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Employment Distribution in Textile Industry of India: A Spatial Econometric Approach

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Abstract
This study uses a modified version of Ellison and Glaeser (EG) index to observe the agglomeration pattern of Indian textile industry. Firstly, the locational distribution of textile industry in terms of industrial employment is observed for the year 2001 and 2022 using ASI factory level data. Secondly, the modified EG-index is calculated using econometric and statistical methods to analyse the degree of natural advantage and spillover affecting the location decisions of textile firms leading to spatial convergence or divergence. Finally, a spatial panel is estimated using the concept of spatial econometrics to determine the factors affecting the location decision of the firms. This study observes that states of Gujarat, Tamil Nadu, Punjab, Haryana and Maharashtra have agglomeration of textile industry. West Bengal has industrial concentration of jute while, Delhi and Karnataka have industrial concentration of apparel. The location decision of these industries is guided by cost of production and availability of labor. There exists a negative spatial auto correlation for cotton and apparel leading to regional divergence and formation of a core-periphery structure. A positive spatial auto-correlation is observed for jute industry implying a regional convergence and non-formation of core-periphery structure.

Keywords: Textile manufacturing, Neighboring effect, spatial distribution, India

1. Introduction:

This paper analyzes the locational choice of textile industry using panel data from Annual Survey of Industries (ASI) in India by applying spatial regression model. Locational choice is analysed in the framework of agglomeration, the spatial concentration of factory units in a certain area[1]. In this paper, we refer agglomeration as the spatial concentration of factory units producing textiles products or other interconnected producing units in a certain area. Textile industry has occupied an important place in Indian industrial system especially, the cotton industry. In India, it is the second largest employment provider absorbing more than 13 million weavers in the handloom sector. Cotton textile industry of India is one of the largest in the world due to abundant availability of raw materials. India is the largest jute producer in the world and second chief producer of silk and cotton. Jute and cotton textile industries in India had experienced significant changes in terms of location of factory units and pattern of investment over time since its inception (Bagchi (1975)).

[1] A spatial concentration (industrial agglomeration) of firms constitutes an agglomeration where the motivations for, and/or results of, being spatially concentrated are that individual units of activity are in some sense better off than they would have been if they were located in an industrially isolated setting (Jacobson et al., 2002).

In India, most of the composite mills of cotton textiles were located in Gujarat and Maharashtra, but, a significant structural change towards power looms have shifted the cluster to several parts of Southern India, Ludhiana, Delhi, Solapur and Jaipur. Factors like availability of raw material, labor, energy sources, transport facilities[2] and market potential plays an important role in the location decision of the textile industry. Areas of large-scale cotton production has emerged as important centers like Ahmedabad, Solapur, Nagpur, Coimbatore and Indore, while Mumbai is not far away from cotton producing areas of Maharashtra and Gujarat. West Bengal, Bihar, Orissa, Uttar Pradesh and Kerala do not grow cotton yet, big centers of cotton textile have flourished due to existence of vast potential markets. The labour cost and hydroelectricity development played a crucial role in establishing this industry in Madurai, Coimbatore and Tirunelveli. This industry also reached places with additional advantage[3]. Thus, although in early stages of industrialization the cotton textile industry was concentrated in Mumbai, it witnessed a great spatial spread during its journey.

The main focus of this study is to examine whether the states are agglomerated or industrially concentrated. It analyses regional divergence by considering natural advantage and spillovers, and analyses the factors leading to such divergence. The empirical work of this study is based on the clustering theories and agglomeration theories focusing on the geographical proximity. In this framework, the location decision of an individual firm is guided by the geographical distribution of the other closely related firms. We use spatial econometric technique to analyze the location decision by considering the "neighborhood set" which is defined as the set of those locations that potentially interact with a particular location. This method suggests the importance of neighboring state characteristics along with operating state characteristics in the location decision of the industries. A modified Ellison and Glaeser (1997) index is proposed in this study by introducing the concept of density to analyze the distributional behavior of factory units separately for cotton, jute, man-made fibers, apparel industry and other textiles. The industrial mass distribution of textile industry is analysed across major states of India in 2001 and 2022 by using ASI data.

