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Factors Affecting Firm's Annual Turnover in Selected Manufacturing Industries of India: An Empirical Study

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Research Article

Abstract

Purpose: *This study makes a comparison of the manufacturing sector and its determinants for India and selected Asian countries. It examines the factors affecting the annual turnover of randomly selected 154 firms in seven different industries of the Indian manufacturing sector.*

Methods: *In this study, the firm's annual turnover is used as a dependent variable. Labor productivity, age, investment on plant & machinery, annual expenditure on marketing, total employees, production technology up-gradation, shortage of skilled workers, skills to improve the process, use of hi-tech tool and technique in production activities, technology transfer abilities, in-house R&D expertise, quality certification, foreign collaboration, waste management capabilities and building capacity of firms are used as independent variables. Regression coefficients of explanatory variables are assessed using linear, log-linear, and non-linear regression models.*

Results: *The study concluded that the firm's annual turnover has a significant association with technological development related variables, labor productivity, age, technology transfer abilities, in-house R&D expertise, quality certification, and waste management practices of firms.*

Implications: *It suggests that Indian policymakers need to adopt a strong IPRs, education, and S&T policy in research institutions. India needs to increase R&D expenditure and researchers in research institutions. Research institutions should collaborate with the existing industries to discover more technologies and innovations for the manufacturing sector. All research organizations must set up technology transfer offices to increase technology transfer and commercialization. Furthermore, India needs to set up hi-tech firms to face global challenges.*

Originality: *It uses primary data of 154 firms which are collected from seven different industries across Indian states. Thus, the study substantially contributes to the existing literature.*

Limitations: *This study considers seven different industries that have high diversity in socio-economic, science & technological and IPRs related activities, technology transfer, commercialization of technology,*

and association with research institutions. Therefore, this study cannot provide policy suggestions for a specific industry.
Keywords: Asian countries; Indian manufacturing sector; IPRs policy; R&D expenditure; Technology transfer; commercialization.

1. Introduction

Small and medium-sized enterprises in the manufacturing sector have effective contributions to the socio-economic development of a nation (Patnaik & Satyaprakash, 2015; Kaur, 2016; Singh, Ashraf & Arya, 2019; Kapoor, 2018; Etim, Umoffong & Goddymkpa, 2020). It is a crucial sector to absorb the skilled and unskilled workforce at a larger-scale as compared to other sectors of a country (Sen & Das, 2016; Singh, Ashraf & Arya, 2019). Thus, the manufacturing sector is an option to create jobs for the present and future population in agrarian economies (Kapoor, 2018). In the past two decades some economies like China, Thailand, and South Korea have adopted effective policies to increase the transfer of technologies from research organizations to the industrial sector through science and technological development (STD), and strong intellectual property rights (IPRs) regime (Singh, Acharya & Chavda, 2017). Also, research institutions could generate enough revenue through technology transfer and commercialization, thus, the manufacturing sector could create extensive jobs for skills and unskilled laborers in these countries. STD works as a vital driver to increase the technological advancement and skills of people in a country (Singh, Acharya & Chavda, 2017; Singh et al., 2017; Singh, Ashraf & Arya, 2019; Singh, Arya & Jyoti, 2019; Singh & Ashraf, 2020). Technological development is useful to reduce human effort and to complete their desired goals in various sectors (e.g., education, health, employment generation, transport, shelter, food security, and others) (Singh, Singh & Ashraf, 2020). It is an essential driver to increase the productivity, efficiency, and effectiveness of the manufacturing sector (Abri & Mahmoudzadeh, 2015). It is also useful to discover new products for the manufacturing sector (Çalışkan, 2015). Thus, the monopoly power of a firm decreases due to an increase in technological development in a country. Subsequently, the prices of goods decrease when a manufacturing firm introduces a new product in the market. Further, it is obvious that the demand for products increases as price declines. Therefore, it encourages the manufacturing units to increase the supply of more goods in the market. It also contributes to human well-being by creating new business/venture, employment, product development, new market, and infrastructure development. Thus, technological development is required for the socio-economic development of a country (Singh, Singh, & Ashraf, 2020).

In India, Micro, Small, and Medium Enterprises (MSMEs) are useful to increase social and economic development (Kaur, 2016; Singh, Ashraf & Arya, 2019). Around 80% of Indian workers are engaged in the unorganized manufacturing sector which adds around 16% share in India's GDP (Vrajlal, 2015; Sen & Das, 2016). Thus, the manufacturing sector has a significant contribution to the Indian economy (Mitra, Sharma & Véganzonès-Varoudakis, 2016; Sen & Das, 2016). However, the Indian manufacturing sector could not create extensive jobs. Thus, this sector has a lower contribution to its GDP as compared to China, Japan, South Korea, Thailand, and Malaysia (Dougherty, Herd & Chalaux, 2009; Kaur, 2016). The Government of India (GoI) has implemented several policies (e.g. Make in India, Skill India, Startup India, and National

Intellectual Property Rights Policy, and others) to create jobs and the share of the manufacturing sector in India's GDP. These policies are also centralized to use the skills of the young generation to create the entrepreneurship ecosystem in India. Despite that, there is little improvement in employment creation and productivity of the manufacturing sector in India. Thus, this sector could not increase its share in India's GDP. Thus, aforesaid policies could not show a positive impact on the performance of the manufacturing sector in India. Indian manufacturing sector has a low global value chain, low R&D spending, poor quality of products, extensive dependency of firms on foreign technologies, low innovative ability of firms, ineffective IPRs regime, low association across firms, low applications of advance technologies, low trust of entrepreneurs on domestic technologies, insignificant association of research institutions with industries, low technology transfer and commercialization, low financial support from banking sector and financial institutions for small-scale firms, inadequate public-private co-operation, low productivity of human resource, poor infrastructure, stringent and complex labor law, technological backwardness and scarcity of skilled workforce, and others (Deolalikar & Röller, 1989; Mazumdar, Rajeev & Ray, 2009; Ray & Saha, 2010; Iyer, Koudal & Saranga, 2011; Srivastava & Chandra, 2012; Vrajlal, 2015; Kaur, 2016; Singh & Ashraf, 2019; Singh, Ashraf & Arya, 2019; Singh, Singh & Ashraf, 2020; Singh & Ashraf, 2020).

India has the 2nd largest population in the world. Thus, it has a huge body of consumers who can buy the goods and services manufactured by Indian firms. Thus, the manufacturing sector has high possibilities to meet the employment demand of the present and growing population. Moreover, India has a highly educated and youth population, thus, the manufacturing sector has a better possibility to grow in the future (Mehta & Johan, 2017; Singh, Singh & Ashraf, 2020). Also, Indian manufacturing firms have a scope for capital and skill enterprises which have a low job opportunity for unskilled workers (Singh, Singh & Ashraf, 2020). Thus, India should use science & technology and IPRs regime to boost the growth of the manufacturing sector.

In India, earlier studies have estimated the impact of various socio-economic, science & technological development and IPRs related factors on various aspects of firms in manufacturing sector (Rajesh, 2007; Bhayani, 2010; Pattnayak & Chadha, 2013; Kathuria, Raj & Sen, 2013; Debnath & Sabastian, 2014; Mahajan, Nauriyal & Singh, 2014; Sahu & Narayanan, 2015; Abri & Mahmoudzadeh, 2015; Sen & Das, 2016; Kapoor, 2016; Chaudhuri, 2016; Singh et al., 2017; Mehta & Johan, 2017; Singh, Narayanan & Sharma, 2019; Jyoti & Singh, 2020; Singh, Singh & Ashraf, 2020). Also, several studies have assessed the impact of socio-economic and policy factors on growth, profit, and other characteristics of the manufacturing sector in India (Tripathy et al., 2016; Tyagi & Nauryal, 2016). Also, several studies have estimated the impact of various activities on a firm's output, sales growth, employment rate, TFP, TE, and performance of the Indian manufacturing sector (Mazumdar, Rajeev & Ray, 2009; Kumar & Arora, 2012; Kathuria, Raj & Sen, 2013; Pattnayak & Chadha, 2013; Sahu, 2015; Bhatia & Mahendru, 2015; Chaudhuri, 2016; Kumar & Sharma, 2016; Mitra, Sharma & Véganzonès-Varoudakis, 2016; Singh, Ashraf & Arya, 2019). Though, limited studies could examine the firm's annual turnover affecting factors using firm-level information of the Indian manufacturing sector. Therefore, this study evaluates the firm's annual turnover affecting factors in the Indian manufacturing sector. This study assesses the answers to the following research questions:

- What is the contribution of the manufacturing sector in India and a few Asian countries?
- How the firm's annual turnover has an association with its socio-economic activities in the Indian manufacturing sector?
- What is the significance of science, technology, as well as IPRs related factors on the performance of Indian manufacturing firms?

2. Research Method and Material

2.1. Selection of Asian Countries

Japan, South Korea, Malaysia, Indonesia, and Thailand are major competitive countries for the Indian manufacturing sector in Asia. Thus, these countries are considered to make India's comparison in the manufacturing sector (i.e. manufacturing value-added, share in world's manufacturing, the share of foreign direct investment net inflow, high-technology exports, share in world's high-technology exports) and its associated activities (i.e. R&D expenditure and researcher, charges for the use of intellectual property payments and receipts, and patent and industrial design applications files by researchers and scientists) in this study. For this, secondary data on aforesaid variables are collected from the websites of the world development indicator (World Bank) and the International Labor Organization.

2.2 Introduction of Indian States

This study includes the firm-level information of seven different industries which are taken from Delhi, Gujarat, Haryana, Karnataka, Maharashtra, Punjab, Tamil Nadu, Telangana, and Uttar Pradesh states of India. These states have a large share in the Indian manufacturing sector (see Figure 1).

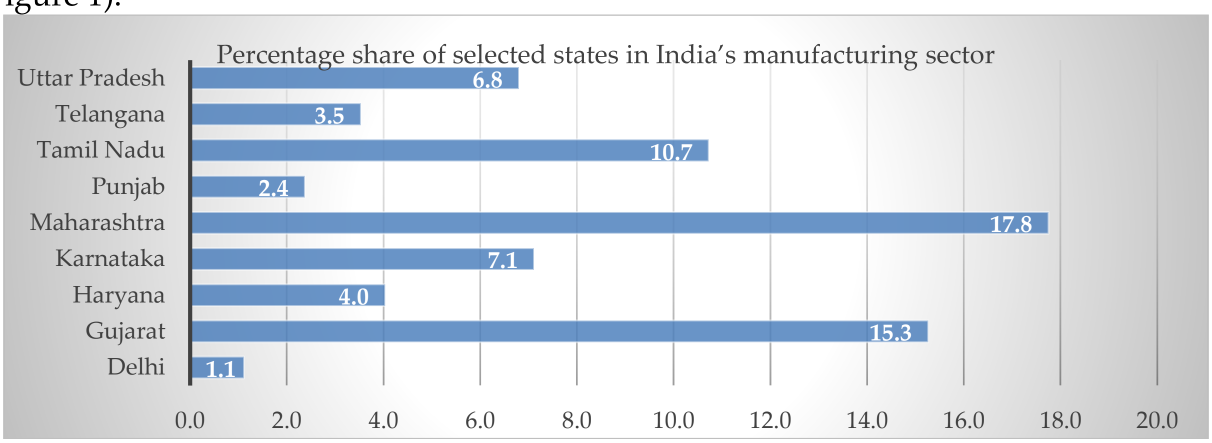

Figure 1: Share of selected states in India's manufacturing sector in 2016-17

Source: Central Statistics Office, MOSPI, Government of India

[% share of the manufacturing sector of these states is assessed based on sectoral gross state domestic product at factor cost with constant prices as the base year of 2011-12].

These states occupy around 67% of India's total factories. The percentage share of these states in India's total factories in 2016-17 is given in Figure 2. Also, a group of these states provides jobs to around 69% of industrial workers of India. The percentage share of selected states in India's total industrial workers in 2016-17 is given in Figure 3. Furthermore, these nine states contribute around 61% industrial product of India. The percentage share of selected states in India's total industrial product in 2016-17 is shown in Figure 4.

