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

268
WORKING PAPER

Manufacturing Productivity in Indian States: The Role of Infrastructure, Agglomeration, and Exports

Mahua Paul
Smruti Ranjan Sahoo

Azadi Ka Amrit Mahotsav

September 2023

ISID Working Paper **268**

Manufacturing Productivity in Indian States:
The Role of Infrastructure, Agglomeration, and Exports

Mahua Paul
Smruti Ranjan Sahoo

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

September 2023

Manufacturing Productivity in Indian States: The Role of Infrastructure, Agglomeration, and Exports

Mahua Paul [*]
Smruti Ranjan Sahoo [**]*

[***Abstract***: *The growth in the Indian manufacturing takes place through investment and productivity growth. The present study attempted to estimate total factor productivity (TFP) at the state / NIC 3-digit industry level during the period 2008-09 to 2019-20 for 18 states and 20 industries using the Ackerburg framework of TFP estimation. Data on state as well as industry level on firm characteristics were taken from the Annual Survey of Industries (ASI) reports. The study shows that some of the laggard industrial states have done better in terms of productivity, while some of the advanced states have seen no change in TFP. Also, there is varying growth in TFP across the industries, while some industries have shown a decline in TFP. Interestingly, the endowment of physical infrastructure has a positive impact on TFP, but its impact was minimal, while increase in the financial and social infrastructure have no impact on states' TFP. A rise in manufacturing exports have no significant role in states' TFP.]*

1. INTRODUCTION

1.1 Manufacturing productivity is a measurement of the overall efficiency of production. It describes the complex interlinked relationship between the output and inputs used in the manufacturing process. Productivity is often considered as a residual once we account of the growth in output due to the growth in inputs of labor and capital. Total factor productivity (TFP) compares total outputs relative to the total inputs used in the production

---

[*] Assistant Professor at Institute for Studies in Industrial Development, New Delhi.
[**] Research Associate. ISID

Acknowledgements: This paper is a part of the major Project, titled" Trends in Inter-State Disparity in Indian Manufacturing", sponsored by ICSSR. The paper was presented at National Conference: Towards Industrial Transformation of India: Building an Inclusive, Sustainable, and Competitive Manufacturing Sector to Realize the 2047 Vision on 4-6 October 2023 held at ISID, New Delhi. I am grateful to Prof. Vinish Kathuria for continuous encouragement at every critical stage in carrying out the study and Prof. Amit Batabyal of Rochester University and Prof Sushant Mallick also in providing the insightful comments and suggestions in revising the study.

of an output. Since both outputs and inputs are usually expressed in terms of volume of indices, the indicator measures TFP growth (TFPG). TFP cannot be explained using the growth in other observable inputs, since firm level inputs are measurable but the residuals which is the outcome of process of production are not measurable. In analyzing the residual growth, the underlying dynamics in the economy that may influence the output growth are ignored by the traditional estimation methods of TFP such as the Solow residual. There is a need to study regional and industrial factors that affect sectoral productivity in the organized manufacturing sector. Regional factors like specific policies and incentives offered by the state governments, locational factors (ports, airports and railways), composition of labor and accessibility to internal and international markets impact productivity in more than one ways. Industrial factors like concentration, availability of inputs and raw materials, etc. are industrial factors that also determine productivity. This paper, therefore attempts to calculate the TFP at the state-industry level. The rest of the paper is organized as follows. Section two is on the objectives of the Study. Followed by which in section three rationale and in section four the hypotheses of the study are described. Section five surveys the recent literature on productivity and its determinants the context of Indian manufacturing industry. Section six provides the data sources and the methodology of the study is explained in section seven. Section 8 discusses the estimation results and analyze it. Section 9 is on the outcome of the Study, and Section 10 provides a snapshot or conclusion of the Study.

1.2 For this, the paper considers the performance of the Indian organized manufacturing sector in the post-2008 era. The post-2008 years saw major transformation in the availability of credit in the context of the financial turmoil that took place. It would look at the role of infrastructure in pushing productivity and the interesting linkage between agglomeration on productivity and the impact of exports on productivity. There are a plethora of studies on TFP growth in India for the period pre and post-1991 reforms period of liberalization (Das et al., 2017; Saibal Ghosh, 2013; Deb and Ray, 2013; Virmani and Hashim, 2011; Kathuria et al., 2010; Surender, 2010). Some of these studies found that Indian organized manufacturing was performing well before the reforms than after the reforms. Das et al. (2017) explained that the 1990s was a period of factor accumulation and a gradual diffusion of technology may have fed the higher TFPG in the 2000s. Virmani and Hashim (2011) explained that the fall in productivity in the post-reform era was the result of technological obsolescence and the gradual adoption of new technology, and the slow effect of learning by doing.

1.3 Whilst India was progressing on the path of output and productivity growth in the 2000s, in 2008 it faced instability due to global factors such as the US financial crisis and the European debt crisis that jolted the entire global economy. Few studies have looked at the productivity performance of Indian industries during the post-2008 period (See Das et al., 2017; Singh, 2017; Goldar, 2015 for instance). Most of the analyses have been restricted to the year 2011-12 at an aggregate industry/ state level. As an advancement to the existing studies, this paper considers a longer period from 2008-09 to 2019-20 and analyses the productivity for the disaggregated industries by state for the organized manufacturing sector of India.

2. OBJECTIVES OF THE STUDY

2.1 There are two dimensions that this paper considers which have not been attempted so far. The first one is taking the TFP estimations at the state-industry level at NIC 3-digit. The other dimension is to determine the factors like infrastructure, agglomeration and exports for the variation in TFP across states.

2.2 Agglomeration refers to the concentration of economic activity which generates positive effects on the productivity of the economic units located in the region. Some industries tend to exhibit economies of scale due to concentration and others benefit from concentration due to operation of agglomeration economies. The benefits of agglomeration economies contribute towards enhanced Total Factor Productivity (TFP). Productivity gains are an outcome of the benefits of innovation, knowledge transfer and access to business service conditional upon the location of the firm in a metropolitan. The positive relation between agglomeration and productivity can have various policy implications. Government can incentivize clustering of industries through apt policies. On the job training for skill specialization will enhance productivity at micro firm level and through spillover effects it generates positive externality for other firms in the location. However, there may be agglomeration dis-economies as well due to congestion, fierce competition, high rents for land and intense competition in input and output market. Hence there are reasons to study and establish a link between agglomeration and productivity.

2.3 There is econometric evidence supporting the hypothesis that export behaviour cause learning effects. The idea is that exporting firms obtain efficiency gains through a variety of channels, among which are international knowledge and technology spill overs and the exploitation of economies of scale in a larger market. Following the existing literature, learning-by-exporting is modelled as a change, induced by export behaviour, in the stochastic process governing firm's productivity. Empirically, this is implemented specifying cross-section regressions of TFP growth on measures of export behaviour, controlling for past TFP growth and other firm's characteristics. Using data on a sample of Italian manufacturing firms, it is found, consistent with most previous works, that exporters do not exhibit faster TFP growth. Nevertheless, TFP growth has a positive and significant relation with firm's export intensity. In other words, only firms with a substantial involvement in exporting activity have a significantly higher rate of TFP growth. This result, consistent with a similar work using a sample of Chinese firms, suggests that learning-by-exporting is by no means simply the outcome of the presence into the export market. Indeed, learning requires commitment and experience of foreign activities, which in turn are associated with the relative importance of foreign activities and the length of time since entry.

2.4 The key questions in this stream of literature are "Do more efficient firms become exporters" and "Do exporters become more efficient firms?". In fact, the correlation between export and firm's productivity can be the result of two different, but not mutually exclusive, forces. On the one hand, more productive firms become exporters, because exporting require some additional cost, such as transport costs, expenses related to establishing a distribution channel, or production costs to modify products for international markets. This in turn implies that only the outperforming firms expect to be able to cover this additional cost and will rationally choose to enter the export market. Hence, correlation between productivity and export may arise as a result of the self-selection of better firms into the export market. On the other hand, exporters might learn from their presence in international markets for two main reasons. First, international contacts with buyers and customers are likely to foster knowledge and technology spillovers, such as access to technical expertise, including new product designs and new production methods. Second, international demand determines a higher capacity utilization and allows the exploitation of economies of scale. It would be interesting to analyses the correlation between exports and manufacturing productivity at 3-digit level NIC.

With the onset of unprecedented urbanization, it is crucial to establish the impact urbanization will have on inequality. Urbanization is accompanied by agglomeration of industries. Agglomeration significantly improves total factor productivity. However, there are other factors that affect productivity such as innovation and technological efficiency. International trade and exports have significant impact on productivity. There exists a significant positive relationship between TFP and export intensity. Similarly, a profound infrastructure plays a critical role in enhancing total factor productivity. Agglomeration improves total factor productivity, indicating production processes at a lower cost. Thus, agglomeration enhances exports by improving total factor productivity. Thus, agglomeration, exports and infrastructure have a significant impact to TFP.

2.5 Based on the above discussion, this paper has the following objectives (i) to analyse the trends in TFPG across selected industry groups and States, and (ii) to look at factors like agglomerations, exports and infrastructure responsible for variation in the TFPG across states.