Some studies put forward theories on agglomeration of industries and the difference between developed and developing countries based on this agglomeration. Heanue (2008), Ahlström (2012), Kathuria & George (2005), Kathuria (2016), Jana & Adhikary (2016) and others have observed the agglomeration pattern of manufacturing industries in different countries. Chand (2005) and Chandra (2006) explained the importance of various Indian state in regard to textile industry and the factors leading to its high importance. The existing literature focuses mostly on the agglomeration of manufacturing industries but this study will specifically focus on India's textile industry. This study contributes to the literature on agglomeration by analysing the pattern of distribution, locational shifts and important factors determining location of textile industry. It provides a detailed picture of spatial distribution of the textile sector at a micro level for a period of 22 years. It is followed by the determinants of this spatial distribution incorporating the effect of neighboring regions characteristics along with that of operating region's.

The rest of the article is organised as follows. Section 2 explains the methodology used in this study. Section 3 is the description of data and construction of relevant variables used in empirical works. Section 4 deals with empirical findings and interpretation of estimating results. Section 5 summaries and concludes.

[2] Transport cost is not much different for raw cotton and finished goods as their weight is almost similar, making location decision a function of availability of favorable transport facilities towards market making it a market-oriented industry.

[3] Nagpur for nearness to coal, Kanpur for financial facilities and Kolkata for port facilities.

2. Methodology

To understand the nature of concentration of textile industries, we measure agglomeration by modifying the methodology developed in Ellison and Glaeser (EG) (1997). In this methodology, agglomeration is the combined effect of natural advantage and industry spillovers. By using random utility maximisation model of location, they developed an index that accounts for the amount of spatial concentration of an industry. The simple model explains the geographic concentration of an industry as a result of location decision made by the profit maximising industrial plants. Some locations are blessed with natural advantage and the industry-specific spillover leads to clustering of firms while the idiosyncratic plant specific factors counterbalance the clustering force and resist against the concentration at a single point.
Ellison and Glaeser has formulated the index as:

$$\gamma_i = \frac{\sum_{i=1}^{N}(s_i - x_i)^2 - (1-\sum_{i=1}^{N} x_i^2)\sum_{k=1}^{M} z_k^2}{(1-\sum_{i=1}^{N} x_i^2)(1-\sum_{k=1}^{M} z_k^2)} \qquad (1)$$

The γ measures the strength of agglomerative forces in the model. The EG-index has various advantages which includes it an unbiased estimate of agglomerative forces independent of the source of such forces. This estimate is interpreted, as the probability that a firm choosing its location follows the prior firm rather than locating randomly. The EG index is comparable across industries with varying firm in size distributions and controls for overall agglomeration trends. It measures the tendency of one industry to agglomerate in relation to the general tendency of all industries to agglomerate. It accounts for the inherent discreteness that will be observed if location decisions are driven by the chance factor alone (Devereux, Griffith, and Simpson 2004).
The EG index is constructed at the sector level so the index varies across industry or state. Kathuria (2016) in a study calculated this agglomeration index of an industry i in a state j by multiplying the share of particular industry i in state j (w_{ij}) with the EG index of agglomeration of industry i. The share of particular industry is multiplied by the agglomeration index because it is assumed as a conditional probability which suggests that given the share of the industry in a state what is the probability that the location selection was random or due to natural advantage and spillover. Hence, the index is formulated as:

$$\gamma_{ij} = \gamma_i * w_{ij} \qquad (2)$$

However, the EG index and the modification suggested by Kathuria (2016) unable to capture the geographic size differences that affects agglomeration pattern[4]. This problem was recognised by Franceschi & Pelloni (2009) and they calculated regional industrial mass as an index of industrial agglomeration. The authors used the simple concept from physics to calculate Regional Industrial Mass (RIM) in an area as a product of Regional Industrial Volume (RIV) and Regional Industrial Density (RID) of the same area.