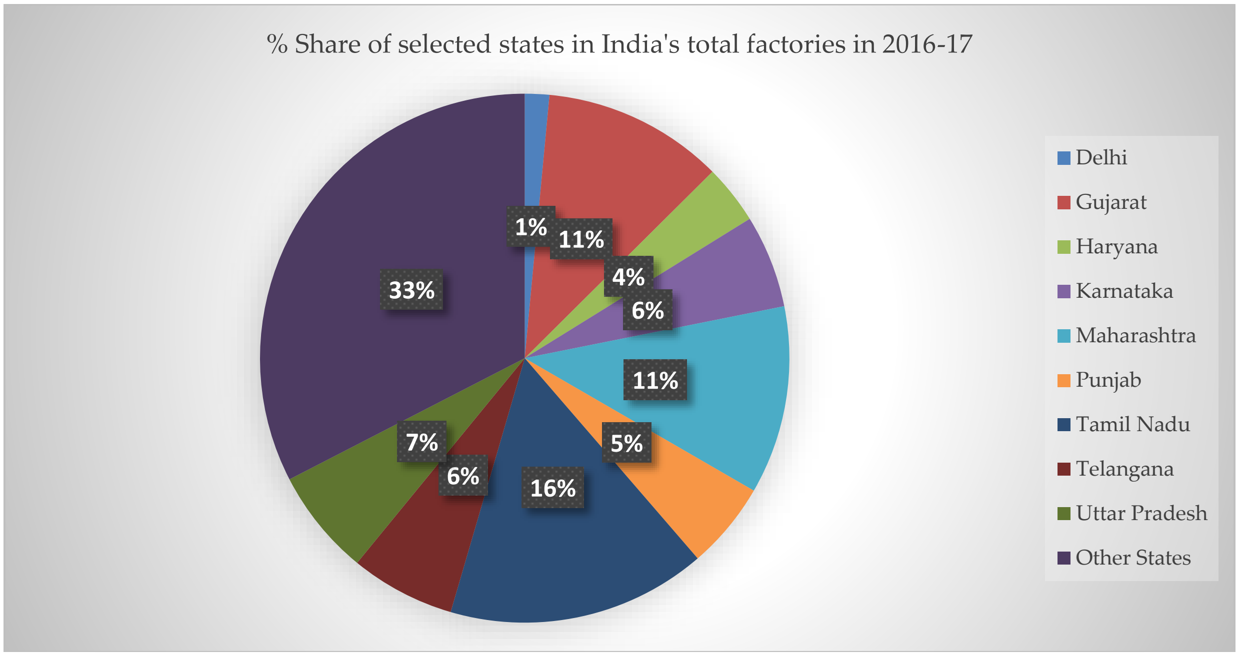

Figure 2: The percentage share of selected states in India's total factories in 2016-17

Source: Annual Survey of Industries (ASI), MOSPI, Government of India.

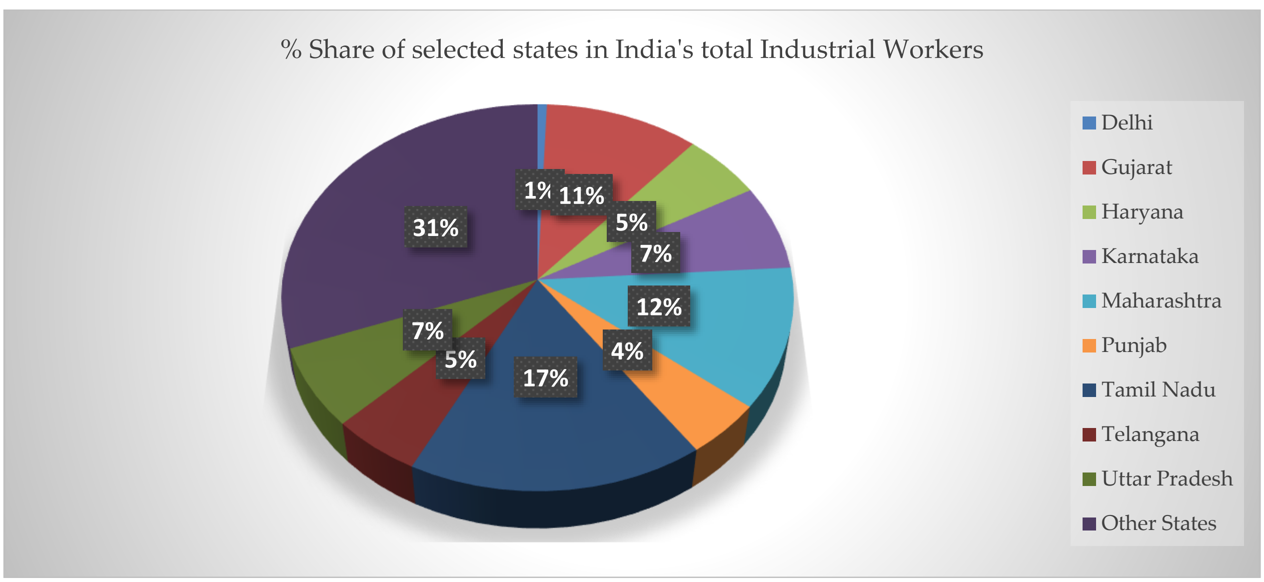

Figure 3: % share of selected states in India's total industrial workers in 2016-17

Source: Annual Survey of Industries (ASI), MOSPI, Government of India.

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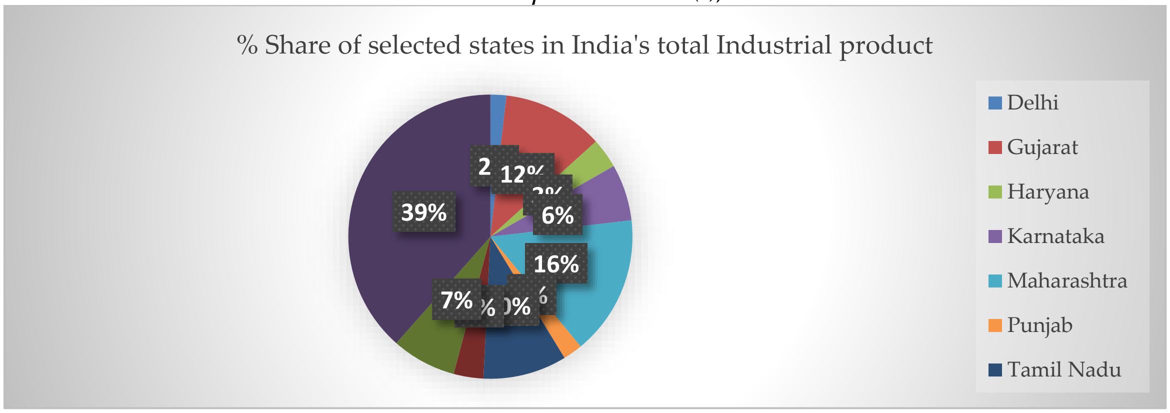

Figure 4: % share of selected states in India's total industrial product in 2016-17

Source: Central Statistics Office, MOSPI, Government of India.

2.3 Process of Data Collection

This study uses firm-level data that is collected through a primary survey of randomly selected 154 firms from seven different industries. For this, face to face interview of CEOs and representatives of firms are conducted to collect the necessary information using a well-structured questionnaire. The survey of respondents is completed from 01st March 2016 to 31st May 2016.

Table 1: Region and state-wise distribution of firms (in Number)

Region	State	Small	Medium	Large	Total
West	Maharashtra	18	12	9	39
	Gujarat	10	4	2	16
South	Tamil Nadu	8	10	5	23
	Karnataka	10	4	5	19
	Telangana	10	5	6	21
North	Delhi	5	4	4	13
	Uttar Pradesh	3	1	2	6
	Punjab	9	4	1	14
	Haryana	1	2	0	3
	Total	74	46	34	154

Source: Field survey

The distribution of 154 firms in small, medium, and large-scale enterprises is given in Table 2.

Table 2: Distributions of sample firms in small, medium, and large-scale enterprises

Name of Industries/Types of Firms	Small	Medium	Large	Total
Automobile and Auto Components	11	6	5	22
Chemicals and Petrochemicals	10	7	5	22
Construction (Equipment, Materials & Technology)	11	6	5	22
Electronics	11	7	4	22
Industrial Equipment & Machinery (Electrical Machinery)	10	7	5	22
Pharmaceuticals	11	6	5	22
Textiles and Apparels	10	7	5	22
Total	74	46	34	154

Source: Field survey

Quantitative and qualitative information on various activities of firms is included in the questionnaire. Region and state-wise distribution of selected firms are given in Table 1. The size-wise divisions of firms in small, medium, and large-scale enterprises are based on the annual turnover of the firm (in Rs. Lakh) that is defined by the Ministry of Micro, Small and Medium Enterprises (GoI). The brief overview of selected seven industries is given as:

***1) Automobile and auto components**:* The automobile and auto components industry has a high share in GDP and exports in India. The industry has been identified as a key sector that has better technological abilities with the potential for high value-addition in India.

2) Chemicals and petrochemicals: India contributes around 70000 various chemicals and petrochemical products in the world.[1]

3) Construction (equipment, materials & technology): This industry is the 2nd largest contributor to employment and infrastructure development in India.

4) Electronics: India has the 3rd largest pool of electronic scientists and engineers. There is a higher domestic demand for electronic goods as compared to other products in India.[2] Despite that, this industry is lagging in terms of technical capabilities. In India, the electronic device and semiconductor design market is largely dominated by electro-mechanical and associated components only.

5) Industrial equipment & machinery (electrical machinery): This industry would be useful to increase the growth of the manufacturing sector in India.

6) Pharmaceuticals: The Indian pharmaceutical industry has a dominant position among the developing economies (Mahajan, Nauriyal & Singh, 2014). This industry needs knowledge and indigenous technology to increase the growth of this sector in India.

7) Textiles and apparel: It is a large industry which counts for around 22% of manufacturing employment in India (Vrajlal, 2015). The sector also has larger sales of textile products as compared to other manufacturing products in India (Vrajlal, 2015). Furthermore, it is the oldest industry and contributes a large share of gross domestic product (GDP) of India.[3]

3. Empirical Analysis

3.1 Selection of Dependent and Independent Variables

Previous studies have used different factors such as gross value added and output as a dependent variable to assess the performance, technical efficiency (TE), and determinants of firms in the Indian manufacturing sector (Rajesh, 2007; Mazumdar, Rajeev & Ray, 2009; Kumar & Arora, 2012; Pattnayak & Chadha, 2013; Sahu, 2015; Mitra, Sharma & Véganzonès-Varoudakis, 2016; Kapoor, 2016; Sen & Das, 2016; Chaudhuri, 2016; Satpathy, Chatterjee & Mahakud, 2017; Kumar & Paul, 2019; Chawla & Manrai, 2019; Singh, Ashraf & Arya, 2019). The summary of the most relevant studies is given in Table 3. In this study, the firm's annual turnover (in Rs. Lakh) uses as a dependent variable. Labor productivity, age, investment on

[1] https://www.ibef.org/download/Chemicals-November-2016.pdf.

[2] https://www.maiervidorno.com/electronics-industries-boom-india/.

