiman, B., & Golovko, E. (2011). Innovation and internationalization through exports. *Journal of International Business Studies*, *42*(1), 56-75.

Chen, Z., J. Zhang, & W. Zheng (2017). Import and innovation: Evidence from Chinese firms. *European Economic Review*, 94, 205-220.

Cohen, W. M., & Klepper, S. (1996). A reprise of size and R&D. Economic Journal, 106, 925–951.

Cohen, W. M., & Levinthal, D. A. (1989). Innovation and learning: the two faces of R & D. *The economic journal*, *99*(397), 569-596.

Cohen, W.M., 1995. Empirical studies of innovative activity. In: Stoneman, P. (Ed.), Handbook of the Economics of Innovation and Technological Change. Blackwell, Oxford, pp. 182–264.

Czarnitzki, D., & Thorwarth, S. (2012). Productivity effects of basic research in low-tech and high-tech industries. *Research policy*, *41*(9), 1555-1564.

Feinberg, S. E., & Majumdar, S. K. (2001). Technology spillovers from foreign direct investment in the Indian pharmaceutical industry. *Journal of International Business Studies*, *32*(3), 421-437.

Goldar, R.N., Renganathan, V.S. (1998). Economic reforms and R&D expenditure in industrial firms in India. The Indian Economic Journal 46 (2), 60–75.

Hasan, R. (2002). The impact of imported and domestic technologies on the productivity of firms: panel data evidence from Indian manufacturing firms. *Journal of Development Economics*, *69*(1), 23-49.

Hsiao, F. S., & Mei-Chu, W. H. (2003). "Miracle Growth" in the Twentieth Century—International Comparisons of East Asian Development. *World Development*, *31*(2), 227-257.

Katrak, H. (1989). Imported technologies and R&D in a newly industrialising country: The experience of Indian enterprises. *Journal of development economics*, *31*(1), 123-139.

Kiriyama, N. (2012). Trade and innovation: synthesis report. OECD Trade Policy Papers 135.

Klette, T. J., & Kortum, S. (2004). Innovating firms and aggregate innovation. *Journal of political economy*, *112*(5), 986-1018.

Kumar, N., & Aggarwal, A. (2005). Liberalization, outward orientation and in-house R&D activity of multinational and local firms: A quantitative exploration for Indian manufacturing. *Research Policy*, *34*(4), 441-460.

Kumar, N., & Siddharthan, N. S. (1994). Technology, firm size and export behaviour in developing countries: The case of Indian enterprises. *The journal of development studies*, 31(2), 289-309.

Lee, C. Y. (2005). A new perspective on industry R&D and market structure. *The journal of industrial economics*, *53*(1), 101-122.

Liu, Q., & Qiu, L. D. (2016). Intermediate input imports and innovations: Evidence from Chinese firms' patent filings. *Journal of International Economics*, *103*, 166-183.

MacGarvie, M. (2006). Do firms learn from international trade? *Review of Economics and Statistics*, *88*(1), 46-60.

Majumdar, S. K. (2011). Scalability versus flexibility: firm size and R&D in Indian industry. *The Journal of Technology Transfer*, *36*(1), 101-116.

Mansfield, E. (1964). Industrial research and development expenditures: Determinants, prospects, and relation to size of firm and inventive output. *Journal of Political Economy*, *72*(4), 319-340.

Marjit, S., & Mukherjee, A. (2008). International outsourcing and R&D: long-run implications for consumers. *Review of International Economics*, *16*(5), 1010-1022.

McCausland, W. D., & Theodossiou, I. (2012). Is manufacturing still the engine of growth?. *Journal of Post Keynesian Economics*, *35*(1), 79-92.

Mo, J., Qiu, L. D., Zhang, H., & Dong, X. (2021). What you import matters for productivity growth: Experience from Chinese manufacturing firms. *Journal of Development Economics*, *152*, 102677.

Nayyar, D. (2008). The internationalization of firms from India: Investment, mergers and acquisitions. *Oxford Development Studies*, *36*(1), 111-131.

Nelson, R. (2004). The challenge of building an effective innovation system for catch-up. *Oxford development studies*, *32*(3), 365-374.

Parameswaran, M. (2010). International trade and R&D investment: evidence from manufacturing firms in India. *International Journal of Technology and Globalisation*, *5*(1-2), 43-60.

Raut, L. K. (1995). R&D Spillover and productivity growth: Evidence from Indian private firms. *Journal of Development Economics, 48*(1), 1–23

Rijesh, R. (2015). Technology import and manufacturing productivity in India: Firm level analysis. *Journal of Industry, Competition and Trade*, *15*(4), 411-434.