$$RIM_j = RIV_j * RID_j \qquad (3)$$

Franceschi & Pelloni (2009) suggested another index known as Index of Regional Industrial Concentration (IRIC) which is similar to the concept of weight which can be formulated as:

$$IRIC_{i,j} = \frac{RIC_{i,j}}{RIC_i} = \frac{RID_{i,j} * RIV_{i,j}}{RID_i * RIV_i} \qquad (4)$$

[4] If the employment in 100 sq.km and 500 sq.km is 10,000 workers then EG index and Kathuria (2016) will reveal equal natural advantage and spillovers, but, according to density the small area will be more agglomerated generating greater natural advantages and spillovers.

The $RIC_{i,j}$[5] is divided by the RIC of i[th] industry in overall nation to obtain the IRIC. Though these measures reduce potential bias by considering both volume and density, this measure also have disadvantages[6]. This paper aims to capture the variation of each industry across the states so an agglomeration index is constructed for an industry in a state. This paper incorporates the concept of density into EG index and then multiply it with the $IRIC_{i,j}$ instead of weight as in (2):

$$\gamma_{density\ ij} = \gamma_{density\ i} * IRIC_{ij} \qquad (5)$$

The index value ranges from -∞ to +∞ because the density of a state might be greater than the overall Indian density.

If the concept of density is incorporated into EG index, then natural advantage and spillover per unit area will be observed. States having higher IRIC for industries and higher EG index per unit area will have higher natural advantage and spillovers. However, some small states might have very high EG index values implying that a particular industry is very densely located in that state. The above discussed methodology of EG index will be considered after normalising by the size of the area.

The EG index analyzes the location decision of an industry based on natural advantage and spillovers. In order to observe the factors which affect the location decision of the textile divisions in a particular state, a fixed effect spatial panel regression is estimated. The regions might be correlated in terms of characteristics hence, the location decision in a particular region is not only the function of own region characteristics but also a function of neighboring region characteristics. For example, the employment-unemployment pattern in a region affects the location decision of an industry in that particular region, but high availability of unemployed workers in neighboring region might positively affect the location decision because in-migration of huge unemployed workers from neighboring region might reduce the wage rate and the cost of production. However, the high unemployment rate in neighboring might also affect location decision negatively because high unemployment rate leads to increase in crimes like theft. The in-migration is a more common phenomenon between the neighboring regions because the workers feel closer to home, hence the characteristics of immediate neighbor is more important than distant neighbor in deciding the operating location. The neighboring region can affect the dependent variable (y) in a region through three ways which includes: it might be related to the dependent variable of the neighboring region(y_j), it might be related to the independent variables (X_js) in neighboring region and it might be related to the residual (ϵ) of the neighboring region. The last relation is regarded as spatial heteroscedasticity where the unexplained factors affecting the dependent variable in a particular region is similar to the unexplained factors affecting the dependent variable in the neighboring region. The difference between the panel data and spatial panel data is that the panel data is unidimensional where the time component varies only one way that is the lag values of a state effect the present of the same state but in case of spatial panel data the ordering is two – dimensional. This means that region k is a neighbor of region j affecting region j's dependent variable and also region j is a neighbor of region k affecting region k' s dependent variable. Unlike the panel data where y_{jt-1} can affect y_{jt}but the reverse is not possible. The spatial panel regression is estimated if the following form which is known as Manski model:

$$y_{jt} = \rho W_{jkt} y_{kt} + X_{jt}\beta + W_{jkt} X_{kt}\theta + u_{jkt} \qquad (6)$$

The error term u can be rewritten as:

[5] Regional Industrial Concentration which is formulated as: $RIC_{i,j} = RID_{i,j} * RIV_{i,j}$. The density here, is the volume of i[th] industry in j[th] state divided by the area of j[th] state.