[3] https://www.ibef.org/industry/textiles.aspx.

plant and machinery, annual expenditure on marketing, the annual salary of workers, total manpower (employees), scarcity of skilled workforce, production technology up-gradation, proficiency to improve processes of firms, use of hi-tech tools and techniques in production activities, technology transfer capabilities, in-house R&D expertise, export products, quality certification, foreign collaboration, waste management capabilities and building capacity of firms are used as independent variables in this study. Rajesh (2007); Mazumdar, Rajeev & Ray, 2009; Sahu & Narayanan (2011); Kumar & Arora (2012); Pattnayak & Chadha (2013); Debnath & Sabastian (2014); Mahajan, Nauriyal & Singh, 2014; Sahu (2015); Chaudhuri (2016); Tyagi & Nauryal (2016); Singh, Acharya & Chavda (2017); Satpathy, Chatterjee & Mahakud (2017); Kumar & Paul (2019); Singh, Ashraf & Arya (2019); Mishra (2019) have also used similar variables to examine the performance and determinants of firms in the Indian manufacturing sector. In this study, the linear regression model is used as:

$$(fcyt)_i = \alpha_0 + \alpha_1 (lpfcyt)_i + \alpha_2 (af)_i + \alpha_3 (fipm)_i + \alpha_4 (faem)_i + \alpha_5 (fasw)_i + \alpha_6 (tmpe)_i + \alpha_7 (ptuuf)_i + \alpha_8 (ffpssw)_i + \alpha_9 (pipf)_i + \alpha_{10} (httpaf)_i + \alpha_{11} (ttcf)_i + \alpha_{12} (ihrdef)_i + \alpha_{13} (fep)_i + \alpha_{14} (fhqc)_i + \alpha_{15} (fhfc)_i + \alpha_{16} (wmcf)_i + \alpha_{17} (bcqsf)_i + u_i \quad (1)$$

Here, *fcyt* is the firm's current annual turnover (in Rs. Lakh), *lpfcyt* is the labor productivity [Firm's annual turnover/total manpower] (in Rs. Lakh), *af* is the age of firms (in Years), *fipm* is the firm's investment on plant & machinery (in Rs. Lakh), *faem* is the firm's annual expenditure on marketing (in Rs Lakh), *fasw* is the firm's annual salary of workers (in Rs. Lakh), *tmpe* is the total manpower (employees) (in Number), *ptuuf* is the production technology upgradation by firms (in Years), *ffpssw* is the scarcity of skilled workforce in the firms (Yes = 1 and No = 0), *pipf* is the ability of firm to improve processes (Yes = 1 and No = 0), *httpaf* is the use of hi-tech tools and techniques in production activities by firms (Yes = 1 and No = 0), *ttcf* is the technology transfer abilities of the firms (Yes = 1 and No = 0), *ihrdef* is the in-house R&D expertise of firm (Yes=1 and No=0), *fep* is the firm's export products (Yes = 1 and No = 0), *fhqc* is the quality certification of firms (Yes = 1 and No = 0), *fhfc* is the foreign collaboration of firms (Yes = 1 and No = 0), *wmcf* is the waste management capability of firms (Yes = 1 and No = 0), and *bcqsf* is the building capacity of firms (Yes = 1 and No = 0). α_1 is the constant coefficient, and α_1, α_2, …, α_{17} are the regression coefficients of explanatory variables, and u_i is the error term.

Table 3: Summary of relevant studies of firms in the Indian manufacturing sector

Author(s)	Main Objective	Method	Dependent Variable	Independent Variables
Rajesh (2007)	Examine the level and sources of TE in the unorganized sector	Translog production function model	Gross value added and TE of firms	Total capital equipment and the total number of workers
Mazumdar, Rajeev & Ray (2009)	Examine the TE of firms in the pharmaceutical industries	Data envelopment analysis	Firm's output	Various inputs of firms
Sahu & Narayanan (2011)	Estimate the determinants of energy intensity in the manufacturing firms	Non-linear regression model	Energy intensity	The intensity in the capital, labor, repair, R&D, technology, profit margin; and size and age

Kumar & Arora (2012)	Examine the inter-temporal and inter-state variants in TE of sugar industries	Panel data truncated regression model	Gross output of industries	Labor, intermediate inputs, and gross fixed capital use
Sahu (2015)	Examine the TE of the manufacturing sector	Cobb Douglas production function	Firm's output	Capital and labor
Sahu & Narayanan (2015)	Examine the impact of environmental certification on TE of the firm and its determinants in the manufacturing sector	Cobb Douglas production function	Output and technical efficiency of firms	Capital, labor, raw material and energy, farm's size and age, export intensity, debt capital, R&D intensity, profit margin, multinational affiliation, and ISO certification
Goldar & Sharma (2015)	Examine the impact of FDI on the performance of manufacturing firms	Difference-in-difference estimator and probit model	Growth in real sales, change in profitability, change in export intensity	Foreign direct investment
Narwal & Pathneja (2015)	Assess the productivity and profitability of the banking system	Linear programming method	TFP, efficiency change, technological change, and return on average assets	Spread to total average assets, diversification, and share of the bank in total deposits
Bhatia & Mahendru (2015)	Estimate the TE and its determinants in public sector bank	Panel Data TOBIT regression model	Investment, advances, and total income	Deposits, borrowings, interest expenses, and operating expenses
Mitra, Sharma & Véganzonès-Varoudakis (2016)	Estimate the TFP and TE of the manufacturing sector	OLS, panel co-integration model	Gross value added	WPI, capital stock, export and import, R&D, infrastructure and ICT, and capital, labor
Tyagi & Nauryal (2016)	Examine the determinants of profitability of drug and pharmaceutical industry	OLS regression model	Return on assets	Leverage ratio; intensity in export, advertising, and marketing, R&D, capital; operating expenditure to total assets ratio, patent regime
Bawa & Chattha (2016)	Assess the role of intermediary channels like individual agents, corporate agents, brokers, and direct selling in life insurance companies	Log-linear regression model	Premium and policy	Individual agent, bank, agent, brokers, direct selling
Chaudhuri (2016)	Examine the impact of economic liberalization on technical progress and TE of electronics firms.	Translog stochastic frontier production function model	The output of the firms	Capital stock, labor, and raw material
Satpathy, Chatterjee & Mahakud (2017)	Measure the TFP and productivity affecting factors in firms of the manufacturing sector	Levinsohn–Petrin (L-P) method	The output of the firms	Labor, material, and energy, size of the firm; intensity in technological, R&D, advertisement, import of raw material
Singh et al. (2017)	Investigate the factors affecting the firm's decision to hire contractual workers	Logit model	Contract worker employed (Yes or No)	Firm's age and output, labor intensity, labor law regime, trade union activity, the ratio of labor costs to total costs, employment size

Soni, Mittal & Kapshe (2017)	Assess the energy intensity affecting factors in 5 industries	Linear regression model	Energy intensity	Labor, repair, technological development, raw material, outsourcing, software, plant & machinery, and profit intensity
Kumar & Paul (2019)	Estimate the TFP growth of industries in the manufacturing sector	Cobb Douglas production function	Valued added of firms	Labor and capital
Mishra (2019)	Assess the influence of mergers and acquisitions on the financial performance of firms	Linear regression model	Financial performance	Market concentration, present import-export ratio; current advertising, the current capital, marketing and distribution, lagged in-house R&D, foreign technology
Singh, Ashraf & Arya (2019)	Estimate the TE affecting factors of firms in 7 different industries	Stochastic frontier production function model	Technical efficiency of firms	The ratio of export to total revenue, product and process innovation, sales growth, foreign collaboration, quality certification, R&D expertise, association with public R&D institution, and skilled workforce
Chawla & Manrai (2019)	Assess the reasons for the low growth of the manufacturing sector	Correlation and regression analysis	ROA, ROCE, and ROE	Capital structure, liquidity, firm's size, and working capital
Jyoti & Singh (2020)	Examined the factors affecting the annual sale of start-ups	Probit regression model	The annual sale of start-ups	Stage of start-ups, support from the mentor, team member, education qualification of the member, skilled workers, and professional collaboration

In this study, the log-linear regression model is used as:

$$(fcyt)_i = \beta_0 + \beta_1 \ln(lpfcyt)_i + \beta_2 \ln(af)_i + \beta_3 \ln(fipm)_i + \beta_4 \ln(faem)_i + \beta_5 \ln(fasw)_i + \beta_6 \ln(tmpe)_i + \beta_7 \ln(ptuuf)_i + \beta_8 \ln(ffpssw)_i + \beta_9 \ln(pipf)_i + \beta_{10} \ln(httpaf)_i + \beta_{11} \ln(ttcf)_i + \beta_{12} \ln(ihrdef)_i + \beta_{13} \ln(fep)_i + \beta_{14} \ln(fhqc)_i + \beta_{15} \ln(fhfc)_i + \beta_{16} \ln(wmcf)_i + \beta_{17} \ln(bcqsf)_i + v_i \quad (2)$$

Here, ln is the natural logarithm of respected variables; β_0 is the constant coefficient; $\beta_1, \ldots, \beta_{17}$ are the regression coefficient of associated explanatory variables; and v_i is the error-term. Furthermore, the non-linear regression model is also used as:

$$(fcyt)_i = \gamma_0 + \gamma_1 (lpfcyt)_i + \gamma_2 (Sq\ lpfcyt)_i + \gamma_3 (af)_i + \gamma_4 (Sq\ af)_i + \gamma_5 (fipm)_i + \gamma_6 (Sq\ fipm)_i + \gamma_7 (faem)_i + \gamma_8 (Sq\ faem)_i + \gamma_9 (fasw)_i + \gamma_{10} (Sq\ fasw)_i + \gamma_{11} (tmpe)_i + \gamma_{12} (Sq\ tmpe)_i + \gamma_{13} (ptuuf)_i + \gamma_{14} (Sq\ ptuuf)_i + \gamma_{15} (ffpssw)_i + \gamma_{16} (pipf)_i + \gamma_{17} (httpaf)_i + \gamma_{18} (ttcf)_i + \gamma_{19} (ihrdef)_i + \gamma_{20} (fep)_i + \gamma_{21} (fhqc)_i + \gamma_{22} (fhfc)_i + \gamma_{23} (wmcf)_i + \gamma_{24} (bcqsf)_i + \mu_i \quad (3)$$

Here, Sq is the square term of corresponding variables; γ_0 is the constant coefficient; $\gamma_1, \gamma_2, \ldots, \gamma_{24}$ are the regression coefficients of associated explanatory variables; and μ_i is the error-term.

3.2 Selection of the model

The Normality test: If a data set for a specific variable has high variation, then it shows that the data set is not in a normal form (Jyoti & Singh, 2020). For this, the values of skewness and kurtosis of the individual data set are estimated. A variable will be in normal form when the values of skewness and kurtosis of this lie between – 1 and + 1.

Functional Form of the Model: As this study is used linear, log-linear, and log-linear regression models to estimate the regression coefficients of explanatory variables. Therefore, the appropriate functional form of the model is verified through the Ramsey *RESET* test (Singh, 2017; Singh & Singh, 2020; Singh & Ashraf, 2020). The statistical value of the Ramsey *RESET* test is found statistically insignificant for the log-linear regression model, thus, the functional form of this model appears suitable. Akaike information criterion (*AIC*) and Bayesian information criterion (*BIC*) tests are applied to select a consistent model (Kumar, Sharma, & Joshi, 2015; Singh, 2017; Singh, Issac & Narayanan, 2019; Singh & Singh, 2020). *AIC* and *BIC* values are found lower for the log-linear regression model. Therefore, this model produces better results as compared to other models (See Table 4).

Multi-correlation: Multi-correlation measures the exact linear relationship among the explanatory variables (Kumar, Sharma & Ambrammal, 2015; Jyoti & Singh, 2020). The value of variance inflation factor (*VIF*) is estimated to assess the presence of multi-correlation among the independent variables (Kumar, Sharma, & Joshi, 2015; Singh & Singh, 2020). The mean *VIF* values for linear and non-linear regression models are less than 10, thus it suggests that explanatory do not have multi-correlation (See Table 4).

Table 4: Summary of statistical test

Statistical Test	Linear Regression	Log-linear Regression	Non-linear Regression
Ramsey RESET test using powers of the fitted values of the firm's annual turnover	26.11*	0.92	98.83*
Ramsey RESET test using powers of the independent variables	5.27*	13.42*	6.91*
Akaike information criterion (*AIC*)	-2424.29	-10.87245	-2418.23
Bayesian information criterion (*BIC*)	-2478.83	-43.43858	-2493.991
Mean *VIF* for multi-correlation	1.27	1.56	14.8
Breusch-Pagan/Cook-Weisberg test for heteroskedasticity	280.88*	35.96*	369.10*
Cameron & Trivedi's decomposition of IM-test for heteroskedasticity	187.79**	178.99*	201.29*

**: the coefficient is significant at the 0.01 level and *: the coefficient is significant at the 0.05 level.

Heteroskedasticity: Cameron & Trivedi decomposition of IM-test and Breusch-Pagan/Cook-Weisberg tests are used to identify the presence of heteroskedasticity in the proposed models (Jyoti & Singh, 2020). The *Chi*^{2} values under the aforesaid tests seem statistically significant for all models. Thus, it shows the presence of heteroskedasticity in the data set (See Table 4). Proposed regression models are run using SPSS and STATA statistical software.