3. RATIONALE OF THE STUDY

3.1 Given total funds for the nation as a whole, the flow of investments (both public and private) is seen to have concentrated in limited regions. A large part of investment flows into development of infrastructure (physical, financial and social) and, inter alia, it spurs economic activities like manufacturing and exports. Manufacturing sector is largely influenced by regional disparities across Indian States. Economists are of the view that Indian manufacturing growth takes place through two channels – investment growth and productivity growth. The former however, because of diminishing returns may retard growth, but the later plays an important role in sustaining long term growth and improve manufacturing competitiveness in the country (Das et al, 2016).

3.2 Most of the earlier studies in this context covered the period up to 2011-12. Therefore, it is worth making an effort to study this issue covering a long time period from

2008-09 till 2019-20. This being a long period, it is expected that there would have been substantial changes in the trend of TFPG across various industries. Also the impact of infrastructure development, expanding exports and the ever increasing trend of industrial agglomeration on the States TFPG would throw some interesting outcome.

3.3 The present study tries to estimate total factor productivity at the states NIC 3-digit industry level during the period 2008-09 to 2019-20 which has not been attempted so far in earlier studies. This helps us in capturing trends of TFP in Indian States. Further, the paper tries to examine the role of infrastructure, agglomeration and export in enhancing TFPG across states.

3.4 For this study, a total of 20 industry groups at 3-digit level NIC and 18 states were considered as it represented around 93 percent of total organized manufacturing GVA and around 91 percent of the total number of factories. This way the analysis will take into consideration a substantial part of the manufacturing landscape of the country.

4. HYPOTHESES

4.1 Based on the overall objectives, the following are the hypotheses of the Study:

(a) There is a secular growth trend in TFPG cross selected industry groups during the period of selection;
(b) Across the selected States, there is an upward trend in TFPG;
(c) The rise in factors like agglomerations, exports and infrastructure responsible have a positive impact on the TFPG across states.

5. REVIEW OF RELEVANT LITERATURE

5.1 Productivity is a very well-studied concept and there are a plethora of studies which have looked at the productivity growth patterns of the Indian manufacturing sector. There is a general conclusion from most of these studies that productivity growth stagnated in the post-reform era, which was against the expectations of many especially when one of the tenets of reforms has been to increase productivity (Das et al., 2017; Goldar, 2015; Saibal Ghosh, 2013; Virmani and Hashim, 2011; Kathuria et al., 2010; Surender, 2010).

5.2 There have been some studies analysing state-level productivity measures (Deb and Ray, 2013; Kumar and Managi, 2009). Deb and Ray found state-level disparities where most of the states performed better in the post-liberalization era than earlier. Their results show that at the national level, manufacturing productivity grew faster during the post-reform period. Their paper also finds that it is not technological progress per se that contributed to TFPG as there were few states where growth in TFPG occurred with a decline in their respective technological progress. Kumar and Managi (2009) found considerable variations in productivity growth across states during 1993-2004. The study found that Punjab, Andhra Pradesh and Karnataka to be moving towards the production frontier (using Stochastic

Frontier Approach). Their Malmquist Index measures of the components of productivity showed that the most significant factor behind the improvement in TFP during 1993-1994 to 1996-97 could be found in the improvement in technical efficiency. This was evident from the positive rates of efficiency change in 12 out of 14 states.

5.3 An analysis by Govinda et.al, June, (2022) tries to empirically study various factors (economic, fiscal, demographic, social, institutional, and political) determining inter-state infrastructure inequality. Their results show that economic factors are more influential on physical infrastructure. Financial infrastructure is mainly driven by demographic and economic factors. In a study by Mitra et.al, January, (2002), the authors in order to explain Indian States industrial performances have focused on the role of broadly measured infrastructure. They showed that differences in infrastructure endowments across Indian States explain in a significant way their differences in industrial performances. They concluded that this phenomenon is true for total factor productivity as well for technical efficiency. They claimed that enhancing equipment infrastructures can constitute powerful engine of industrial take off. Targeting public investment on those infrastructures that most favour the convergence of industrial productivity can constitute an important element of a strategy of balanced regional growth. In this context, investment in primary education shows a comparatively high return in terms of total factor productivity and gains in technical efficiency. Moreover, reforming the financial system in order to improve its efficiency in the mobilisation of deposits and the distribution of credit could be an efficient and low opportunity cost means to promote industrial growth. Finally as far as core infrastructure is concerned, their findings confirm that enhancing the potential of power production appears to be, in the case of India , a key factor for increasing industrial total factor productivity and technical efficiency. Work by Davide Castellani, January,(2001) validates the hypothesis that exporting behaviour promotes learning behaviour. In a study by Buddhadeb Ghosh and Prabir De. November,21,(1998) confirmed that regional imbalance in physical infrastructure has been found to be responsible for rising income disparity across states. Renjith et. al,(2020) confirmed the positive impact of industrial agglomeration on plant productivity.

5.4 In his study, Jagannath Mallick (2021) examines the club-convergence and conditional convergence of economic growth of the major 15 states in India over the period from 1993–1994 to 2004–2005 by using dynamic fixed effect growth models. Findings of this paper suggested that regional disparity in income can be reduced by equitable allocation of private investment and equitable distribution of public investment. In a work by Rupika Khanna and Chandan Sharma (2018), it confirmed that low productivity states display a higher variation in TFP across industries as compared to high productivity states. Econometric analysis by Rupayan and Udayan (2014), in one of their papers showed that amendments in labor regulation concerning resolutions of industrial disputes by State government(s) which aims to reduce costs of dispute resolution and/or to simplify the procedures involved, strengthened workers' bargaining power.

6. DATA DEFINITION AND ITS SOURCES

6.1 Rich data on the state as well as industry level firm characteristics are available in the Annual Survey of Industries (ASI) reports from 2008-09 to 2019-20. This paper takes into account the organized manufacturing sector in India from the period from 2008 to 2019 and estimates the TFP at NIC 3-digit level for 18 states and 20 industries using the Ackerburg framework of TFP estimation.

6.2 At the regional level, 18 states were considered which represented around 93 percent of total organized manufacturing GVA and around 91 percent of the total number of factories. These states are Maharashtra, Gujarat, Tamil Nadu, Karnataka, Uttar Pradesh, Haryana, Uttarakhand, Andhra Pradesh (Andhra Pradesh + Telangana 2012-13 onwards), Rajasthan, Madhya Pradesh, Himachal Pradesh, West Bengal, Punjab, Odisha, Kerala, Jharkhand, and Goa, Bihar, Chhattisgarh, Jharkhand.

6.3 For estimating the TFPG, firm-level data at NIC 3-digit level sourced from the ASI is aggregated for various industry characteristics such as the number of factories, gross value added, fixed capital assets, inputs, number of workers, financial particulars like outstanding loans, etc. This study made use of gross value added for output, fixed capital assets representing capital, number of workers as labour and exports. Nominal exports at three-digit level across States over the years are extracted from ASI Unit Level Data for various years.

6.4 Infrastructure was collected from a number of sources. An index for infrastructure comprising all-States and UTs was constructed covering all three broad dimensions - physical, financial and social infrastructure.

6.5 For creating physical infrastructure index, the following indicators were used:

(i) Road density [roads length per geographical area -(km/000km^2)] - data were sourced from the Central Statistical Organization's Annual Statistical Abstract of India (various issues) whose original data was from the Ministry of Shipping and Transport;

(ii) Rail density (track length by area of states) – data were sourced from the Central Statistical Organization's Annual Statistical Abstract of India (various issues) whose original data was from the Railway Board, Ministry of Railways;

(iii) Telecom density (telephone lines per 100 people) - data were sourced from the Ministry of Communications, Department of Telecom.

(iv) Power (Mw/population) – data were sourced from the Annual Report (various issues), Ministry of Power;

(v) Air passenger traffic (per 00000 population) – data were source from the Annual Report (various issues), Airport Authority of India, Ministry of Civil Aviation;

vi) Commodity-wise traffic handled at major ports – data were source from the Annual Report (various issues), Ministry of Shipping.

6.6 In order to estimate the financial index, the following data from the Reserve Bank of India's Annual Statistical Tables on Indian Banks (various issues) were used:

(i) Outstanding credit of Scheduled Commercial Banks as a percentage of SDP;
(ii) Deposits of Scheduled Commercial Banks as a percentage of SDP;
(iii) Number of bank branches (per 100,000 population).

6.7 In order to estimate the human capital or social index, the following data were used:

(i) Infant mortality rate for health as available from the Annual Statistics (various issues), Director General of Health Services, Ministry of Health and Family Welfare;
(ii) Gross Enrolment ratio across the age group (6-11 years and (11-17 years) for education;
(iii) Secondary school attendance (11–17 years of age, as % of age group)

Data for Gross enrollment ratio and secondary school attendance were source from the Educational Statistics (various issues), Human Resources Department, Ministry of Education.

6.8 For measuring industrial agglomeration, the framework based on the Ellison-Glaeser (EG) (1997) was used and employment data at three-digit level were taken from ASI for the selected 20 (twenty) industry groups.

6.9 Data on exports from selected 18 (eighteen) States and 20 (twenty) industry groups and these were sourced from the ASI.

6.10 Productivity for each state has been computed by estimating the industry level production function. Detailed discussion on this is given in the next section.

6.11 Necessary deflators were used to deflate the value added and capital stock series. Wholesale Price Index (WPI) for various commodities at a disaggregated level were sourced from the Office of the Economic Adviser, Ministry of Commerce & Industry. Detailed concordance was carried out between NIC 2008 and the WPI codes using the description of the commodities to ensure a one-to-one concordance. Wherever the WPI description did not match that of the NIC, the aggregate WPI was taken as the price deflator. Lastly, to compute material price index we have taken weights of material consumption for industries from the supply-use table. The weights are then multiplied with the value of material consumed by plants, the composite value is then deflated with the WPI of plants and machineries.