[6] It is heuristic and does not calculate natural advantages and spillovers of geographical areas.

$$u_{jkt} = \eth W_{jkt} u_{kt} + \epsilon_{jt} \quad (7)$$

In equation (6) y is the dependent variable of region j which depends on the dependent variable of region k (y_k), the independent variables of region j (X_j), the independent variables of region k (X_k) and the error term which includes both region j error and region k error (spatial heteroscedasticity). The independent variable includes IRIC of output, IRIC of emolument, IRIC of profit, IRIC of net income and IRIC of gross closing value of plant and machinery. The dependent variable is the modified EG index of employment. The spatial weight matrix, W, measures the effect of the neighbors and since spatial panel is two – dimensional ordering the choice of spatial weight matrix is very crucial step of this regression as it helps in determining the neighbors.

The spatial weight matrix is positive and symmetric which expresses for each observation (row) those locations (column) that belongs to it neighborhood set as a non-zero element. The diagonal elements of the matrix are always zero implying that the distance of a region from itself is 0. There are various methods of forming the spatial weight matrix which includes the contiguity method, row standardized method, inverse distance method, distance decaying method and economic distance. In the contiguity method the regions are regarded as neighbors if they share same boundary. The matrix value becomes 1 if regions share same boundary and 0 elsewhere. In the row standardized method, the summation of the row from the contiguity matrix is calculated and then each element of the row is divided by that sum. In inverse distance matrix the inverse of the distance between each region is considered so that the effect of nearer regions is strong and that of distant regions are weak. The decaying distance method considers a parameter which decays the impact as the distance increases and the economic distance multiplies the value of an economic indicator with the physical distance. This method calculates the magnitude of economic distance and it is important because the physical distance between two states might be equal but the weight will dependent on the economic factors. In this study the spatial panel equation of the form (6) is estimated and the W matrix is calculated by inverse distance method. The inverse distance matrix is considered because it considers both the regions with same boundary and the regions not sharing same boundary but are very close as neighbors.

3. Data and construction of Variables

We construct panel data using factory level survey data from ASI, the principal source of industrial statistics in India provided by the Central Statistical Office (CSO). To analyze the changing distribution, the importance of particular state and the detailed locational pattern an ASI panel using ASI survey data from year 2001 to 2022 for textile and apparel industry is constructed.

The Dispatch Serial Number is the cross-section identification number of factory units which is used for combining information from different blocks for each year. The industry group at 5 digits National Industrial Classification is considered. It has changed twice during this period, once in 2004 and another in 2008. Only the textile and apparel industry which has 2-digit NIC codes of 13 and 14 respectively in 2008 is considered. State code is used to identify the location of factory units. The currently operating factory units are only considered. Labor input is calculated by summing the manufacturing man-days for male and female regular workers, contractual workers, supervisory workers and unpaid family workers. The total output is calculated according to ASI definition.

4. Empirical Findings

4.1 Locational shift of Indian textile industry

The textile industry has been facing various challenges after the colonialization of Europeans in India. One of the most important manufacturers of textile became a mere supplier of raw materials to the Europeans due to mechanization in Europe and the invention of chemical dyes which reduced time and cost. This study focuses on the present distribution of the industry. The textile industry is divided into five sub-sections namely, cotton, jute, man-made fibre (MMF), apparel and other textiles.

We have calculated the Index of Regional Industrial Mass (IRIM)[7] and plotted as shown in Figures 1 and 2 displaying the locational distribution of textile industry in 2001 and 2022 respectively.