4. Contribution of Manufacturing Sector in India and Selected Asian Countries

China, Japan, South Korea, Malaysia, Indonesia, and Thailand are the major competitive countries for the Indian manufacturing sectors in Asia. China, Japan, South Korea, Malaysia, Indonesia, and Thailand have a greater contribution to the manufacturing sectors in their GDP as compared to India. The manufacturing value-added as a % of GDP of these economies is presented in Figure 5. It shows that India has a lower contribution of manufacturing sectors in its GDP as compared to China, Japan, South Korea, Malaysia, Indonesia, and Thailand.

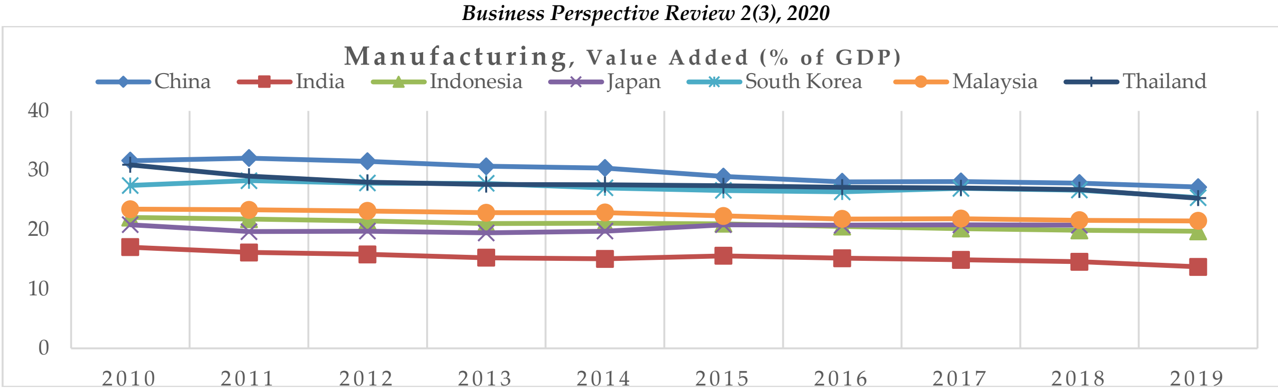

Figure 5: Manufacturing value-added as a % of GDP in India and Asian economies

Source: World Development Indicators, World Bank

China's manufacturing sector contributes more than a 15% share in the World. China is using a labor-intensive technique with low wages and the cost of raw materials in the manufacturing sector in the last decade (Wei & Balasubramanyam, 2015). Thus, China could improve its position in the world's manufacturing sectors. The share of the manufacturing sectors of India and China, Japan, South Korea, Malaysia, Indonesia, and Thailand in the world's manufacturing production is given in Figure 6. It shows that India's share in the world's manufacturing production is only 3.73% in 2019 (WDI, 2016).

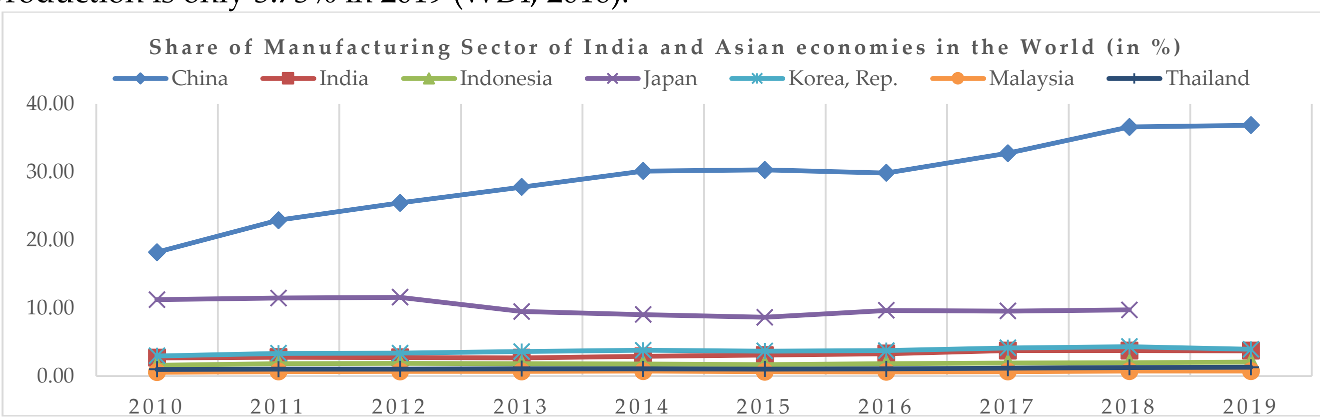

Figure 6: Share of the manufacturing sector of India and Asian countries in the World

Source: World Development Indicators, World Bank

China, Japan, and South Korea have around 20%, 10%, and 4% contributions respectively, and India's contribution is 3% in the world's manufacturing production in 2017. In 2018, China became the world's largest producer of manufacturing products in the world.[4] The manufacturing sectors of China, South Korea, Japan, and Indonesia could provide jobs to 16.9%, 16.9%, 16.9%, and 13.5% working population respectively. While, 11.4% working population of India is employed in the manufacturing sector (International Labor Organization, 2017).

Foreign direct investment (FDI) plays a crucial role to increase the international production networks of a country (Hoda & Rai, 2014). FDI inflow has a larger effect on bilateral imports of a nation than exports. India has low participation in international production networks (Hoda & Rai, 2014). Thus, India could attract a limited stock of FDI. While, China introduced more comprehensive and attractive export-orientated FDI policies (OECD, 2013). Thus, China could attract the highest level of FDI. Furthermore, China's development in the manufacturing sector

[4] https://www.statista.com/chart/20858/top-10-countries-by-share-of-global-manufacturing-output/.

could get significant benefit from inward FDI (Wei & Balasubramanyam, 2015). Accordingly, China has a greater share in World's FDI net inflow than India and other Asian countries. The share of FDI net inflow of India and Asian countries in the World is given in Figure 7.

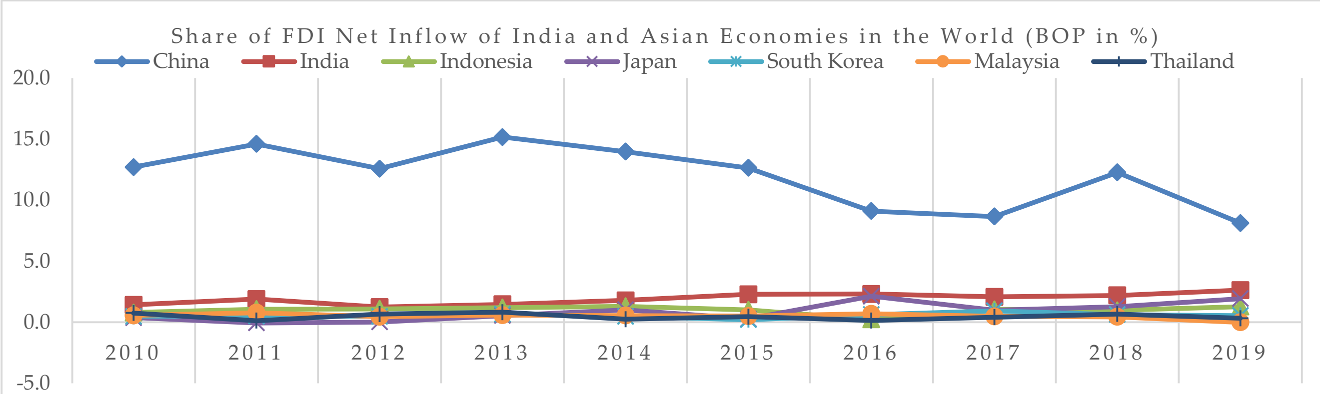

Figure 7: Share of FDI net inflow of India and Asian countries in the World

Source: World Development Indicators, World Bank

High-technology exports are products which introduce through high R&D intensity and technological advancement. China, South Korea, and Malaysia increased the share of high-technology export in manufacturing exports after 2010. Thus, these economies could improve their technological up-gradation during 2011-2018. India's progress in exporting high-technology products is very less (Wignaraja, 2013). While, China is dominated in low-tech manufacturing exports for a decade (Wei & Balasubramanyam, 2015). The high-tech exports as a % of manufactured exports of India and other Asian countries are given in Figure 8.

China's contribution to the world's high-technology manufactures exports is consistently increased since 2008. Hence, China became the world's largest producer of high-technology manufactured in 2008. At present China's export trade consists of high-skill and technology-intensive manufactured goods, low-skill, and labor-intensive goods (Wei & Balasubramanyam, 2015).

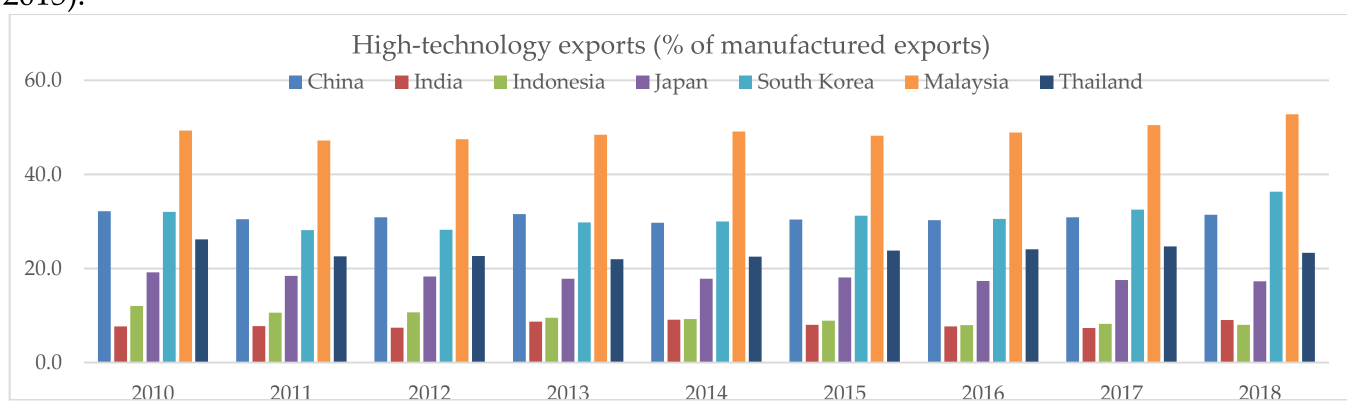

Figure 8: Hi-tech exports (% of manufactured exports) in India and Asian economies

Source: World Development Indicators, World Bank

In 2008, China became the largest producer of hi-tech manufacturing goods and services in the world. The share of India and Asian countries in the World's high-technology exports at current prices (in %) is shown in Figure 9. It infers that India has less than a 1% share of high-technology exports in the world.

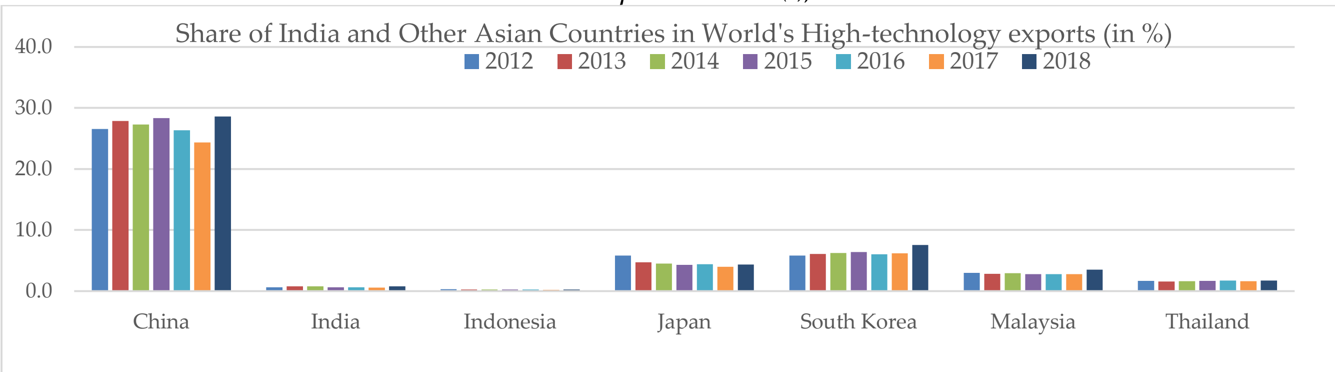

Figure 9: Share of India and Asian countries in World's high-technology exports

Source: World Development Indicators, World Bank

China has adopted effective science & technology policies to be a globally competitive economy. Science & technological development (STD) is useful to produce highly innovative and valuable products. Thus, STD plays a significant role to increase the growth of the manufacturing sector (Singh, Singh & Ashraf, 2020). R&D expenditure, number of researchers, high–technology exports, patent, and industrial design applications, and intellectual property payments and received are the main components of science & technological advancement and IPRs regime (Ashraf & Singh, 2019; Singh, Singh & Negi, 2020). China's public spending in R&D (as a % of GDP) is greater than India and other Asian countries. China's R&D expenditure (as a % of GDP) is increased from 1.7% in 2008 to 2.2% in 2018. Japan, South Korea, and Malaysia are also spending a greater share of their GDP on R&D activities than India. India's R&D expenditure is declined after 2011, thus, it could not improve its position in science & technological development and IPRs related activities during the last decade (Singh, Singh & Ashraf, 2020). R&D expenditures as a % of GDP for India and Asian countries are presented in Figure 10.