7. METHODOLOGY

7.1 The methodology to examine the role of infrastructure, agglomeration, and export on the productivity of Indian states involves two stages. First is the estimation of the state-level and industry-level total factor productivity growth, and second finding out how the endowment of various infrastructure (which includes physical, financial and social infrastructure), industrial agglomeration, and extent of manufacturing export in a state determines its productivity. The following paragraphs explain both these stages in detail.

7.2 Estimation of Total Factor Productivity at the State level

7.2.1 To compute states' productivity, the procedure delineated by 'Manufacturing Productivity in the Indian States' by Khanna and Sharma (2018) was adopted. The estimated productivity of each manufacturing industry has been aggregated to arrive at the productivity of the state. However, the above study is limited in nature as it computed the productivity of the NIC two-digit industries for only two years, 2008-09 and 2011-12. As mentioned in the previous sub-section, the present study used a balanced panel data of NIC three -digit industries over the period 2008-09 to 2019-20, and estimated gross value-added production function, given below.

$$v_{it} = \alpha + \beta_l l_{it} + \beta_k k_{it} + \epsilon_{it} \quad (1)$$

where,

i and t represents industry and time respectively.
v_{it} : Gross value added
l_{it} : Labor
k_{it} : Capital
ϵ_{it} : Error term.

The error term in the above model have two part that is a random error term (ε_{it}) and a productivity term (ω_{it}). For the econometric model both these components are un-observable. However, ω_{it} is known to the the industrial producers/entrepreneurs. It includes factor internal to the industries, for example anticipated failures of machines, expected future expansion of output because of past input patterns. Since the producers are aware about these socks, it is very likely that their choice of factor inputs such as labor and capital might determine by it. This gives rise to endogeneity in the estimation of production function. Estimating production function without considering the endogeneity problem results inconsistent estimates of the parameters. Therefore, a number of methods has been proposed for the estimation of production function accounting endogeneity. Olley and Pakes (1996), Levinsohn and Petrin (2003) and Ackerberg, Caves and Frazer (2015) are the few recent methods. These methods essentially control the unobserved productivity, ω_{it}, by an observable proxy variable. Levinsohn and Petrin (2003) and Ackerberg, Caves and Frazer (2015) used material input (m_{it}as a proxy variable. The proxy variable eliminates that part of the error which is correlated to industries productivity, thus provides consistent estimates of the parameters.

7.2.2 For this study, the Ackerberg, Caves and Frazer (2015) method was used to estimate the production function of the industries, thereby their productivity. ACF method of measuring production function is a development over OP and LP. It highlighted the functional dependency problem which previous proxy variable methods suffers in the first stage, while estimating l_{it}. Olley and Pakes (1996) and Levinsohn and Petrin (2003) method do away this problem by assuming that labour is static in nature, as it is only decided at time period t. Unlike k_{it} which is determined at $t-1$ thus influenced by industries productivity, l_{it} is a free variable and independent of ω_{it}. Since, both (Olley and Pakes)OP and (Levinsohn, J and Petrin)LP does not provide the data generating process (DGP) for l_{it}, Ackerberg, Caves and Frazer by constructing a number of DGP showed that l_{it} is in fact a function of other factor inputs, such as k_{it} and m_{it}. For detail on this see Ackerberg, Caves and Frazer (2015), page 2416 – 2422.

As explained above, Ackerberg, Caves and Frazer (2015) method use a proxy variable control for the part of error that is correlated with the productivity. In this method material demand is used as a proxy variable. It is assumed that industries demand for proxy variable (Material in this case) is a strictly increasing function of the capital and productivity. This assumption allows to invert the material input demand function, i.e.

$$m_{it} = h(k_{it}, \omega_{it}) \text{ (2)}$$

and express the ω_{it} in terms of capital and material, that is

$$\omega_{it} = h_t^{-1}(k_{it}, m_{it}) \text{ (3)}$$

Replacing the equation 3 in equation 1 we obtain the production function that we can estimate to find out the efficient of l_{it} and k_{it} . The production function is given below.

$$v_{it} = \alpha + \beta_l l_{it} + \beta_k k_{it} + h_t^{-1}(k_{it}, m_{it}) + \varepsilon_{it} \text{ (4)}$$

TFP can be estimated as

$$\ln(TFP_{it}) = \ln(v_{it}) - \widehat{\beta_l} \ln(l_{it}) - \hat{\beta}_k \ln(k_{it}) \text{ (5)}$$

where, $\widehat{\beta_l}$ and $\hat{\beta}_k$ are the estimated coefficient of labor and capital.

Now the estimated productivity values of an industry can be multiplied with the output/value added share ($share_{it}$) in the total manufacturing industry to obtain the weighted TFP (WTFP)

$$WTFP_{it} = TFP_{it} * share_{it} \text{ (6)}$$

The $WTFP_{it}$ can be added together to arrive obtain productivity at the state level, that is

$$STFP_{ts} = \sum_{i=1}^{N} WTFP_{it} \text{ (7)}$$

Inter industry and - State Comparison of Total Factor Productivity for the years 2008 and 2019 by Industries is given bellow (See table 1 and 2)[†].

In the second stage of our methodology, we regress $STFP_t$ on the infrastructure, agglomeration and exports. The model we for that is given below.

$$STFP_{ts} = \alpha + \beta_1 TINFRA_{st} + \beta_2 PINFRA_{st} + \beta_3 FINFRA_{st} + \beta_4 SINFRA_{st} + \beta_5 AGGLOMERATION_{st} + \beta_6 EXPORT_{st} + \beta_7 COASTAL_s + \epsilon_{st} \quad (8)$$

where, s and t represent state and year respectively,

$TINFRA_{st}$ is the total infrastructure,
$PINFRA_{st}$ is the physical infrastructure,
$FINFRA_{st}$ is the financial infrastructure,
$SINFRA_{st}$ is the social infrastructure,
$AGGLOMERATION_{st}$ represent industrial agglomeration,
$EXPORT_{st}$ is the value of manufacturing export, and
$COASTAL_s$ is a dummy variable for coastal regions.

A number of studies have pointed out that availability of infrastructure and intensity of manufacturing activities and export of a state are generally higher in states with high productivity. Therefore, it is likely that the dependent and independent variables in the above model are correlated contemporaneously. This led to biased estimates of the coefficient. To resolve the endogeneity problem, we resort to instrumental variable method to estimate the above model.

The results of the econometric models are presented in the next section, the reminder of this section however explains the construction of the independent variables of our model that is infrastructure indices, EGI index and exports in detail.

7.3 Infrastructure Index

7.3.1 The term infrastructure refers to the basic system that undergirds the economic activities. Depending on the role of inputs, infrastructure can be divided into three parts: Physical, Social and Financial. Infrastructure acts as a catalyst for crowding-in both domestic and foreign investments. The positive spill-over effect of physical infrastructure comes through an increase in investment, employment and an increase in income. The social infrastructure plays a vital role in building human capital which further augments the process of R&D and it also increases the ability of people to absorb rapidly changing technology thereby improving productivity. A well-organized financial infrastructure provides efficient allocation of financial resources. A well-established, equitable, sufficient

[†] We also computed the labour productivity (LP) for the states and compared it with their respective TFP values from 2008 to 2019. We find that, during these periods there is a high correlation between LP and TFP, as shown in the Graph A1 in the appendix.

and efficient physical, human and financial infrastructure are a precondition for economic growth and also for its quickening. On the other hand, a lopsided distribution of infrastructure brings in disparities in social and economic development across regions.

7.3.2 A max min method analysis was deployed by creating an index for each of the factors such as infrastructure (both physical and financial), economic factors, and the subsequent impact of the computed indices is observed on the economic development and regional inequality. A composite index for infrastructure comprising 18 states was constructed covering all three broad dimensions of physical, financial and social infrastructure. Using the max min method is also a way to avoid collinearity among variables considered for construction of the indices.

7.3.3 For normalizing some of the indicators by population have been extrapolated the data state-wise as per the years considered for the study. Looking at the correlation coefficient and Principal Component Analysis it is found that all variables are correlated to each other, so has to be converted into the index hence index has been constructed using the max-min method.

7.4 Estimating Exports

7.4.1 Economic analysis provides empirical support for the notion that export behaviour contributes to the emergence of learning effects. The central concept is that plants engaged in exporting activities attain enhanced efficiency through diverse avenues, including the transfer of international knowledge and technology, as well as capitalizing on economies of scale within broader markets. Drawing from existing scholarly discourse, the phenomenon of "learning-by-exporting" is conceptualized as a modification, triggered by engagement in export activities, within the random process dictating a firm's productivity. As a result, states with larger number exporting plants will experience higher productivity growth. To test this, we constructed the export variable by taking the log of states real exports. Real exports are obtained by deflating nominal exports with industry specific Unit value of Index for Exports as deflators.