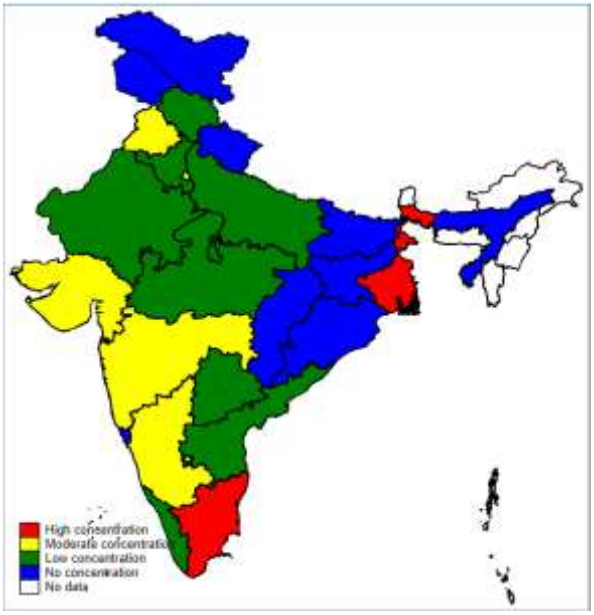

Figure 1: Index of Regional Industrial Mass in 2001

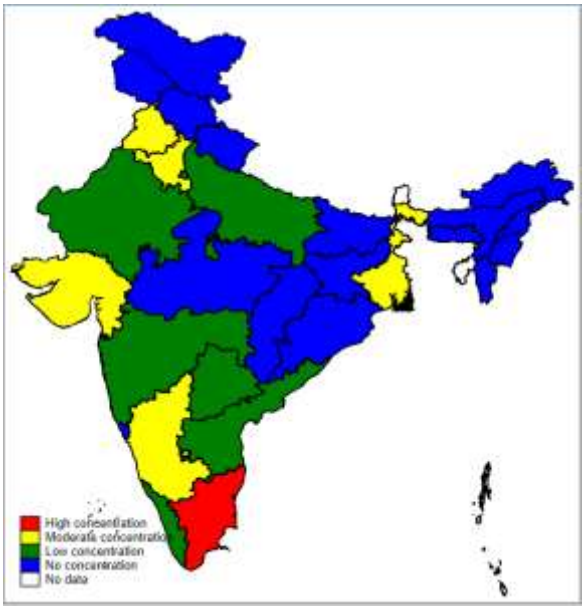

Figure 2: Index of Regional Industrial Mass in 2022

[7] Franceschi & Pelloni (2009) has measured it as: $IRIM_j = \frac{RIM_j}{RIM} = \frac{RID_j}{RID} * \frac{RIV_j}{RIV}$

The IRIM calculates proportion of the density of industrial employment of the industries located in each state with respect to the density of overall India. Since, IRIM is a density measure, the industrial mass will be higher if employment per sq.km of a state is high. Graph 1 suggests that Tamil Nadu and West Bengal had high industrial mass in 2001 implying their importance to overall India's textile employment. While, Punjab, Delhi, Gujarat, Maharashtra and Karnataka was observed to have moderate employment concentration in 2001. Graph 2 suggests that in 2022, West Bengal no longer contributes to high employment concentration, but, Tamil Nadu continues to hold the high concentration. This graph shows a decline in the mass of Delhi, Maharashtra, Madhya Pradesh and Himachal Pradesh while, only Haryana experienced an improvement. This implies a huge reduction of employment concentration during the 22 years in Indian textile industry. 20th century marks the beginning of mechanization and movement towards power loom which is cost and time efficient reducing the employment opportunities in one of the most labour intensive industry of India.

Significant employment growth Haryana is due to structural, economic and policy-driven changes. The state has transformed from a primarily agrarian economy to an important manufacturing and export hub especially of textiles. The major advantage of Haryana is the location and the proximity which expanded textile clusters in Gurugram, Faridabad, Panchkula and Sonipat. The textile policies in Haryana offers capital subsidies, interest subsidies, power tariff concessions, employee provident fund reimbursement for new workers, support for technology upgradation along with skill development programs which started in 2005 and was updated in 2019 and 2020. Haryana has also invested heavily in infrastructural growth which led to formation of clusters like Udyog Vihar (Gurugram), Faridabad Industrial Area, Barhi Industrial Estate (Sonipat) and Panipat (famous for home textiles). The lower cost of living compared to Delhi has led to a migration of labor to the peripheral cities of Haryana like Faridabad, Sonipat and Panipat.