Rodrik, D. (2006). Industrial development: stylized facts and policies. *Harvard University, Massachusetts. Mimeo*.

Salomon, R. M., & Shaver, J. M. (2005). Learning by exporting: new insights from examining firm innovation. *Journal of Economics & Management Strategy*, *14*(2), 431-460.

Scherer, F. M. (1965). Firm size, market structure, opportunity, and the output of patented inventions. *The American economic review*, *55*(5), 1097-1125.

Schumpeter, Joseph A (1942). *Capitalism, Socialism and Democracy*. New York, NY: Harper & Brothers.

Seenaiah, K. & B.N. Rath (2018). Determinants of innovation in selected manufacturing firms in India: Role of R&D and exports. *Science, Technology and Society*, 23(1), 65-84.

Shi, X., & Wu, Y. (2017). The effect of internal and external factors on innovative behaviour of Chinese manufacturing firms. *China Economic Review*, *46*, S50-S64.

Solow, R. M. (1957). Technical change and the aggregate production function. *The review of Economics and Statistics*, 312-320.

Stiglitz, J. E. (1996). Some lessons from the East Asian miracle. *The world Bank research observer*, *11*(2), 151-177.

Szirmai, A. (2012). Industrialization as an engine of growth in developing countries, 1950–2005. *Structural Change and Economic Dynamics, 23*(4), 406–420.

Wang, C., & Kafouros, M. I. (2009). What factors determine innovation performance in emerging economies? Evidence from China. *International Business Review*, *18*(6), 606-616.

Appendix

Table A1: Sample Firms Under Different Sectors (NIC-2008)

Firms	*Sectors*	*Technology Intensity*
10	food products	LOW
11	Beverages	LOW
12	tobacco products	LOW
13	Textiles	LOW
14	wearing apparel	LOW
15	leather and related products	LOW
16	wood and related products	LOW
17	paper and paper products	LOW
18	Printing and reproduction of media	LOW
19	coke and refined petroleum	LOW
25	fabricated metal products*	LOW
31	Furniture	LOW
22	rubber and plastics products	MED
23	other non-metallic mineral products	MED
24	basic metals	MED
32	Other manufacturing*	MED
20	chemicals and chemical products	HIGH
21	pharmaceutical products	HIGH
26	computer, electronic and optical products	HIGH
27	electrical equipment	HIGH
28	machinery and equipment	HIGH
29	motor vehicles, trailers, and semi-trailers	HIGH
30	other transport equipment*	HIGH

Source: Ministry of Corporate Affairs, Govt of India.

Table A2: R&D Behaviour and Outward Orientation of Manufacturing Firms (2001-2020)

Year (a)	*No of firms (b)*	*R&D oriented firms (c)*	*Total R&D (d)*	*Net sales (e)*	*Forex earnings (f)*	*% of R&D oriented firms (g)*	*% of R&D in total sales (h)*	*% of Exports in total sales (i)*
2001	3665	821	32421	11507128	1142589	22	0.3	10
2002	3786	901	35837	10985503	1183937	24	0.3	11
2003	4416	972	43038	12063159	1405891	22	0.4	12
2004	4672	979	54555	13036108	1719068	21	0.4	13
2005	5196	984	63267	16065552	2403727	19	0.4	15
2006	5416	996	74346	17708200	2758382	18	0.4	16
2007	5614	1015	87619	21410118	3852126	18	0.4	18
2008	5783	1022	106659	24043523	4398746	18	0.4	18
2009	6100	1044	127383	27218278	4859950	17	0.5	18
2010	6270	1078	127615	27712519	4686466	17	0.5	17
2011	6163	1089	143788	31376785	5541030	18	0.5	18
2012	6042	1103	166810	36431813	6720292	18	0.5	18
2013	6005	1156	189159	39678850	7619317	19	0.5	19
2014	7918	1383	211485	46476356	9458890	17	0.5	20
2015	8797	1424	249815	48485397	10322189	16	0.5	21
2016	9132	1452	287001	44870749	8351209	16	0.6	19
2017	9136	1446	311262	46671810	8215434	16	0.7	18
2018	9195	1370	300047	50810930	8838170	15	0.6	17
2019	8987	1376	315374	58705170	10291483	15	0.5	18
2020	8414	1332	334805	53281476	9451087	16	0.6	18

Source: Prowess IQ, CMIE. Calculations made in this table are similar to that of Table 2 and it covers the whole manufacturing sectors inlcuding low, medium and high-technology intensive sectors