7.5 Estimating Agglomeration

7.5.1 Agglomeration refers to the concentration of economic activity which generates positive effects on the productivity of the economic units located in the region. Some industries tend to exhibit economies of scale due to concentration and others benefit from concentration due to operation of agglomeration economies. All the benefits of agglomeration economies quoted above contribute towards enhanced Total Factor Productivity (TFP). TFP is often interpreted as technological progress and technical efficiency. Positive externalities or the benefits of agglomeration quoted above result in productivity gains. Such productivity gains are an outcome of the benefits of innovation, knowledge transfer and access to business service conditional upon the location of the firm in a metropolitan. Hence there are reasons to study and establish a link between agglomeration and productivity.

7.5.2 However, there may be agglomeration diseconomies as well due to congestion, fierce competition, high rents for land and intense competition in input and output market.

7.5.3 Goldar (1997) notes that factories are classified into industries according to their principal products. In some cases, this causes reclassification of factories from one class to another in successive surveys, making inter-temporal comparisons difficult. Classical measures like Gini Index and Location Quotient are criticized in measuring spatial inequality as they are not derived from theoretical location choice models and hence fail to capture the impact of industrial structure.

7.5.5 The Ellison-Glasser (1997) index of concentration was used in this Study to see if industrial activity within sectors is clustered across locations. The EG index is explicitly derived from the micro foundations of a firm's location choice. It takes on a value close to zero when the distribution of plant location is completely random (as opposed to a uniform distribution). Therefore, a non-zero value implies agglomeration or clustering above and beyond what we would observe if the firm's location decisions are random. In particular, Lall et al (2004) find a positive relationship between agglomeration economies and productivity. However, Lin et al (2011) find a non-linear relationship between industrial agglomeration and productivity. Further, Overman et al. (2010) posit a negative relationship between agglomeration and productivity. Given the mixed evidence, the present Study contributes to this rising debate by examining the effects of industrial agglomeration (specialization) on plant-level productivity in the context of an emerging economy, India. Unlike the existing studies on India, which are based on cross-section data, this Study used a large-scale plant level panel data of 65 three-digit industries to examine the agglomeration productivity linkage.

7.5.6 The rich panel dataset of the Indian manufacturing sector over the period 2008–2019 from the Annual Survey of Industries (ASI) database was used. Prior studies in the Indian context were mainly concerned with the agglomeration economies (localization and urbanization economies), while this Study focus on the missing element of industrial agglomeration and productivity. To this end, the Ellison-Glasser Index (EGI) which is the widely accepted measure of industrial agglomeration was used. EGI of industries are then multiplied with their employment share in states total manufacturing employment to compute the agglomeration of industries in the state.

7.5.7 EG index has certain advantages that it allows for comparability across industries and the scale of the index allows for comparison with a "no agglomeration" benchmark (EG index=0). Further, very little information is available regarding plant level distribution, on which only one variable (employment) is required for the construction of EG index. A formal representation of the EG index is given below.

$$r = \frac{\sum_{i=1}^{M}(s_i - x_i)^2 - (1 - \sum_i^M x_i)H}{(1 - \sum_i^M x_i)(1 - H)}$$

where,

r: extent to which an industry is concentrated in a geography

s_i: region i's share of the study industry.

X_i: regional share of total employment

H: Herfindahl industry plant size distribution index. H= $\sum_{j=1}^{N} z_j^2$

7.5.8 When the distribution of plant location is completely random, index takes on value close to zero. If it takes a non-zero value, it indicates agglomeration or clustering. It can be generally concluded that an industry is highly concentrated if $r > 0.05$, moderately concentrated if $0.02 < r < 0.05$ and not concentrated if $r < 0.02$. The EG index is explicitly derived from the micro foundations of a firm's location choice. The index is designed to allow comparisons across industries, countries, and over time.

7.5.9 The index for industries dis-aggregated at three-digit level was calculated for the years 2008-09 to 2019-20 using EG (Ellison-Glaeser) framework. EGI then multiplies with the industries employment share to compute the agglomeration of industries in the state. Finally, the mean EGI of all three-digit industries in a state was computed to arrive at its EGI values. A figure comparing state wise EGI values for the year 2008 and 2019 is given in the appendix of the paper (See figure - A2) and the table below:

AGGLOMERATION ACROSS STATES BETWEEN 2008 AND 2019

Year	State	stateegi	Year	State	stateegi
2008	Himachal Pradesh	0.082	2019	Himachal Pradesh	0.078
2008	Punjab	0.134	2019	Punjab	0.129
2008	Uttarakhand	0.058	2019	Uttarakhand	0.067
2008	Haryana	0.092	2019	Haryana	0.065
2008	Rajasthan	0.086	2019	Rajasthan	0.075
2008	Uttar Pradesh	0.102	2019	Uttar Pradesh	0.086
2008	Bihar	0.123	2019	Bihar	0.077
2008	West Bengal	0.103	2019	West Bengal	0.074
2008	Jharkhand	0.167	2019	Jharkhand	0.192
2008	Orissa	0.173	2019	Orissa	0.126
2008	Chattisgarh	0.165	2019	Chattisgarh	0.117
2008	Maharastra	0.088	2019	Maharastra	0.059
2008	Gujrat	0.082	2019	Gujrat	0.081
2008	Madhya Pradesh	0.086	2019	Madhya Pradesh	0.058
2008	Andhra Pradesh	0.179	2019	Andhra Pradesh	0.107
2008	Karnataka	0.116	2019	Karnataka	0.088
2008	Kerala	0.136	2019	Kerala	0.071
2008	Tamil Nadu	0.134	2019	Tamil Nadu	0.131

Stateegi: Denotes State level EG Index

It is well known fact that inter-state disparity in Indian manufacturing impacted income, agglomeration economies and industrialization as a whole in some states (Lall and Chakravorty, 2005) . Industries get concentrated in regions where capital is more easily located and the States which are having larger industrial base, there has been concentration of economic activities in these areas during the period 2008-19 under study.

8. ESTIMATION AND RESULTS

As mentioned above, in this section we explain the results of the econometric model specified in the equation 8. However, before that the trends and pattern of Total Factor Productivity Growth (TFPG) across industries and states has been explained.

(8.i) Trends in TFPG across industry groups and States

8.1 The estimates of the Weighted Average (WA) TFPG of the selected 18 industries for the periods 2008 and 2019 showed that TFPG estimates vary significantly across industry groups. Out of the 18 industries under consideration for the year 2008, it is observed that four industries have seen a reduction in TFPG, while there are eight industries which have witnessed a less than one percent growth in TFP and only three industries have grown by more than two percent. Similar trend existed in TFPG in 2019 as well. Interestingly, those industries which witnessed negative TFPG in 2008 have also seen negative TFPG in 2019.

Table 1: Weighted Average Total Factor Productivity by Industry

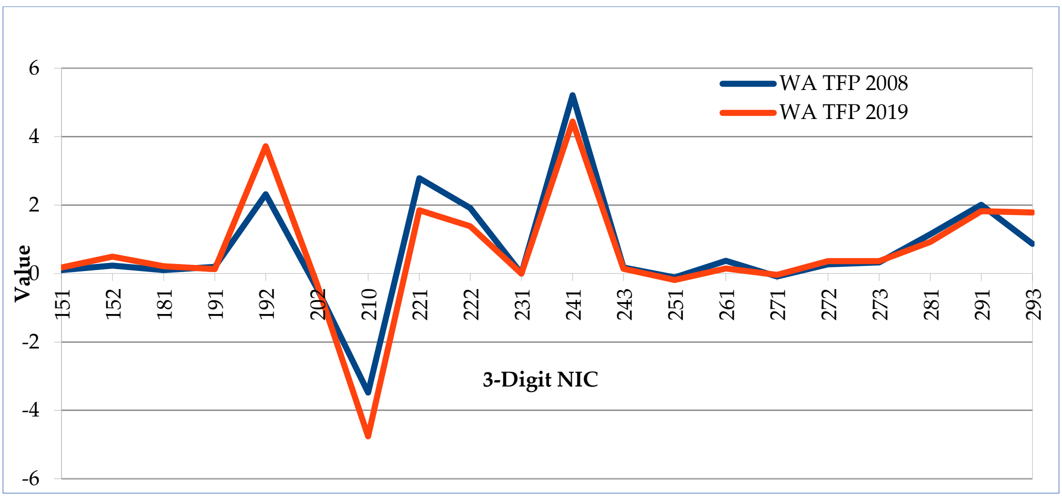
NIC 3-digit	*Industry*	*WA TFPG (2008 over 2007)*	*CV*	*WA TFPG (2019 over 2018)*	*CV*
151	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery	0.1	0.004	0.17	0.15
152	Manufacture of footwear	0.23	0.032	0.49	0.11
181	Printing and service activities related to printing	0.1	0.134	0.21	0.07
191	Manufacture of coke oven products	0.19	0.282	0.13	1.4
192	Manufacture of refined petroleum products	2.32	0.398	3.72	0.14
202	Manufacture of other chemical products	-0.42	0.145	-0.3	0.09
210	Manufacture of pharmaceuticals, medicinal chemical and botanical products	-3.48	0.086	-4.76	0.83
221	Manufacture of rubber products	2.78	0.119	1.85	0.09
222	Manufacture of plastics products	1.91	0.184	1.38	0.37
231	Manufacture of glass and glass products	0	0.028	0	0.04
241	Manufacture of basic iron and steel	5.21	0.084	4.44	0.83
243	Casting of metals	0.17	0.008	0.14	0.15
251	Manufacture of structural metal products, tanks, reservoirs and steam	-0.12	0.4	-0.19	0.03
261	Manufacture of electronic components	0.37	0.067	0.15	0.23
271	Manufacture of electric motors, generators, transformers and electricity	-0.09	0.017	-0.04	0.02

NIC 3-digit	Industry	WA TFPG (2008 over 2007)	CV	WA TFPG (2019 over 2018)	CV
272	Manufacture of batteries and accumulators	0.27	0.102	0.36	0.11
273	Manufacture of wiring and wiring devices	0.32	0.1	0.36	0.02
281	Manufacture of general-purpose machinery	1.15	0.058	0.92	0.06
291	Manufacture of motor vehicles	2.01	0.175	1.82	0.12
293	Manufacture of parts and accessories for motor vehicles	0.87	0.14	1.78	0.13

Source: Author's calculation. Note: WA TFPG Weighted Average Total Factor Productivity Growth CV- Coefficient of Variation

8.2 Industries relating to manufacture of refined petroleum products, rubber products, plastic products, basic iron & steel, general purpose machinery, and motor vehicles have seen TFPG growth in 2008 by more than one percent. These industries also saw the largest increase in TFPG in 2019. On the other hand, industries like chemical products, pharmaceuticals, medicinal chemical and botanical, structural metal products, tanks, reservoirs and steam, electric motors, generators, transformers and electricity saw a negative growth in TPFG in both 2008 and 2019. The manufacturing of glass and glass products saw no change in the TFPG.