The formal textile industry in India started in Bombay and Maharashtra is still a significant producer in power looms (Bhiwandi, Malegaon) but the dominance in employment generation has declined due to economic forces and spatial reallocation. Higher factor cost, rigid labor laws, the Great Bombay Textile Strike of 1982 and mechanization initiated the decline when thousands of stable mill jobs disappeared. This decline further aggravated presently when textile employment in more attracted towards Gujarat, Tamil Nadu and Haryana. Earlier 20th century witnessed the gradual mechanization when the movement towards power-loom fail to compete with the growing centres of Coimbatore in Tamil Nadu. The initial higher cost of production led to a gradual reduction in employment concentration as the firms move out to comparatively low wage neighbouring state of Gujarat. Apparently, employment concentration remained moderate in Gujarat but, IRIM value has increased implying creation of more job opportunities. Gujarat was historically important textile hub but, recently the job opportunities have increased due to rising demand of Gujarat hand-work.

The decline of West Bengal is the result of historical, political, economic and structural shifts. West Bengal was well-known for jute industry which was the largest formal employers. A significant decline in jute industry led to decline in employment concentration. Various jute mills including Birla Jute Mill Manufacturing Co., Victoria Jute Mill, Caledonian Jute Mill, Budge Budge jute mills were either closed down or relocated to Andhra Pradesh, Madhya Pradesh, Gujarat or recently to Bihar. The decline was primarily due to outdated machinery, low productivity, lack of modernization and poor management. West Bengal still have a strong handloom and traditional weaving sectors especially in the rural areas, but these

are largely informal, low-wage and experiencing slow growth. The industrial mass of employment in West Bengal declined mainly due to the inability to mechanize and move towards power looms.

The modified EG index is calculated for years 2001 and 2022 in order to observe the changes in the natural advantage and spillover in various states of India. The top 5 concentrated states in each division of textile industry for 2001 and 2022 are shown in Table 1.

Table 1: Position of States comparing the modified EG indices in 2001 & 2022

Position of State	Index	Cotton	Jute	Man-Made Fibre	Apparel	Other Textiles
1st	2001	Tamil Nadu (1.96)	West Bengal (0.99)	Dadra & N. Haveli (8.82)	Delhi (4.02)	Punjab (-0.009)
	2022	Tamil Nadu (0.81)	West Bengal (33.4)	Dadra & N. Haveli (2.54)	Tamil Nadu (0.59)	Dadra & N. Haveli (-0.36)
2nd	2001	Puducherry (0.96)	Dadra & N. Haveli (0.005)	Gujarat (1.15)	Karnataka (1.01)	Delhi (-0.005)
	2022	Punjab (0.11)	Kerala (0.30)	Gujarat (0.28)	Karnataka (0.20)	Haryana (-0.07)
3rd	2001	Maharashtra (0.14)	Andhra Pradesh (0.0048)	Rajasthan (0.29)	Tamil Nadu (0.72)	Dadra & N. Haveli (-0.004)
	2022	Gujarat (0.06)	Tamil Nadu (0.0083)	Punjab (0.01)	Dadra & N. Haveli (0.079)	Tamil Nadu (-0.05)
4th	2001	Punjab (0.10)	Kerala (0.004)	Maharashtra (0.10)	Haryana (0.19)	Tamil Nadu (-0.0015)
	2022	Haryana (0.04)	Bihar (0.0081)	Rajasthan (0.007)	Haryana (0.078)	Gujarat (-0.03)
5th	2001	Gujarat (0.03)	Punjab (0.003)	Punjab (0.07)	Dadra & N. Haveli (0.10)	Maharashtra (-0.0013)
	2022	Maharashtra (0.036)	Andhra Pradesh (0.0079)	Tamil Nadu (0.0066)	Delhi (0.05)	Punjab (-0.02)