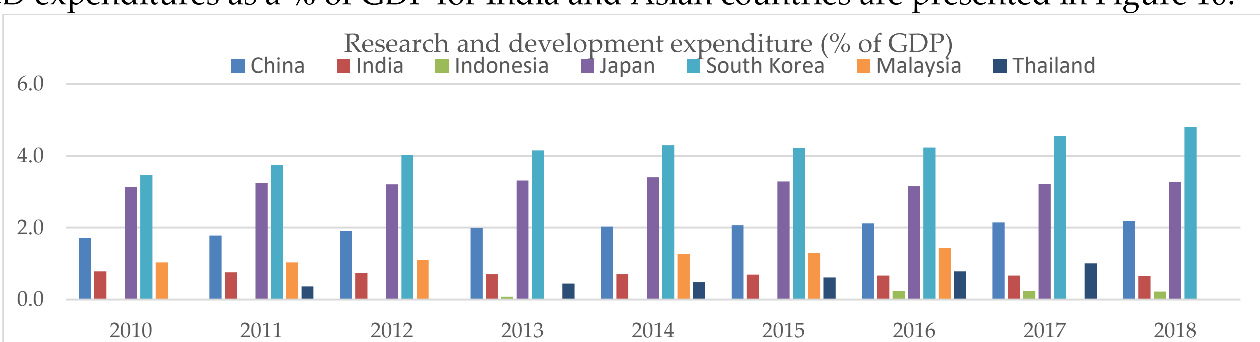

Figure 10: R&D expenditure as a % of GDP in India and Asian countries

Source: World Development Indicators, World Bank.

The number of researchers per million increased in China after 2010. In China, high R&D spending is useful to increase the number of researchers and scientists in research institutions. South Korea also increased its R&D investment during the last decade. Consequently, the number of researchers per million population also increased in South Korea. Furthermore, China, Japan, South Korea, Malaysia, and Thailand have a larger number of researchers per million population as compared to India (See Figure 11).

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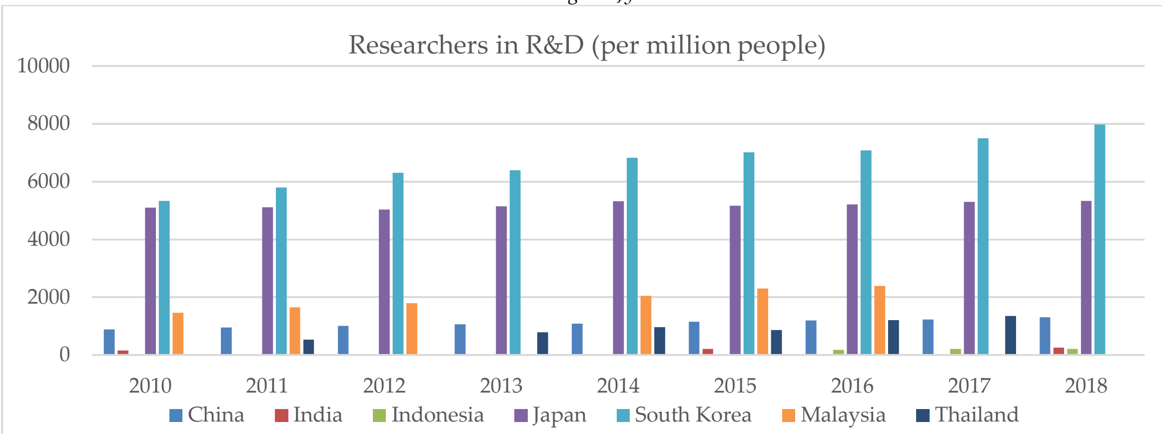

Figure 11: Researchers in R&D (per million people) in India and Asian Economies

Source: World Development Indicators, World Bank

Intellectual property (IP) protection is useful to increase domestic innovation and technology transfer in developing countries (Falvey & Foster, 2006; Yueh, 2007; Singh, Singh & Ashraf, 2020). Intellectual property rights (IPRs) are also helpful for entrepreneurs to recovers the costs of their innovative expenses (Laik, 2015). IPRs also play a crucial role to reinforce the institutional infrastructure development that encourages private investments in formal R&D and creative activities (Yueh, 2007; Singh, Singh & Ashraf, 2020). It provides an incentive to the researchers to increase their involvement in research and development (R&D) in a country (Besen & Raskind, 1991). China and South Korea increased charges for use of intellectual property payments during 2010–2018. Thus, China and South Korea became the major producers of manufacturing goods. On contrary, India, Indonesia, Malaysia, and Thailand could not adopt strong IPRs policies. Therefore, the manufacturing sectors in these countries could not increase their performance. The charges for the use of intellectual property payments (IPP) (BoP, Current US$ Billions) for India and Asian economies are presented in Figure 12. It shows that China and Japan have a better position in IP as compared to other Asian countries.

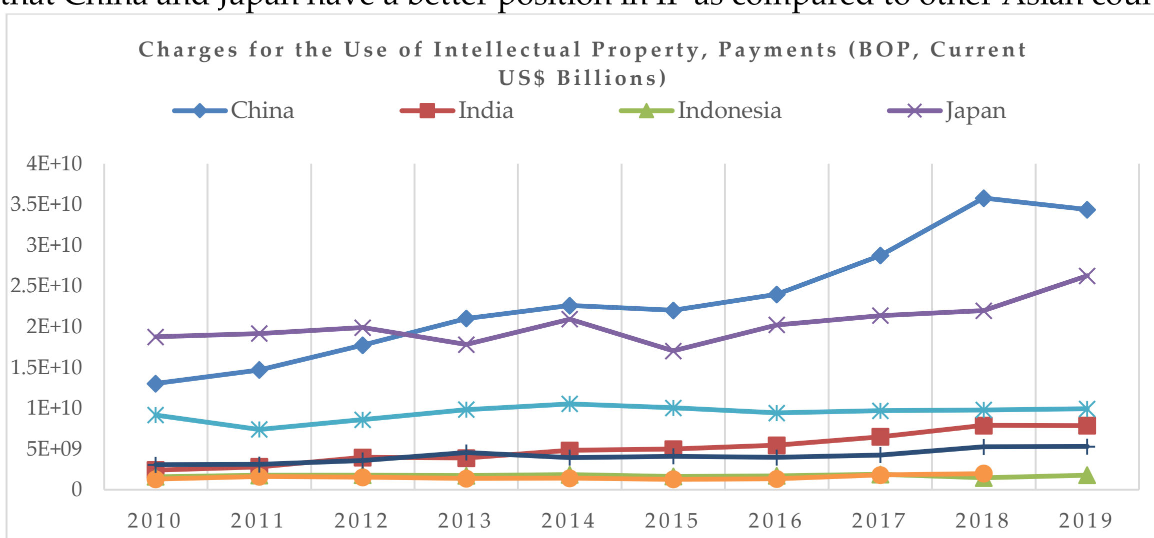

Figure 12: Charges for the use of IPP in India and Asian economies

Source: World Development Indicators, World Bank

Japan, China, and South Korea have a better position in IPRs related activities. Thus, these countries could improve the performance of the manufacturing sector (Singh, Singh & Ashraf, 2020). These economies also increased charges on the use of intellectual property receipts during 2010-2019. While, Indonesia, India, Malaysia, and Thailand did not pursue similar policies which are adopted by Japan, China, and South Korea to increase intellectual property receipts. Charges for the use of intellectual property receipts (BoP, current US$) for India and Asian countries are shown in Figure 13.

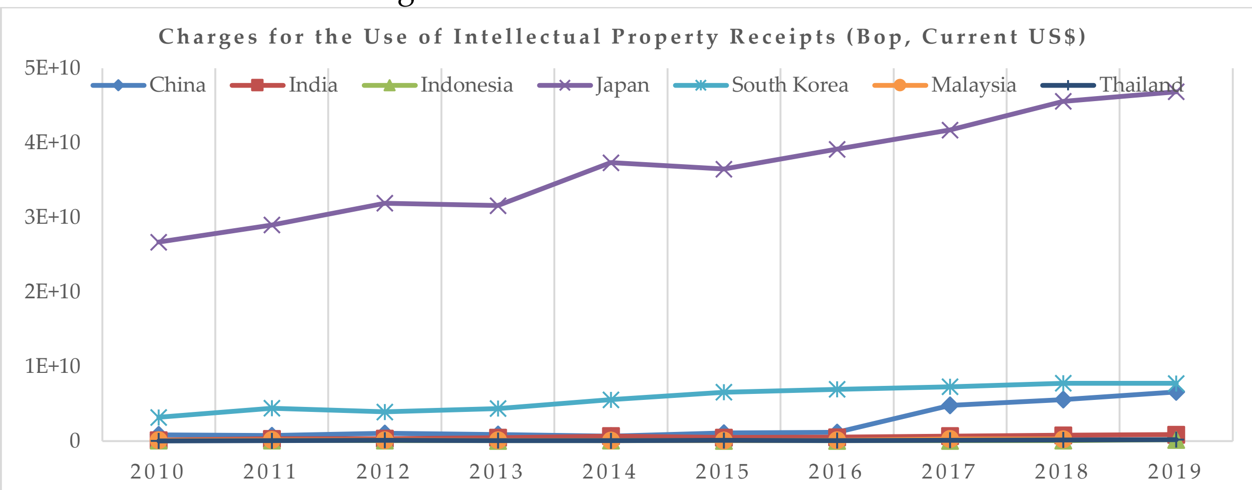

Figure 13: Charges for the use of intellectual property receipts (BoP, current US$)

Source: World Development Indicators, World Bank.

Patent and industrial design applications files by researchers and scientists show the strong IPRs regime of a country (Singh, Singh & Ashraf, 2020). China, Japan, and South Korea have a better position in patent and industrial design applications files as compared to India, Indonesia, and Thailand. As patented technologies are useful to increase the trust of entrepreneurs to buy these (Jyoti & Singh, 2020). Thus, in these countries, the manufacturing sector has achieved high growth (Singh, Singh & Ashraf, 2020). The number of patent and industrial design applications (Residents + Non-residents) filled by India and Asian countries is presented in Figure 14 and Figure 15 respectively.