Figure 1: Weighted Average TFPG by Industry



8.3 Trends in TFPG across States

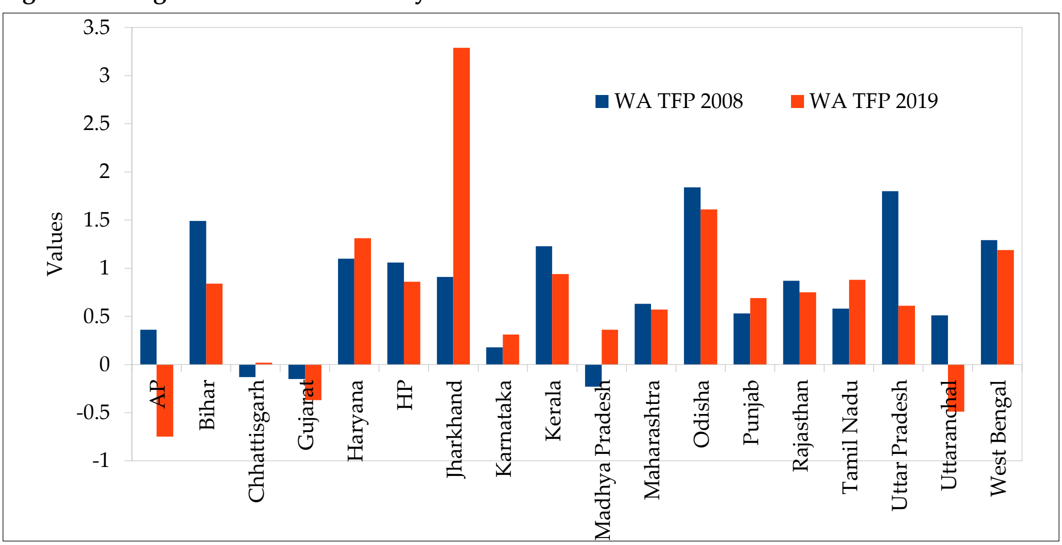
The estimates of the Weighted Average (WA) TFPG of the 18 states shows that in 2008 States like Odisha and Uttar Pradesh have the highest TFPG, followed by Bihar, West Bengal, Kerala, Haryana and Himachal Pradesh. On the other hand, States like Chhattisgarh, Gujarat and Madhya Pradesh have seen a negative TFPG during the same period. For the year 2019, Jharkhand has the highest TFPG, while Odisha, Haryana, West Bengal also performs well in productivity terms. TFPG of Karnataka, Maharashtra, Punjab and Rajasthan have seen little variation during the two periods under study. Also States that showed higher productivity growth variation across industries are Andhra Pradesh, Jharkhand, Madhya Pradesh and Uttarakhand. Interestingly over the two period, Jharkhand has seen the highest jump in TFPG, Odisha has seen steady performance between the two periods, while Andhra Pradesh has seen the worst decline in TFPG.

Table 2: States TFP between 2008 and 2019 and its growth

States/NIC	WA TFP [2008 OVER 2007]	CV	WA TFP [2019 OVER 2018]	CV	Growth rate (%)
Andhra Pradesh	0.36	2.1	-0.75	1.42	-308.18
Bihar	1.49	0.93	0.84	0.54	-43.57
Chhattisgarh	-0.13	1.21	0.02	0.49	-113.16
Gujarat	-0.15	2.16	-0.37	1.95	154.51
Haryana	1.10	0.23	1.31	0.44	19.19
Himachal Pradesh	1.06	0.15	0.86	0.21	-18.71
Jharkhand	0.91	1.43	3.29	2.65	262.87
Karnataka	0.18	1.48	0.31	1.38	69.83
Kerala	1.23	1.39	0.94	1.44	-24.00
Madhya Pradesh	-0.23	1.71	0.36	1.69	-256.36
Maharashtra	0.63	1.32	0.57	1.36	-9.08
Odisha	1.84	1.41	1.61	0.86	-12.55
Punjab	0.53	1.06	0.69	1.43	31.53
Rajasthan	0.87	1.65	0.75	1.64	-14.31
Tamil Nadu	0.58	2.13	0.88	2.64	50.78
Uttar Pradesh	1.80	1.16	0.61	0.35	-66.07
Uttaranchal	0.51	0.92	-0.49	0.91	-195.62
West Bengal	1.29	0.76	1.19	0.93	-7.69

Note: WA TFP is Weighted Average Total Factor Productivity; CV is Coefficient of Variation

Figure 2: Average Total Factor Productivity across States



By observing the 11-year long term TFPG across the 18 states, it is seen that after 2014 till 2019 there is wide variation in the TFPG trend which is quite unique. Though there has been variation in the preceding periods, but the variation in the trend has never been more prominent. But there are also States like Himachal Pradesh and Madhya Pradesh which have seen lesser variation in TFPG over the 11-year period. Other the other hand, there are States like Punjab, Rajasthan, Odisha, West Bengal, Jharkhand, Andhra Pradesh, Maharashtra, Gujarat and Karnataka which have seen varying TFPG especially after 2014.

Figure 3: Weighted Average TFPG (States)

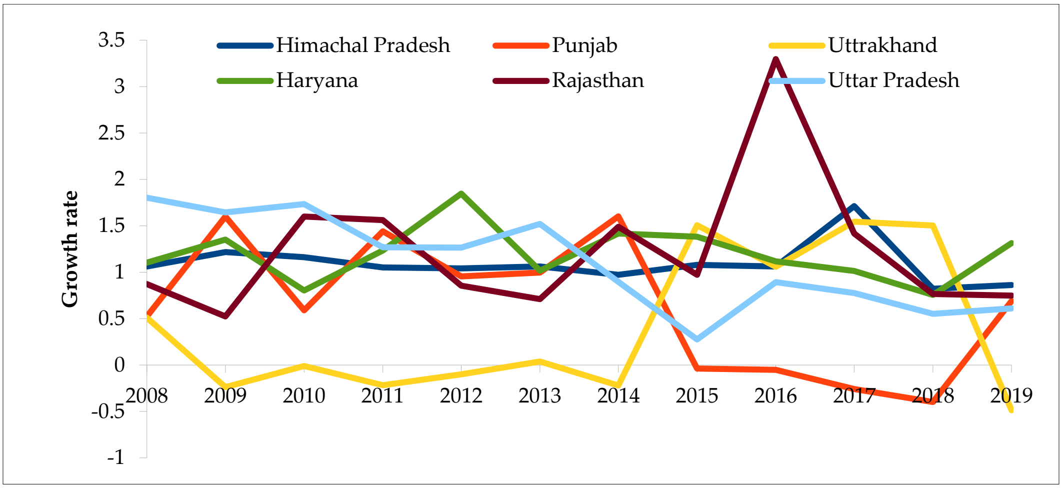


Figure 4: Weighted Average TFPG (States)