List of ISID Working Papers

265 Impact of Import Liberalisation on Employment in Manufacturing Industries in India, *Ramaa Arun Kumar*, March 2023

264 Public Sector Performance in India and the Ongoing Contestation between Efficiency and Equity, *Satyaki Roy & Santosh Kumar Das*, March 2023

263 Trade, Structural Change, and Productivity Growth in the Indian Manufacturing Sector, *R Rijesh*, February 2023

263 Trade, Structural Change, and Productivity Growth in the Indian Manufacturing Sector, *R Rijesh*, February 2023

262 Adoption of Industry 4.0 Technologies in India's Start-up Ecosystem, *Sanjaya Kumar Malik*, February 2023

261 For Whom the Bell Tolls: Inclusive Innovation and Innovation Policy, *Suma Athreye & Abhijit Sengupta*, January 2023

260 The Complementarity between the Formal and Informal Sub-Sectors of the Indian Industry, *Mehak Majeed, Saeed Owais Mushtaq, & Zahid Gulzar Rather*, January 2023

259 Competitive Manufacturing as a Driver of India's next Economic Transformation: Opportunities, Potential, and Policies, *Nagesh Kumar,* December 2022

258 Vaccine Manufacturing Industry of India: Structure, Size, and Competitiveness, *Shailender Hooda,* December 2022

257 India's Unbalanced Industrial Development: Possible Explanations for Inter-State Variations, *Shiladitya Chatterjee*, December 2022

256 Status and Scope of Industrial Development in Aspirational Districts of India, *Surya Tewari,* November 2022

255 Growth Slowdown in the Automobile Industry in India: Dwindling Middle Class Demand or Changing Consumption Pattern? *Satyaki Roy,* November 2022

254 Examining Regional Disparities among States of India through Sectoral Compositions, *Sangeeta Ghosh*, October 2022

253 India's Trade in Manufactures: The Role of Intra Industry Trade, *Manmohan Agarwal & Neha Betai*, September 2022

252 The Survival of Outward Investments from India and China: Is there a North-South Divide? *Suma Athreye, Abubakr Saeed, Muhammad Saad Baloch*, September 2022

251 Manufacturing Units and Employment in India: A District Level Analysis Using Economic Census, *Surya Tewari*, August 2022

250 India in the Global Vaccine Market Prior To and During COVID-19: Some Structural Issues, *Shailender Hooda*, August 2022

249 Unlocking India's Potential in Industrial Revolution 4.0: National Innovation System, Demography, and Inclusive Development, *Nagesh Kumar*, July 2022

248 India's Trade in Pharmaceutical Products: A Method for the Classification of Pharmaceutical Products and Recent Trends, *Reji K. Joseph & Dinesh Kumar*, July 2022

247 Exports and Growth in Indian Manufacturing: An Econometric Analysis, *Bishwanath Goldar*, June 2022

* ISID Working Papers can be downloaded at https://isid.org.in/

The **Institute for Studies in Industrial Development** (ISID) is a public-funded, non-profit, autonomous institution dedicated to conducting policy research, advocacy, capacity-building, and outreach activities to foster the industrial transformation of India.

Registered on October 7, 1986, under the Indian Societies Registration Act 1860, ISID in 1988, became one of the institutions that are supported by the Indian Council of Social Science Research (ICSSR), (Government of India), through grants-in-aid. Since 2006, the Institute operates from its own well-appointed campus located in the Vasant Kunj Institutional Area in South Delhi.

The research themes and key projects are classified under following broad thematic areas:

- Industrial Structure, Performance, and Polices
- Corporate Governance and Industrial Financing
- Leveraging MSMEs and Start-ups for Industrial Transformation
- Globalization, FDI, and Trade
- Technology, Innovation and Industry 4.0
- Green Industrialization Strategy
- Employment and Labour Markets
- Spatial Dimensions of Industrial Development and Industrial Infrastructure
- Sectoral Studies on Competitiveness of Indian Manufacturing

ISID is recognized as a Scientific and Industrial Research Organization (SIRO) by the Government of India. It is also listed on DARPAN portal of NITI Aayog (India's Planning Agency) as a recognized think-tank. It is also a member of the Asia-Pacific Research Network on Trade (ARTNet) and the South Asia Network on SDGs (SANS) of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). ISID's Databases and e-resources are accessed by the academic community across the country through the Information and Library Network (INFLIBNET) Centre of the University Grant Commission (UGC).

ISID Institute for Studies in Industrial Development
An institution of Indian Council of Social Science Research (Ministry of Education)
4 Vasant Kunj Institutional Area, New Delhi - 110070, India
Phone: +91 11 2689 1111 | E-mail: info@isid.org.in | Website: https://isid.org.in