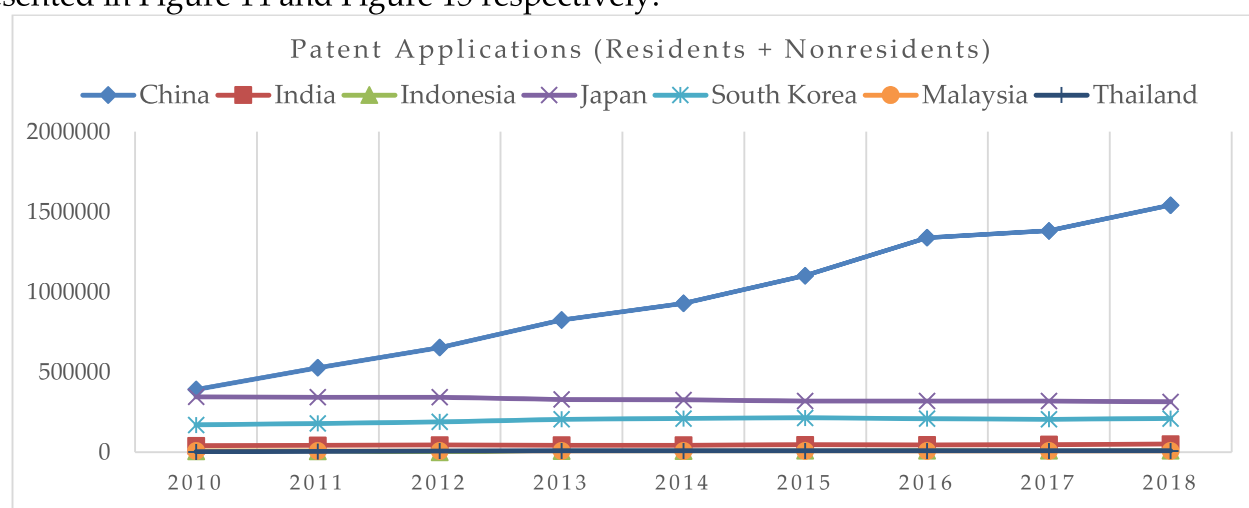

Figure 14: Patent applications filling by India and Asian economies

Source: World Development Indicators, World Bank

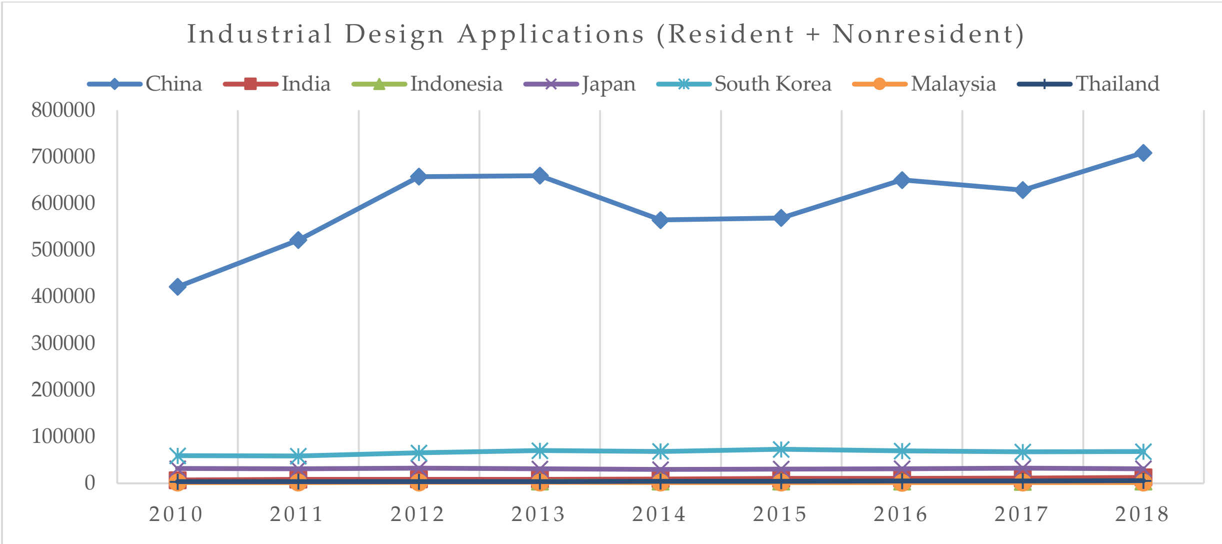

Figure 15: Industrial design applications in India and Asian economies

Source: World Development Indicators, World Bank

5. Descriptive Results of Selected Firms of Indian Manufacturing Sector

5.1 Statistical Summary of Variables

The mean, standard deviation, variance, skewness, and kurtosis values of undertaken variables are given in Table 5. The values of standard deviation and variance for all variables are greater than one. Thus, it implies that there is a high possibility of the existence of heteroskedasticity in the data set (Singh & Singh, 2020). For this, the log of all quantitative variables is considered to reduce the presence of heteroskedasticity in the proposed model. The values of skewness for most variables are not found between –1 to +1, thus, it demonstrates that these variables are not in normal forms.

Table 5: Statistical summary of variables

Total Obs.	154	Obs./ Industry	22	Total Industry		7	
Variables	*Minimum*	*Maximum*	*Mean*	*Std. Dev.*	*Variance*	*Skewness*	*Kurtosis*
fcyt	2	7276	466.89	956.89	915632	5.6674	37.7197
lpfcyt	0	1851.85	24.40	149.95	22486	11.881	145.1222
af	1	85	24.30	15.07	227	0.8459	4.3277
fipm	15	1000	387.71	348.55	121485	0.4123	1.7310
faem	1	1500	133.43	249.11	62055	3.2843	14.746
fasw	1	3684	109.83	325.85	106175	8.9817	96.0085
tmpe	2	88061	908.79	7471.63	55800000	10.785	123.2552
ptuuf	1	38	5.51	5.09	26	2.4977	13.3447
ffpssw	0	1	0.50	0.50	0.25	0.000	1.000

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pipf	0	1	0.90	0.30	0.09	-2.7156	8.3746
httpaf	0	1	0.88	0.33	0.11	-2.2904	6.2460
ttcf	0	1	0.67	0.47	0.22	-0.7385	1.5454
ihrdef	0	1	0.85	0.36	0.13	-1.9675	4.8712
fep	0	1	0.44	0.50	0.25	0.2620	1.0686
fhqc	0	1	0.73	0.45	0.20	-1.0206	2.0417
fhfc	0	1	0.14	0.34	0.12	2.1193	5.4912
wmcf	0	1	0.94	0.24	0.06	-3.7647	15.1732
bcqsf	0	1	0.86	0.35	0.12	-2.1083	5.4448

Source: Authors' estimation.

5.2 Correlation Coefficient: Annual Turnover Affecting Factors

Karl-Pearson correlation coefficients of the firm's annual turnover with explanatory variables are given in Table 6. The correlation coefficients of the firm's annual turnover with most variables (except total employees and production technology up-gradation of firms) are found positive.

Table 6: Correlation coefficients of annual turnover with its associated variables

Variables	*fcyt*	*lpfcyt*	*af*	*fipm*	*faem*	*fasw*	*tmpe*	*ptuuf*	*ffpssw*
fcyt	1	0.014	0.127	0.283**	0.179*	0.738**	-0.015	-0.136*	0.152*
lpfcyt	0.014	1	-0.068	-0.003	-0.019	-0.019	-0.019	-0.084	-0.094
af	0.127	-0.068	1	0.074	0.109	0.151*	0.207**	0.139*	0.017
fipm	0.283**	-0.003	0.074	1	0.403**	0.178*	0.127	-0.039	-0.071
faem	0.179*	-0.019	0.109	0.403**	1	0.126	-0.041	0.162*	-0.144*
fasw	0.738**	-0.019	0.151*	0.178*	0.126	1	0.043	-0.080	0.118
tmpe	-0.015	-0.019	0.207**	0.127	-0.041	0.043	1	-0.004	0.059
ptuuf	-0.136*	-0.084	0.139*	-0.039	0.162*	-0.08	-0.004	1	-0.037
ffpssw	0.152*	-0.094	0.017	-0.071	-0.144*	0.118	0.059	-0.037	1
pipf	0.043	-0.249**	0.189**	0.125	0.104	0.062	0.039	0.124	-0.153*
httpaf	0.053	-0.215**	-0.045	0.125	0.144*	0.087	0.044	0.065	0.020
ttcf	0.173*	-0.097	0.040	0.190**	0.117	0.142*	0.082	-0.125	0.014
ihrdef	0.076	-0.197**	0.065	0.089	-0.034	0.087	0.050	-0.152*	0.091
fep	0.106	-0.092	0.139*	0.060	0.161*	0.080	0.122	-0.053	0.170*
fhqc	0.185*	-0.148*	-0.085	0.177*	0.209**	0.121	0.070	-0.099	-0.087
fhfc	0.150*	-0.046	0.209**	0.236**	0.241**	0.274**	0.271**	-0.096	0.132
wmcf	0.064	-0.311**	-0.045	0.161*	0.062	0.049	0.029	0.080	0.083
bcqsf	0.090	-0.204**	-0.097	0.038	-0.079	0.083	0.047	-0.038	0.095

Variables	pipf	httpaf	ttcf	ihrdef	fep	fhqc	fhfc	wmcf	bcqsf
fcyt	0.043	0.053	0.173*	0.076	0.106	0.185*	0.150*	0.064	0.090
lpfcyt	-0.249**	-0.215**	-0.097	-0.197**	-0.092	-0.148*	-0.046	-0.311**	-0.204**
af	0.189**	-0.045	0.040	0.065	0.139*	-0.085	0.209**	-0.045	-0.097
fipm	0.125	0.125	0.190**	0.089	0.06	0.177*	0.236**	0.161*	0.038
faem	0.104	0.144*	0.117	-0.034	0.161*	0.209**	0.241**	0.062	-0.079

fasw	0.062	0.087	0.142*	0.087	0.080	0.121	0.274**	0.049	0.083
tmpe	0.039	0.044	0.082	0.050	0.122	0.070	0.271**	0.029	0.047
ptuuf	0.124	0.065	-0.125	-0.152*	-0.053	-0.099	-0.096	0.080	-0.038
ffpssw	-0.153*	0.020	0.014	0.091	0.170*	-0.087	0.132	0.083	0.095
pipf	1	0.276**	0.095	0.231**	-0.021	0.045	0.003	0.198**	0.125
httpaf	0.276**	1	0.198**	0.286**	0.011	0.214**	0.034	0.243**	0.081
ttcf	0.095	0.198**	1	0.170*	0.005	0.065	0.239**	0.060	0.283**
ihrdef	0.231**	0.286**	0.170*	1	0.110	0.112	0.166*	0.129	0.152*
fep	-0.021	0.011	0.005	0.110	1	0.096	0.338**	0.107	0.005
fhqc	0.045	0.214**	0.065	0.112	0.096	1	0.031	0.096	0.012
fhfc	0.003	0.034	0.239**	0.166*	0.338**	0.031	1	0.018	0.158*
wmcf	0.198**	0.243**	0.060	0.129	0.107	0.096	0.018	1	0.062
bcqsf	0.125	0.081	0.283**	0.152*	0.005	0.012	0.158*	0.062	1

** and *: Correlation coefficients are statistically significant at the 0.01 and 0.05 significance level respectively.

Firm’s annual turnover is positively associated with labor productivity, firm’s age, investment in plant & machinery and marketing, the annual salary of workers, proficiency to improve the process, use of hi-tech tools and technology in production activities, technology transfer capabilities, in-house R&D expertise, export products, quality certification, foreign collaboration, waste management practices and building capacity of firms. The estimate can be justified the firm’s annual turnover increases as increases in labor productivity. Old firms are spending more on advertising as compared to the new firm. Therefore, a firm's age is positively associated with the firm's annual turnover. Faruq & Yi (2010); Sahu & Narayanan (2015); Vu (2016) have also observed a positive association of a firm's age with annual turnover.

The firm's investment in plant & machinery and marketing show a positive impact on the firm’s annual turnover. Thus, it is suggested that firms need to increase more investment in machinery and marketing to increase their turnover. An appropriate marketing management system is useful to increase the sell pattern of firms. Therefore, a firm’s turnover increases as an increase in investment in marketing. The annual salary of workers shows a positive impact on the firm’s annual turnover. Thus, it is advised that firms should provide rational salaries to the workers to increase their production. Technological development related factors such as the ability to improve the process, use of hi-tech tools and technique in production activities, technology transfer abilities, and in-house R&D activities expertise of firms are positively associated with a firm's annual turnover. Previous studies such as Zhu, Zhao & Abbas (2019); Ashraf & Singh (2019); Jyoti & Singh (2020); Singh & Ashraf (2020) have also reported that technological development works as an important driver to discover high-tech goods and services for manufacturing firms. Thus, the use of production technology up-gradation is effective to increase the firm’s annual turnover. The correlation coefficient of production technology up-gradation with the firm's annual turnover is seemed negative. Correlation coefficients of the firm's export products, quality certification, foreign collaboration, waste management capabilities, and building capacity with the firm's annual turnover are found positive. Hence, the estimates indicate that those firms have export products, quality certification, foreign collaboration waste management skills that are potential to increase their annual turnover.