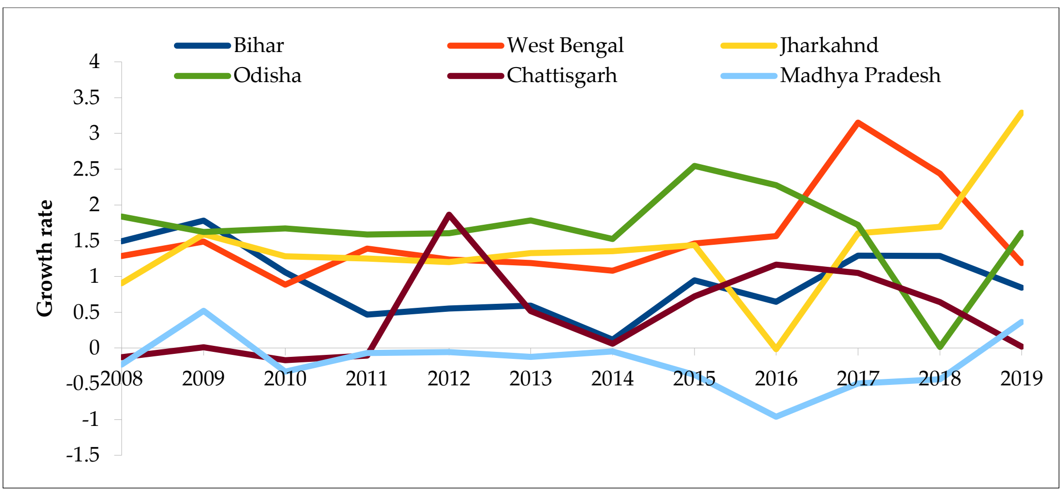
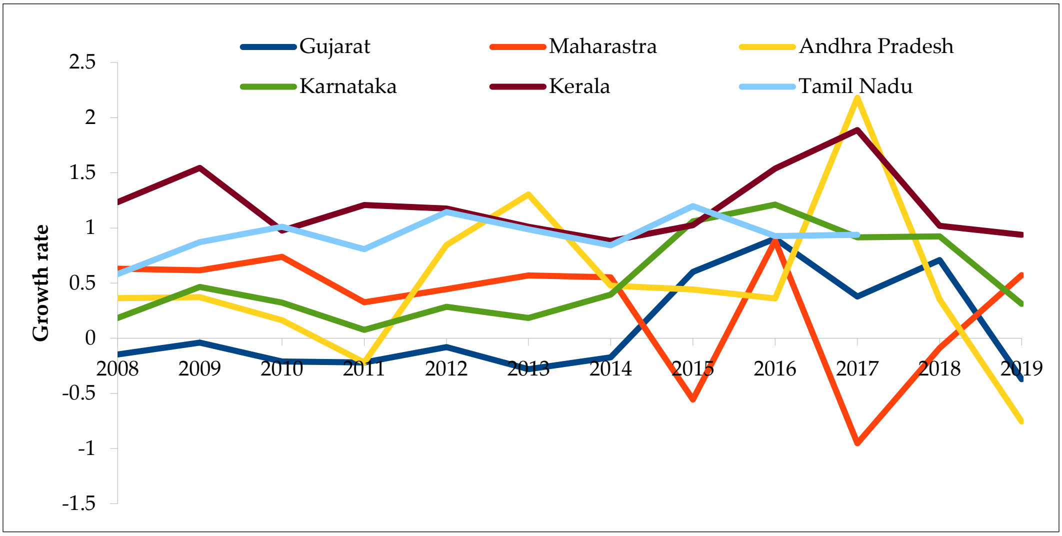


Figure 5: Weighted Average TFPG (States)



8.4 The estimated regional CV for the sample industries suggests that Indian states vary significantly in terms of productivity growth, as most industries have a CV across states tending to unity. The discussion in the previous section suggests that TFP varies widely across the states of India. It is therefore important to assess the factors behind this variation

(8.ii) Results

We have discussed above in this paper that states TFPG are endogenously related with their infrastructure endowments, level of agglomeration and export. To find out the impact infrastructure, agglomeration and export we therefore estimated two model – random effect and Generalised Method of Moment (GMM) models. The random effect model we took the first lag of the afore mentioned variables to resolve the endogeneity issue whereas in the second model we instrument the endogenous variables. The results of random effect and GMM model are presented in the Table 3 and 4 respectively.

The results of the random effect models as presented in the Table 3 shows that in all 10 models the Wald chi squire statistics is significant, which suggests that all the random effect models are valid. The Haussmann test probability values in all model is greater than 0.05 suggesting that the random effect model is appropriate than the fixed effect for our data. Lastly, the R square in all our models are sufficiently high.

Similarly, the significant values of Wald chi square values in Table 4 indicates that the estimated GMM models are valid. The probability values for AR (2) in all model is greater 5 percent accepting the null hypothesis of no higher-order serial correlation in first differences. Finally, the Hansen test statics in the table reject the null hypothesis of weak instruments in all the 10 model. From these test statics it is confirm the instruments we used to resolve the endogeneity problem is valid and our overall model is also well fitted.

Table 3: Determinants of TFP at the State Level: Random Effect Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
LInfraIndex	0.01**	0.01**							0.002	-0.003
	(2.26)	(2.02)							(0.13)	(0.18)
Lstateegi	7.12***	7.36***	7.55***	7.77***	7.30***	7.50***	7.63***	7.83***	7.06**	7.38***
	(2.67)	(2.78)	(2.85)	(2.94)	(2.69)	(2.79)	(2.81)	(2.92)	(2.54)	(2.70)
L.lnexport	0.023	0.041	0.027	0.048	0.033	0.053	0.035	0.054	0.024	0.042
	(0.59)	(0.97)	(0.67)	(1.14)	(0.83)	(1.27)	(0.89)	(1.29)	(0.58)	(0.96)
Costal		-0.317		-0.399		-0.428		-0.381		-0.392
		(1.19)		(1.25)		(1.54)		(1.31)		(1.27)
LPhyIndex			0.008*	0.008*					0.007	0.009
			(1.82)	(1.79)					(0.70)	(0.94)
LFinIndex					0.005	0.005			0.004	0.006
					(1.24)	(1.33)			(0.62)	(0.89)
L.SocIndex							0.005	0.002	0.005	0.004
							(0.74)	(0.31)	(0.68)	(0.50)
Constant	-1.181	-1.325	-0.962	-1.193	-0.879	-1.092	-0.957	-1.036	-1.372	-1.438
	(1.43)	(1.60)	(1.18)	(1.45)	(1.09)	(1.34)	(1.13)	(1.23)	(1.55)	(1.64)
Observations	177	177	177	177	180	180	180	180	177	177
R^2	0.21	0.24	0.18	0.24	0.17	0.24	0.17	0.23	0.19	0.24
Wald chi2	26.0(0.01)	27.6(0.01)	24.0(0.00)	26.6(0.02)	22.4(0.49)	25.0(0.03)	21.2(0.06)	23.5(0.5)	25.5(0.06)	27.5(0.05)
Hausmantest	3.32(0.78)	3.35(0.85)	3.79(0.80)	3.11(0.87)	1.91(0.86)	1.32(0.93)	1.95(0.85)	2.15(0.82)	4.01(0.94)	4.00(0.94)

Source: Author's calculation. Note: Figure in the parenthesis represents the t values for the independent variables, for others it is p values

Table 4: System GMM model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
InfraIndex	0.017**	0.015**							-0.003	-0.009
	(2.05)	(2.48)							(0.13)	(0.41)
EGI	7.105***	2.100	0.176	3.071	7.171	4.380	3.323	10.715*	8.923***	7.831**
	(2.59)	(0.44)	(0.03)	(0.66)	(1.48)	(0.51)	(0.64)	(1.75)	(3.11)	(2.22)
lnexport	-0.022	-0.027	-0.038	-0.030	-0.022	-0.021	-0.038	0.007	-0.031	-0.039
	(0.03)	(1.05)	(1.57)	(1.61)	(0.52)	(0.47)	(1.17)	(0.17)	(1.37)	(1.42)
Costal		0.197		0.114		-0.160		-0.264		-0.399
		(0.68)		(0.32)		(0.61)		(0.47)		(0.77)
PhyIndex			0.011***	0.009					0.016	0.016
			(2.67)	(1.25)					(0.96)	(1.01)
FinIndex					0.005	0.014			0.000	0.003
					(0.47)	(0.89)			(0.04)	(0.25)
SocIndex							-0.012	-0.007	-0.003	-0.010
							(1.20)	(0.54)	(0.22)	(0.92)
Constant	-0.345	0.207	0.856	0.516	0.306	0.281	1.731	0.233	0.002	0.898
	(0.67)	(0.37)	(0.99)	(0.78)	(0.35)	(0.27)	(1.28)	(0.12)	(0.00)	(0.63)
Observations	192	192	192	192	198	198	198	198	192	192
Wald chi2	209.4(0.00)	196.5(0.00)	132.1(0.00)	95.1(0.00)	85.3(0.00)	104.4(0.00)	277.4(0.00)	47.1(0.00)	80.5(0.00)	55.3(0.00)
AR (2)	-1.3(0.18)	-1.3(0.19)	-1.3(0.18)	-1.4(0.17)	-1.2(0.21)	-1.3(0.17)	-1.2(0.20)	-1.2(0.20)	-1.4(0.14)	-1.60(0.11)
Sargan test	196.3(0.00)	190.2(0.00)	210.0(0.00)	190.9(0.00)	245.8(0.00)	220.3(0.00)	244.9(0.00)	216.8(0.00)	223.6(0.00)	226.2(0.00)
Hansen test	13.3(1.00)	8.7(1.00)	10.9(1.00)	10.9(1.00)	14.12(1.00)	11.6(1.00)	10.05(1.00)	14.5(0.99)	9.2(1.00)	9.1(1.00)

Source: Author's calculation. Note: Figure in the parenthesis represents the t values for the independent variables, for others it is p values

By comparing the results of random effect and GMM models in both the tables we find that both the models provide almost similar result. The following paragraphs therefore explain the results of GMM models given in Table 4.

(iii) Infrastructure and Total Factor Productivity Growth

From the table it can be seen that greater availability of infrastructure in a state positive and significantly increases state productivity. However, its explanatory power is less. One-unit increase in total infrastructure in a state increases productivity by 0.01 units. Similar is the case for the physical infrastructure. Though the increase in the endowment of physical in the states increases their productivity but its impact is minimal. On the other hand, the increase in the financial and social infrastructure does not have increased state's TFP.

(iv) Agglomerations and Total Factor Productivity Growth

It is found that agglomeration of manufacturing industries in states is positively determines its productivity. One-unit increase in the value of industrial agglomeration results more than 7 unit increase in the state TFP. This implies that for the manufacturing industries only few states productivity increase.

(v) Exports and Total Factor Productivity Growth

Lastly, the table shows that in all five models the coefficient for lag export is positive but insignificant. Indicating states export have no role in increasing TFPG of States. We have also estimated the model by using export data by state of origin of Directorate General of Commercial Intelligence and Statistics (DGCI&S) data. We did not find any difference in result. Further, in all models the value of Wald chi squire statistics is significant, which suggests that all the random effect models are valid.

9. OUTCOME OF THE STUDY

9.1 Regional disparities are the dominating characteristic of the manufacturing sector across Indian States. The estimation results indicated that there is state as well as sectoral disparities in terms of TFP growth during the period under consideration. It also found that there is a direct relationship between availability of infrastructure, industrial agglomeration and productivity of the states. On the other hand, the increase in manufacturing exports in the states have no significant role in states' TFP. The estimates show that across states, Orissa and UP has the highest TFP in magnitude in 2008–2009, while Himachal Pradesh, Haryana, Bihar and West Bengal performs better in productivity terms. For the year 2019-20, Jharkhand has the highest TFP in magnitude, while Bihar, Haryana, Kerala, Orissa and West Bengal performs well in productivity terms. The TFP for Punjab, Gujarat and Maharashtra has remained more or less same across the time period under the study.

9.2 The results further show that the TFP estimates vary significantly across three-digit industries. Most of the industries have considerably gained in their TFP like coke, petroleum products, rubber & plastic products, basic metals & products, general purpose machinery, and automobiles and components. But there is a decline in the TFP in industries like chemicals & pharmaceuticals, and electrical equipment & parts. We can infer that from the decline of TFP values of the industries.

9.3 Though the increase in the endowment of physical infrastructure in the states increases their productivity, but its impact is minimal. On the other hand, the increase in the financial and social infrastructure does not increase state's TFP. It was also found that the lag of agglomeration is positive and significant.

10. CONCLUSION & RECOMMENDATIONS

10.1 The study examined the role of infrastructure, agglomeration and export on the productivity of Indian States.it was done both at state and industry level. the estimation results show that there is state as well as sectoral disparities in terms of TFP (Total Factor Productivity) growth during the period 2008-09 to 2019-20.

State wise the study shows that Orissa and UP had the highest TFP in magnitude in 2008-09, while HP, Haryana, west Bengal and Bihar performs better in productivity terms. for the year 2019-20, Jharkhand has the highest TFP in magnitude, while Bihar, Haryana, Kerala, Orissa and West Bengal perform well in productivity terms.

The TFP for Punjab, Gujrat and Maharashtra has remained more or less the same across the time period under the study. Thus laggard states have performed better as compared to the advanced ones.

Across the industries, the study revealed that TFP estimates vary significantly across three-digit industries. Most of the industries that have considerably gained in their TFP include industries like coke, petroleum products, rubber and plastic products basic metals and products, general purpose machinery and automobiles and components. But there is a decline in the TFP in industries like chemicals and pharmaceuticals and electrical equipment and parts. So there is a mix picture across industries.

Further, it was found that there is a significant positive impact of availability of physical infrastructure on TFP, but the impact of such physical infrastructure is minimal on TFP growth. But interestingly, the increase in the financial and social infrastructure has no impact on states' TFP. On the other hand, the increase in manufacturing exports in the states has no significant role in states' TFP.

10.2 POLICY RECOMMENDATIONS:

(i) It is observed that states with lower TFP, have demonstrated a higher rate of growth of TFP, indicating that these states are trying to catch up with advanced states exhibiting higher levels of TFP. Therefore, policies must favour a consistent increase in infrastructure, contributing to increase in TFP.

(ii) In states where the TFP growth has stagnated policies (with no reforms in policies) have to be fine-tuned in such a manner that there is growth in TFP across industries.

(iii) The fact that financial infrastructure is not having impact on States' TFP is also a pointer that the extent of penetration of financial institutions like banks and NBFCs is still smaller to have much impact on TFP and also that the financial diffusion from the sources of finance has not been utilized productively to make any difference in TFP.

(iv) Similarly, it is seen that social infrastructure has no impact on States' TFP. It is a fact that the lesser availability of specialised technical institutions across the states which can cater to the needs of industries is a greater contribution to a stagnant labour productivity. It is a known fact that industries across the institutions/ organizations have been complaining about the lack of technical persons which are employable as per the needs of the industries. Upskilling should be encouraged and policy formulation should be fine tune across States;

(v) It is seen that most of the exports from the country have been of low value except for software products and services and generic pharma products. The country has to promote exports of high end manufactured products, but this can be done only when technological know-how is upgraded, productivity is increased.

***

References

Ackerberg, D.A., Caves,K., and Frazer, G(2015). Identification properties of recent production function estimators, *Econometrica*,83(6):2411-2451

Castellani D (2001). Export behavior and productivity growth: evidence from Italian manufacturing firms First Draft: June 2000 (Version: January 2001). *SSRN Working Paper*

Das, D.K.,Erumban, A., A ., Agarwal , and Mallick, J (2021) Economic Growth in India during 1950-2015: Nehruvian Socialism to Market Capitalism , *Journal of Economic Surveys*, 35(3),926-951

Deb, Arnab K. and Ray, Subhash C., Economic Reforms and Total Factor Productivity Growth of Indian Manufacturing: An Inter-State Analysis (February 12, 2013). Available at *SSRN: https://ssrn.com/abstract=2242366*
or http://dx.doi.org/10.2139/ssrn.2242366

Ellison, Glen and Glaeser, Edward L, 1997. "Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach," *Journal of Political Economy* 105(5): 889–927.

Ghosh, Saibal (2010) : Economic reforms and manufacturing productivity: Evidence from India, *EERI Research Paper Series, No. 32*/2010, Economics and Econometrics Research Institute (EERI), Brussels

Goldar, Biswanath, 2015, 'Productivity in Indian Manufacturing (1999–2011) Accounting for Imported Materials Input", *Economic and Political Weekly*, 50(35)

Greene, W.(2005) . Reconsidering heterogeneity in panel data estimators of the stochastic frontier model – *Journal of Econometrics*, 126(2): 269-303

Kumar, Surender and Shunsuke Managi, (2009),Productivity and Convergence in India: State Level Analysis, *MPRA Paper, University Library of Munich, Germany*

Khanna R, Sharma C (2018). Manufacturing productivity in the Indian States. *The Singapore Economic Review*, April-pages-1-32

Lall, S., Koo, J., and Chakravorty, S. (2003). Diversity matters: The economic geography of industry location in India. *The World Bank.Policy Research Paper*

Levinsohn, J and Petrin, A.(2003). Estimating production functions using inputs to control for unobservable, *Review of Economic Studies*, 70(2): 317-341

Mitra A, Varoudakis A, Véganzonès-Varoudakis M.A (2002). Productivity and Technical Efficiency in Indian States' Manufacturing: The Role of Infrastructure. *Economic Development and Cultural Change*, Vol. 50, No. 2 (January 2002), pp. 395-426

Olley, G.S and Pakes ,A.(1996)- The dynamics of productivity in the telecommunications equipment industry , *Econometrica,*64(6) 263-297

Prabir De B G (1998). Role of infrastructure in regional development: A Study over the Plan Period. *Economic & Political Weekly*, Nov 21, 1998.

Ramachandran R, Reddy K, Sasidharan S (2020). Agglomeration and Productivity: Evidence from Indian Manufacturing. *Studies in Microeconomics*, 8(1)75–94.

Ramaswamy, K.V. (2019), Where Have All the Factories Gone? : Growth and Concentration of Sub-National Manufacturing Activity in India*, Indira Gandhi Institute of Development Research, Mumbai*.

Timilsina G.R, Sahoo P, Dash R K (2022). Why Do Indian States Differ in Their Infrastructure Development? *Policy Research Working Paper 10086, Development Research Group.*