6. Explanation of Empirical Results

The regression results which measure the impact of explanatory variables on the firm's annual turnover are shown in Table 7. Regression coefficients of explanatory variables with the firm's annual turnover are estimated using linear, log-linear, and non-linear regression models. The log-linear regression model has low values of *AIC* and *BIC*. Thus, this model produces better results as compared to linear and non-linear regression models. The R^2 value is found 0.6624 under the log-linear regression model. So, it shows that 66% variation in a firm's annual turnover can be explained through undertaken explanatory variables. The regression coefficient of labor productivity with the firm's annual turnover is appeared positive. Thus, it implies that a firm's annual turnover increases as an increase in labor productivity of firms. Rajesh (2017) has also observed the positive impact of human capital on *the TE* of firms in India. The firm's age is also positively associated with the firm's annual turnover. The estimate is consistent with earlier studies such as Faruq & Yi (2010); Akpan et al. (2012); Sahu & Narayanan (2015); Kapoor (2016). The regression coefficients of the firm's investment in plants & machinery, marketing, and annual salary of workers with the firm's annual turnover are appeared negative. Furthermore, total manpower shows a positive impact on the firm's annual turnover. Production technology up-gradation is useful to increase the productivity of firms and annual turnover. It is also seen that the regression coefficient of production technology up-gradation with the firm's annual turnover is positive.

Table 7: Association of the firm's annual turnover with explanatory variables

Model	Linear Regression			Log-linear Regression			Non-linear Regression		
No. of Obs.	154			154			154		
F-Value	12.69*			303.15*			10.46*		
R^2	0.6151			0.9748			0.6624		
Adj. R^2	0.5666			0.9716			0.5991		
fcyt [DV]	*Reg. Coef.*	*Std. Err.*	$P>\|t\|$	*Reg. Coef.*	*Std. Err.*	$P>\|t\|$	*Reg. Coef.*	*Std. Err.*	$P>\|t\|$
lpfcyt	0.359	0.388	0.357	0.950	0.017	0.000	5.721	2.565	0.027
lpfcyt2	-	-	-	-	-	-	-0.003	0.001	0.035
af	3.760	3.807	0.325	0.014	0.023	0.547	0.989	11.420	0.931
af2	-	-	-	-	-	-	0.050	0.195	0.799
fipm	0.406	0.170	0.018	-0.011	0.014	0.440	-0.598	0.552	0.280
fipm2	-	-	-	-	-	-	0.001	0.001	0.142
faem	0.241	0.249	0.336	-0.005	0.014	0.694	1.118	0.675	0.100
faem2	-	-	-	-	-	-	-0.001	0.001	0.097
fasw	2.046	0.169	0.000	-0.018	0.019	0.355	2.945	0.549	0.000
fasw2	-	-	-	-	-	-	0.000	0.000	0.079
tmpe	-0.007	0.007	0.331	0.995	0.024	0.000	-0.067	0.048	0.163
tmpe2	-	-	-	-	-	-	0.000	0.000	0.204
ptuuf	-14.558	10.997	0.188	0.044	0.023	0.055	-26.887	23.968	0.264
ptuuf2	-	-	-	-	-	-	0.760	0.850	0.373

ffpssw	204.442	110.254	0.066	-0.033	0.040	0.413	170.482	113.182	0.134
pipf	10.280	200.223	0.959	0.032	0.070	0.644	25.529	194.009	0.896
httpaf	-139.915	180.048	0.438	0.006	0.062	0.925	-162.852	177.993	0.362
ttcf	124.419	120.543	0.304	0.016	0.043	0.706	63.860	121.809	0.601
ihrdef	-11.538	162.192	0.943	0.010	0.057	0.857	23.139	160.368	0.886
fep	103.710	114.042	0.365	0.025	0.042	0.563	31.766	118.553	0.789
fhqc	181.569	125.493	0.150	0.107	0.046	0.021	189.880	126.128	0.135
fhfc	-412.454	182.300	0.025	0.028	0.063	0.652	-249.446	182.904	0.175
wmcf	58.567	253.702	0.818	0.166	0.085	0.053	36.402	249.316	0.884
bcqsf	129.225	163.654	0.431	0.040	0.059	0.498	127.050	161.833	0.434
Con. Coef.	-310.430	358.982	0.389	-0.206	0.141	0.147	-211.551	367.901	0.566

**: the coefficient is significant at the 0.01 level and *: the coefficient is significant at the 0.05 level.

Indian firms are facing a scarcity of skilled workers. Therefore, firms that do not have a skilled workforce are stuck to improve their annual turnover. The estimate also indicates that the shortage of skilled workforce has a negative impact on the firm's annual turnover. The regression coefficients of proficiency to improve processes, use of hi-tech tools and techniques in production activities, technology transfer abilities, and in-house R&D expertise of firms with the firm's annual turnover is found positive. Thus, estimates clearly infer that science and technological development related factors are useful to increase the performance of manufacturing firms. The results also conclude that product export competency and foreign collaboration of firms have a positive impact on the firm's annual turnover. Here, it proposes that Indian manufacturing firms should increase exports of products and collaboration with foreign firms to increase their performance. The estimates also imply that quality certification, waste management practices, and building capacity of firms are found crucial factors to increase the firm’s annual turnover.

The results based on the non-linear regression model indicate that labor productivity, investment in plant & machinery and marketing, total employees, and production technology up-gradation has a non-linear association with the firm's annual turnover. Furthermore, it found that labor productivity and investment in marketing have a hilly-shaped association with the firm's annual turnover. It implies that aforesaid factors are useful to increase the firm's annual turnover up to a certain extent only. The firm's investment in plant & machinery, total employees, and production technology up-gradation has a U-shaped relationship with the firm's annual turnover. A firm's age and skilled workforce have a linear relationship with the firm's annual turnover.

7. Conclusion, Policy Suggestions, and Further Research Direction

This study makes a comparison of the manufacturing sector and its associated factors in India and selected Asian countries. Thereupon, it examines the impact of firm’s socio-economic activities on their annual turnover in seven different industries of the Indian manufacturing sector. For this, it uses linear, log-linear, and non-linear regression models. Accordingly, it provides several policy proposals to increase the growth of the Indian manufacturing sector.

It is clear that India has a lower share of the manufacturing sector in its GDP as compared to China, Indonesia, Japan, South Korea, Malaysia, and Thailand. China has a significant position in foreign direct investment (FDI) net inflow and high-technology exports at the global level. Also, it is observed that China, Japan, South Korea, Malaysia, and Thailand have a better position in science & technological development and intellectual property rights associated factors such as R&D expenditure, the number of researchers, patents and industrial design applications files, and intellectual property payments and received as compared to India. Therefore, China, Japan, South Korea, Malaysia, and Thailand have a large share of the manufacturing sector in their GDP. The manufacturing sector of China, Japan, South Korea, Malaysia, and Thailand have also provided jobs to a large segment of the working population. Hence, India needs to increase R&D expenditure and researchers in research institutions and intellectual property payments to strengthen technological development.
Descriptive results based on Karl-Pearson correlation coefficients infer that a firm's annual turnover is positively associated with labor productivity, age, investment in plant & machinery and marketing, the annual salary of workers, skilled workforce, proficiency to improve processes, use of hi-tech tools and techniques in production activities, technology transfer capabilities, in-house R&D expertise, export products, quality certification, foreign collaboration, waste management practices and building capacity of firms. Thus, Indian manufacturing firms are required to focus on the aforementioned factors to increase their annual turnover.
The empirical results show that a firm's annual turnover is positively associated with labor productivity, age, total employees, production technology up-gradation, proficiency to improve processes, use of hi-tech tools and techniques in production activities, technology transfer capabilities, in-house R&D expertise, export products, quality certification, foreign collaboration, waste management practices and building capacity of firms.
The results of this study are useful to draw several policy suggestions such as India needs to increase technological advancement to increase the growth of the manufacturing sector. Technological advancement improves as an increase in extensive R&D expenditure and researchers and scientists in research institutions and universities (Singh & Ashraf, 2020). It is also observed that technologies from research institutions to industries are not moving properly in India due to the low literacy of researchers on technology transfer and commercialization. Thus, Indian research institutions should increase technology transfer, commercialization of technology, and collaboration with existing industries (Singh & Ashraf, 2020). It would be helpful for research institutions to generate revenues for further R&D activities and to reduce their dependency on public research grants. For this, scientists in research institutions should do R&D as per the current industrial requirement (Khaled, 2020). Further, it would be helpful to create and nurture students' start-up ecosystem in India. Also, every research institution must set up technology transfer offices (Singh & Ashraf, 2020) and business development cells (BDC) to increase the technology transfer and commercialization at a large scale. It is also seen that most researchers are unaware of the IPRs regime and its implications in technological fields. Thus, every researcher and scientist must aware of the impact of the IPRs regime in

technological development. For this, IPRs related courses must compulsory for the students in research institutions, higher academic organizations, and universities in India. The Government of India should implement a strong IPR regime in public and private research institutions and industries to increase the trust of entrepreneurs to buy the technologies from these. There must be an effective education policy in higher research institutions to create a skilled workforce in India. Indian manufacturing firms should focus on producing goods and services which should meet the global standards. Indian manufacturing firms also need to get a quality certificate and increase collaboration with foreign firms to maintain global standards. It is vital to increase the collaboration of small-scale industries with large industries in India. Indian firms should increase in-house R&D expertise and technology transferability to improve production scale. India needs to set up more high-tech industries to make a global value chain. The industrial sector, particularly the small-scale industries should receive financial support from the banks.
This study includes 154 firms in seven different industries which have high diversity in terms of socio-economic factors, IPRs, and S&T related indicators. Therefore, this study could not provide industry-specific policy suggestions. Hence, the researchers may consider a specific industry for further study. It would be effective for Indian policymakers to formulate industry-specific policies. Furthermore, due to globalization, several activities may have a significant impact on a firm's activities in the manufacturing sector. However, aforesaid activities are not considered in this study. So, it may be another research gap for further study.

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REFERENCES

Abri, A. G, & Mahmoudzadeh, M. (2015). Impact of information technology on productivity and efficiency in Iranian manufacturing industries. *Journal of Industrial Engineering International*, 11(1), 143-157.

Akpan, S. B., Ukoha, O. O., Onyenweaku, C. E., & Johan, D.E. (2012). The empirical relationship among technical efficiency, macroeconomic variables, and industrial policy regimes: A case study of sugar industry in Nigeria. I*nternational Journal of Economics and Management Sciences*, 1(10), 1-11.

Ashraf, S. N., & Singh, A. K. (2019). Does entrepreneurship ecosystem have a long-term relationship with economic growth in selected economies? A statistical investigation. Proceedings of the 13th Biennial Conference on Entrepreneurship Organized by EDII Ahmedabad (pp. 176-187). New Delhi: Bookwell Publishing House.

Bawa, S. K., & Chattha, S. (2016). Performance evaluation of the intermediary channels of life insurance industry in India. *Eurasian Journal of Business and Economics*, 9(17), 51-65.

Besen, S. M., & Raskind, L. J. (1991). An introduction to the law and economics of intellectual property. *Journal of Economic Perspectives*, 5(1), 3-27.

Bhatia, A., & Mahendru, M. (2015). Assessment of technical efficiency of public sector banks in India using data envelopment analysis. *Eurasian Journal of Business and Economics*, 8(15), 115-140.

Bhayani, S. J. (2010). Determinant of profitability in Indian cement industry: An economic analysis. *South Asian Journal of Management*, 17(4), 6-20.

Çalışkan, H. K. (2015). Technological change and economic growth. *Procedia-Social and Behavioral Sciences*, 195(1), 649-654.

Chaudhuri, D. D. (2016). Impact of economic liberalization on technical efficiency of firms: Evidence from India's electronics industry. *Theoretical Economics Letters*, 6(1), 549-560.

Chawla, R., & Manrai, R. (2019). Determinants of financial performance of selected listed manufacturing firms in India. *Journal of General Management Research*, 6(1):78-89.

Debnath, R. M., & Sabastian, V. J. (2014). Efficiency in the Indian iron and steel industry – an application of data envelopment analysis. *Journal of Advances in Management Research*, 11(1), 4-19.