Appendix

Table A1 : Year 2008- Estimated TFP of manufacturing industries by State

States/NIC	151	152	181	191	192	202	210	221	222	231	241	243	251	261	271	272	273	281	291	293	WA STATE TFP	CV
Andhra Pradesh			0.23	2.71		-0.64	-1.96	2.65	0.34	-0.12	1.78		-1.96	1.58		0.91	0.33	0.31		1.42	0.36	2.10
Bihar						-0.62			1.73		1.31		-0.03					0.32			1.49	0.93
Chhattisgarh					2.17	-0.71			-0.04				-0.14					0.10			-0.13	1.21
Gujarat			0.30	3.56			-2.07	2.21	0.34			0.79	0.09				0.16	0.36		1.24	-0.15	2.16
Haryana	0.83	1.07				0.26			0.21		0.90						0.20	0.59	1.56		1.10	0.23
Himachal Pradesh									0.92		1.67			1.18		0.76	0.90	0.47	0.46	1.02	1.06	0.15
Jharkhand					3.04			1.50	0.03				-0.05				0.22		0.60		0.91	1.43
Karnataka				2.08		-0.36	-1.81	1.98	0.81					1.38			0.66	0.07	1.68	1.52	0.18	1.48
Kerala		1.07	0.63			-0.04	-1.59	2.33	0.49									0.48			1.23	1.39
Madhya Pradesh			-0.52		3.16	-0.20	-1.36		0.94						-0.31		-0.18	0.28	1.23		-0.23	1.71
Maharashtra			0.52	2.65			-1.94	2.20	0.56	0.16	1.74	0.78		1.24			0.51	0.43	1.54	1.68	0.63	1.32
Odisha						-0.51			0.39		1.85										1.84	1.41
Punjab						-0.31	-1.27	1.76	0.20	-0.08	1.70							0.04	1.05	1.38	0.53	1.06
Rajasthan						-0.33	-2.01	2.39	0.58					1.31			0.52	0.04	1.43	1.51	0.87	1.65
Tamil Nadu	0.78	0.78			3.38	-1.36	-2.05	2.05	0.01		1.39		-0.22	0.91				0.43	1.52		0.58	2.13
Uttar Pradesh	0.93	1.21	0.08		3.90	-0.44			0.44	-0.26		0.93	-0.16	0.85		0.27		0.33	1.09	1.50	1.80	1.16
Uttaranchal		0.93	0.57				-1.61		0.71		1.62		0.01		-0.50		0.68	1.00			0.51	0.92
West Bengal	0.89	0.76	0.20	2.63		-0.45			0.15	0.09	1.74		-0.32			0.98		0.39		0.44	1.29	0.76
WA NIC	0.10	0.23	0.10	0.19	2.32	-0.42	-3.48	2.78	1.91	0.00	5.21	0.17	-0.12	0.37	-0.09	0.27	0.32	1.15	2.01	0.87		
CV	0.004	0.032	0.134	0.282	0.398	0.145	0.086	0.119	0.184	0.028	0.084	0.008	0.400	0.067	0.017	0.102	0.100	0.058	0.175	0.140		

Table A2 : Year 2019- Estimated TFP of manufacturing industries by State

States/NIC	151	152	181	191	192	202	210	221	222	231	241	243	251	261	271	272	273	281	291	293	WA STATE TFP	CV
Andhra Pradesh			-0.12	2.89		-0.17	-2.12		0.66	-0.10	1.38		-0.2			1.06	0.82	-0.04		0.59	-0.75	1.42
Bihar						-0.18			0.69		1.53		-0.2					0.12			0.84	0.54
Chhattisgarh						-0.76			0.65				-0.2					0.63			0.02	0.49
Gujarat			0.55	3.15			-2.16	2.28	0.59			1.00	0.06				0.76	0.46		1.33	-0.37	1.95
Haryana	1.10	1.20				-0.03			0.77		1.75						0.41	0.61	1.93		1.31	0.44
Himachal Pradesh									0.69		1.31		0.09	0.96		0.87	0.65	0.72		1.62	0.86	0.21
Jharkhand					3.71			1.52	0.77				-0.0								3.29	2.65
Karnataka				1.94		0.08	-1.81	2.18	0.70					1.46			0.45	0.62	1.54	1.73	0.31	1.38
Kerala		1.31	0.77			-0.02	-1.54	2.37	0.72									0.50			0.94	1.44
Madhya Pradesh			0.36		3.11	-0.09	-1.74		0.63						-0.3		0.61	0.46	1.30		0.36	1.69
Maharashtra			0.55	2.62			-1.93	2.45	0.78	0.19	1.73	0.87		1.40			0.52	0.48	1.48	1.81	0.57	1.36
Odisha						-0.21			0.54		1.63										1.61	0.86
Punjab						-0.41	-1.81	2.09	0.70	0.35	1.63							0.22	1.01	1.58	0.69	1.43
Rajasthan					3.12	-0.13	-1.45	2.36	0.62					0.79			0.60	0.30	1.32	1.54	0.75	1.64
Tamil Nadu	1.08	1.45			2.90	-0.96	-1.74	2.42	-1.84		1.80		-0.1					0.43	1.62		0.88	2.64
Uttar Pradesh	0.92	1.29	0.38			-0.37			0.58	-0.11		0.81	0.01	1.09				0.39	0.89	1.62	0.61	0.35
Uttaranchal		1.09	0.43				-1.98		0.62				0.11		-0.2		0.52	0.77			-0.49	0.91
West Bengal	1.00	0.79	0.19	3.31		0.03			0.45	0.34	1.69		-0.3			1.09		0.41		1.32	1.19	0.93
WA NIC	0.17	0.49	0.21	0.13	3.72	-0.30	-4.76	1.85	1.38	0.00	4.44	0.14	-0.1	0.15	-0.0	0.36	0.36	0.92	1.82	1.78		
CV	0.15	0.11	0.07	1.40	0.14	0.09	0.83	0.09	0.37	0.04	0.83	0.15	0.03	0.23	0.02	0.11	0.02	0.06	0.12	0.13		

Figure A1: Correlation between LP and TFP.

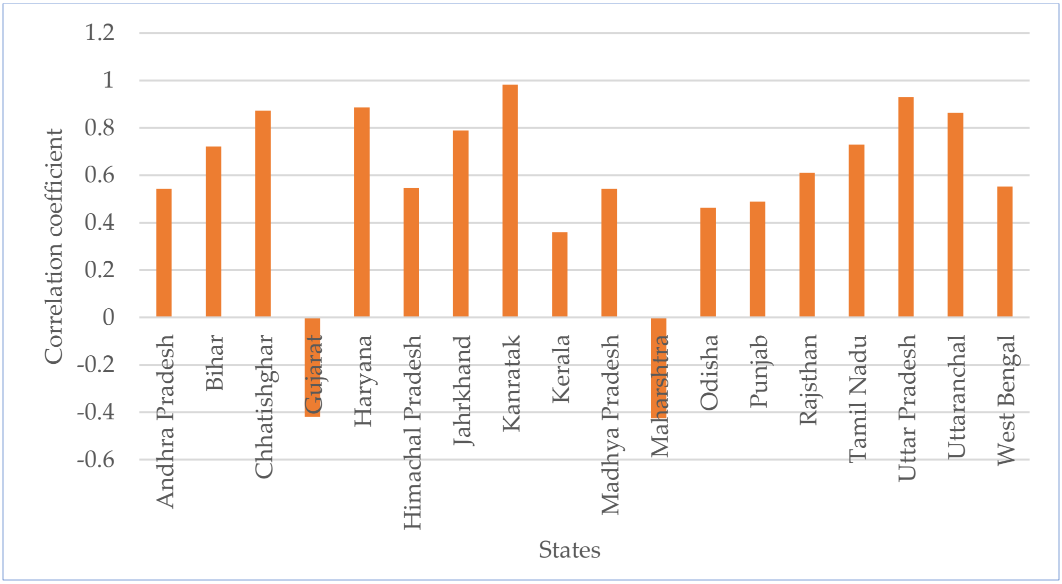
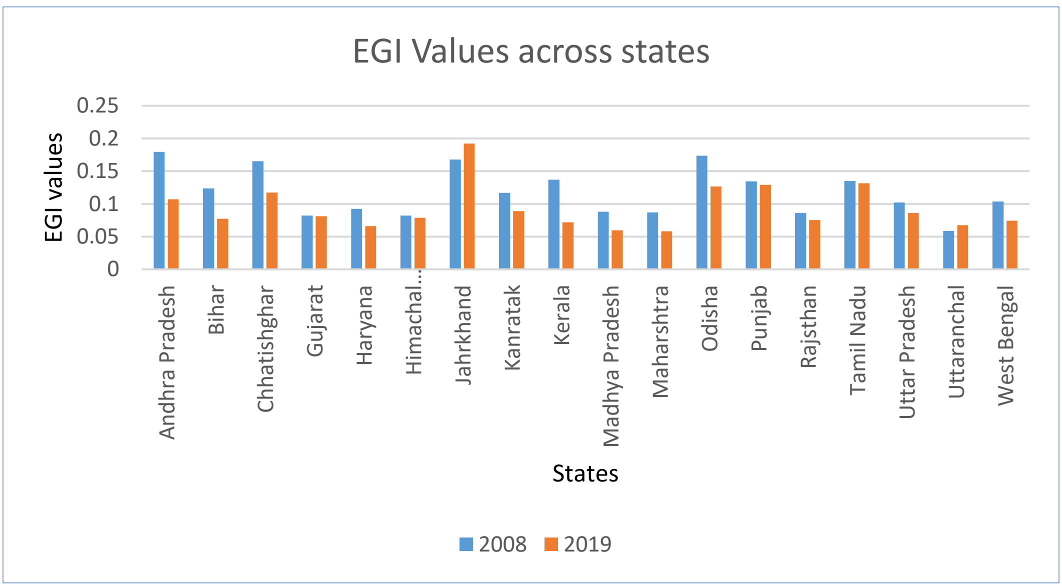


Figure A2: State EGI for 2008 and 2019.



List of ISID Working Papers

267 FDI, International Trade and Global Value Chains (GVCs): Trends and Patterns in India's GVC Participation, *Isha Chawla & Nagesh Kumar*, March 2023

266 R&D behaviour of Indian Firms: A Case of High-tech Manufacturing, *K Seenaiah*, March 2023

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

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

* Most of the working papers are downloadable from the institute's website: 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)
Policy Research to Foster India's Industrial Transformation
4 Vasant Kunj Institutional Area, New Delhi - 110070, India
Phone: +91 11 3510 4511 | E-mail: info@isid.org.in | Website: https://isid.org.in