Deolalikar, A. B., & Röller, L.H. (1989). Patenting by manufacturing firms in India: Its production and impact. *The Journal of Industrial Economics*, 37(3), 303-314.

Dougherty, S. M., Herd, R., & Chalaux, T. (2009). What is holding back productivity growth in India? Recent micro evidence. *OECD Journal: Economic Studies*, 2009, 1-22.

Faruq, H. A., & Yi, D. (2010). The determinants of technical efficiency of manufacturing firms in Ghana. *Faculty Scholarship*, Paper 62.

Etim, E. O., Umoffong, N. J., & Goddymkpa, P. C. (2020). Management accounting practices and the performance of small and medium-sized enterprises in Akwa Ibom State, Nigeria. *Business Perspective Review*, 2(2), 57-74.

Falvey, R., & Foster, N. (2006). The role of intellectual property rights in technology transfer and economic growth theory and evidence. United Nations Industrial Development Organization (UNIDO), Vienna.

Goldar, B., & Sharma, A. K. (2015). Foreign investment in Indian industrial firms and impact on firm performance. *The Journal of Industrial Statistics*, 4(1), 1-18.

Hoda, A., & Rai, D.K. (2014). Trade and investment barriers affecting international production network in India. National Council for Research on International Economic Relations, Working Paper 281. New Delhi.

International Labor Organization (2017) [Online].https://www.ilo.org/global/lang--en/index.htm.

Iyer, A., Koudal, P., & Saranga, H. (2011). Indian manufacturing-strategic and operational decisions and business performance. Working Number 338, Indian Institute of Management Bangalore, India.

Jyoti, B., & Singh, A. K. (2020). Characteristics and determinants of new start-ups in Gujarat, India. *Entrepreneurship Review*, 1(2), 1-25.

Kapoor, R. (2016). Technology, jobs and inequality: Evidence from India's manufacturing sector. Working Paper No. 313, Indian Council for Research on International Economic Relations, New Delhi.

Kapoor, R. (2018). Understanding the performance of India's manufacturing sector: Evidence from firm-level data. CSE Working Paper, 2018-2, Azim Premji University.

Kathuria, V., Raj, R. S., & Sen, K. (2013). Productivity measurement in Indian manufacturing: A comparison of alternative methods. *Journal of Quantitative Economics*, 11(1&2), 148-179.

Kaur, H. (2016). Manufacturing sector of India: Challenging the 'Make in India' campaign. *IRACST – International Journal of Commerce, Business and Management*, 5(1), 9-18.

Khaled, M. C. (2020). Lacking entrepreneurship and small business trust in business education in developing countries: Case of Bangladesh. *Business Perspective Review*, 2(1), 61-76.

Kumar, A., Sharma, P., & Ambrammal, S. K. (2015). Climatic effect on sugarcane productivity in India: A stochastic production function application. *International Journal of Economics and Business Research*, 10(2), 179-203.

Kumar, A., Sharma, P, & Joshi, S. (2015). Effect of climatic factors on agricultural productivity in India: A state-wise panel data analysis. *International Journal of Basic and Life Science*, 3(1), 48-67.

Kumar, S., & Sharma, R. (2016). Patenting and technical efficiency of manufacturing firm in India: Evidence from medium and high technology firms. In: Siddharthan N., Narayanan K. (eds.) Technology. India Studies in Business and Economics. Springer, Singapore.

Kumar, R. A., & Paul, M. (2019). Industry-level analysis of productivity growth under market imperfections. Working Paper, 207, Institute for Studies in Industrial Development, New Delhi.

Kumar, S., & Arora, N. (2012). Evaluation of technical efficiency in Indian sugar industry: An application of full cumulative data envelopment analysis. *Eurasian Journal of Business and Economics*, 5(9), 57-78.

Laik, K. (2015). Role of intellectual property in economic growth. *Journal of Intellectual Property Rights*, 10(1), 456-473.

Mahajan, V., Nauriyal, D. K., & Singh, S. P. (2014). Efficiency and ranking of Indian pharmaceutical industry: Does type of ownership matter? *Eurasian Journal of Business and Economics*, 7(14), 29-50.

Mazumdar, M., Rajeev, M., & Ray, S. C. (2009). Output and input efficiency of manufacturing firms in India: A case of the Indian pharmaceutical sector. Working Paper No. 219, The Institute for Social and Economic Change, Bangalore, India.

Mehta, Y., & Johan R. A. (2017). Manufacturing sectors in India: Outlook and challenges. *Procedia Engineering*, 174(1), 90-104.

Mishra, P. (2019). How have mergers and acquisitions affected financial performance of firms in Indian manufacturing sector? *Eurasian Journal of Business and Economics*, 12(23), 79-96.

Mitra, A., Sharma, C., & Véganzonès-Varoudakis, M. A. (2016). Infrastructure, ICT and firms' productivity and efficiency: An application to the Indian manufacturing (Chapter 2). F. De Beule and K. Narayanan (eds.), Globalization of Indian Industries, India Studies in Business and Economics, DOI 10.1007/978-981-10-0083-6_2.

Narwal, K. P., & Pathneja, S. (2015). Determinants of productivity and profitability of Indian banking sector: A comparative study. *Eurasian Journal of Business and Economics*, 8(16), 35-58.

Organization for Economic Cooperation and Development (OECD) (2013). Innovation in Southeast Asia. OECD Reviews of Innovation Policy, Paris, France. www.oecd.org/publishing/corrigenda.

Pattnayak, S. S. & Chadha, A. (2013). Technical efficiency of Indian pharmaceutical firms: A stochastic frontier function approach. http://conference.iza.org/conference_files/pada2009/pattnayak_s5193.pdf.

Patnaik, K. S. K., & Satyaprakash, B. (2015). Role of social media in the growth of small scale industries in Coastal Orissa. *IOSR Journal of Business and Management*, 17(11), 01-03.

Rajesh, R. S. N. (2007). Technical efficiency in the informal manufacturing enterprises: Firm-level evidence from an Indian state. MPRA Paper No. 7816. http://mpra.ub.uni-muenchen.de/7816/.

Ray, A.S., & Saha S. (2010). Patenting public-funded research for technology transfer: A conceptual –Empirical synthesis of U.S. evidence and lesson for India. Working Paper 244, Indian Council for Research on International Relations, New Delhi.

Sahu, P. K. (2015). Technical efficiency of domestic and foreign firms in Indian manufacturing: A firm-level panel analysis. *Arthshastra Indian Journal of Economics & Research*, 4(2), 7-21.

Sahu, S. K., & Narayanan K. (2015). Environmental certification and technical efficiency: A study of manufacturing firms in India. *Journal of Industry Competition and Trade*, 16(2), 1-17.

Sahu, S. K., & Narayanan, K. (2011). Determinants of energy intensity in Indian manufacturing industries: A firm-level analysis. *Eurasian Journal of Business and Economics*, 4(8), 13-30.

Satpathy, L. D., Chatterjee, B., & Mahakud, J. (2017). Firm characteristics and total factor productivity: Evidence from Indian manufacturing firms. *Margin—The Journal of Applied Economic Research*, 11(1), 77–98.

Sen, J., & Das, D. (2016). Technical efficiency in India's unorganized manufacturing sector: A non-parametric analysis. *International Journal of Business and Management*, 4(4), 92-101.

Singh, A. K., Acharya, S. R., & Chavda, P. (2017). Implications of intellectual property rights and socio-economic factors on the growth of manufacturing sector in selected cross economies: An empirical assessment, In Sasi Misra, Sunil Shukla and Ganapathi Batthini (Eds.). Twelfth Biennial Conference on Entrepreneurship Organized by EDII Ahmedabad [Feb 22-24, 2017] (pp. 262-279). New Delhi: Bookwell Publishing House.

Singh, J., Das, D. K., Chaudhury, H., Kukreja, P., & Abhishek, K. (2017). Factors influencing Indian manufacturing firms' decision to hire contract labor. Working Paper 341, Indian Council for Research on International Economic Relations, New Delhi.

Singh, A. K. (2017). An empirical analysis to assess the GDP projection of Gujarat state of India. *JNNCE Journal of Engineering and Management*, 1(2), 51-58.

Singh, A. K., & Ashraf, S. N. (2019). Viability of Bayh-Dole Act of USA in context of India: Critical evidence from review of literature. *JNNCE Journal of Engineering & Management*, 3(1), 7-22.

Singh, A. K., Ashraf, S. N., & Arya, A. (2019). Estimating factors affecting technical efficiency in Indian manufacturing sector. *Eurasian Journal of Business and Economics*, 12(24), 65-86.

Singh, A. K., Arya, A., & Jyoti B. (2019). A conceptual review on economic, business, intellectual property rights, and science & technological related activities in Asian economies. *JNNCE Journal of Engineering & Management*, 3(2), 1-22.

Singh, A. K., Narayanan K. G. S., & Sharma P. (2019). Measurement of technical efficiency of climatic and non-climatic factors in sugarcane farming in Indian states: Use of stochastic frontier production function approach. *Climate Change*, 5(19), 150-166.

Singh, A. K., Issac, J., & Narayanan, K. G. S. (2019). Measurement of environmental sustainability index and its association with socio-economic indicators in selected Asian economies: An empirical investigation. *International Journal of Environment and Sustainable Development*, 18(1), 57-100.

Singh, A. K., Singh, B. J., & Ashraf, S. N. (2020). Implications of intellectual property protection, and science and technological development in the manufacturing sector in selected economies. *Journal of Advocacy, Research, and Education*, 7(1), 16-35.

Singh, A. K., Singh, B. J., & Negi, V. (2020). Does sustainable development have a causal relationship with environmental development? An evidence from country-wise panel data analysis. *International Journal of Technology Management & Sustainable Development*, 19(2), 147-171.

Singh, A. K., & Singh, B. J. (2020). Assessing the infectious diseases of students in different weather seasons in DIT University Dehradun, Uttarakhand (India). *Asian Journal of Multidimensional Research*, 9(3), 34-48.

Singh, A. K., Ashraf, S. N. (2020). Association of entrepreneurship ecosystem with economic growth in selected countries: An empirical exploration. *Journal of Entrepreneurship, Business and Economics*, 8(2), 36-92.

Soni, A, Mittal, A., & Kapshe, M. (2017). Energy intensity analysis of Indian manufacturing industries. *Resource-Efficient Technologies*, 3(1), 353-357.

Srivastava, P., & Chandra, S. (2012). Technology commercialization: Indian university perspective. *Journal of Technology Management & Innovation*, 7(4), 121-131.

Vu, H. D. (2016). Technical efficiency of FDI firms in the Vietnamese manufacturing sector. *Review of Economic Perspectives*, 16(3), 1-13.

Vrajlal, S. (2015). Indian manufacturing sector: Competitiveness at stake. MPRA Paper No. 68777. https://mpra.ub.uni-muenchen.de/68777/.

Tyagi, S., & Nauryal, D. K. (2016). Profitability determinants in Indian drugs and pharmaceutical industry: An analysis of pre and post TRIPS period. *Eurasian Journal of Business and Economics*, 9(17), 1-21.

Tripathy, S., Aich, S., Chakraborty, A., & Lee G. M. (2016). Information technology is an enabling factor affecting supply chain performance in Indian SMEs: A structural equation modeling approach. *Journal of Modelling in Management*, 11(1), 269-287.

Yueh, L. Y. (2007). Global intellectual property rights and economic growth. Northwestern *Journal of Technology and Intellectual Property*, 5(3), 434-448.

Wei, Y., & Balasubramanyam, V. N. (2015). A comparative analysis of China and India's manufacturing sectors. Economic Working Paper Series, 003. Lancaster University Management School, UK. https://www.lancaster.ac.uk/media/lancaster-university/content-assets/documents/lums/economics/working-papers/LancasterWP2015_003.pdf.

Wignaraja, G. (2013). Trade policy in PRC and India in the new era of slower world growth: Challenges and policy options. http://icrier.org/pdf/Wignaraja_trade_policy.pdf.

World Bank, World Development Indicator [Online]. https://databank.worldbank.org/source/world-development-indicators.

Zhu, H., Zhao, S., & Abbas, A. (2019). Relationship between R&D grants, R&D investment, and innovation performance: The moderating effect of absorptive capacity. *Journal of Public Affairs*, 20(1), 1-10.