Source: Author's estimation based on ASI (2001 and 2022) unit level data

Table 1 observes the modified EG index values of employment for each division for the years 2001 and 2022. Cotton is widely cultivated in India and the major cotton producing areas are Andhra Pradesh, Haryana, Punjab, Tamil Nadu, Gujarat, Karnataka, Rajasthan, Madhya Pradesh and Maharashtra. Tamil Nadu is observed to have highest concentration of employment in cotton textile in both the years. Initially, due to higher cost of production in Tamil Nadu, cotton textiles finds it profitable to locate in neighboring state of Puducherry where the cost of production is lower. However, in 2022 with the infrastructural

improvement the industry gets concentration in Punjab which is a source of raw material. The cotton industry shifted from Maharashtra to Gujarat. In 2001 there was a concentration in Maharashtra because Bombay was the primary seat of cotton textiles but in 2022 Maharashtra's importance fell due to various reasons. Gujarat offered a more favorable environment which led to a shift of cotton textiles towards Gujarat. The importance of Haryana also rose in 2022. Availability of raw materials, well-established market demand and a historic experience are the important factors driving the location decision of cotton textiles.

Jute is mainly cultivated in rich alluvial soil which is found in the Ganga-Brahmaputra delta located in eastern region of India. The major jute producing areas include West Bengal, Assam, Bihar, Orissa and Andhra Pradesh. West Bengal has a substantial concentration of jute industry. The importance of jute industry in West Bengal rose during this period, index values implies that almost the entire production shifted to West Bengal. The index value is high because West Bengal provides the best natural advantage and spillovers to the employees in this division. The index value in Kerala also rose slightly. Some states having slight concentration in 2001 becomes irrelevant in 2022 due to closure resulting from decline in demand and competition from substitutes. The National Jute Board has launched a skill development program in Kerala leading to an increased demand and production of eco-friendly jute bags. The Indian Jute Industries Research Association (IJIRA) was established for promoting Indian jute in global and domestic market in 1937. IJIRA has its headquarters in Kolkata (West Bengal) and regional centres at Cherthala (Kerala), Vizianagram (Andhra Pradesh), and Guwahati (Assam). Hence, there is a slight concentration of the industry in these regions. The importance of Bihar has rose in 2022. The availability of raw materials, historic experience and market demand guides the location decision of jute industry.

The man-made fibre division is observed to be concentrated in Gujarat, Rajasthan and Punjab. The importance of Dadra & N. Haveli is due to high investment in textile industry. The top five industrial sectors in Dadra & N. Haveli includes textiles (18%), plastic (28%), paper (10%), chemical materials (7%) and metal based units (6%). The importance of the industry fell in Rajasthan and Maharashtra but rose in Punjab and Tamil Nadu. The industry do not require any suitable climatic condition, however, this concentration pattern reveals that the industry try to locate in or near states having agglomeration of textile industry. Gujarat and Tamil Nadu which are historically an important state for textile has high concentration. As the division is trying to substitute the traditional fibres mostly cotton, the location choice is determined by high market demand. As export and domestic demand is higher in these states they are one of the leading concentrated region with man-made fibre. The man-made fibre in India recently is trying to capture the global market and become the leading producer and supplier, hence locating near port is an important factor driving location decision. Maharashtra have two major ports while Tamil Nadu has 3 major ports and Indian Ocean have been the trade route of textile since 16th century so, the industry became more concentrated in Tamil Nadu in 2022. Gujarat continued to hold its position and Surat is regarded as the 'synthetic capital of India' as it contributes to 90% of India's polyester fabric production. Since, the demand for this fibre is increasing both domestically and internationally, hence, availability of market demand is factor in location choice reflected by the low index values.

The apparel industry is observed to have highest concentration in Delhi in 2001 but the concentration fell in 2022 because Delhi is not a producer of cotton or jute. Tamil Nadu have high concentration employment of apparel industry due to the availability of raw materials, global connections through ports and well-established the domestic market. Moreover, Tirupur is regarded as the 'knitwear capital of India' and recently accounts for almost 90% of India's knitwear (part of apparel industry). Karnataka is a leading

location of apparel industry though the index value fell during this period. The importance of Karnataka is mainly due to Bengaluru which is one of the important apparel hub accommodating various apparel brands and it is well connected to market and raw material producing areas through road and rails. The availability to human resource is also another reason for apparel industry getting concentrated in Karnataka. Gurgoan, Panipat, Bengaluru and Tirupur are the leading areas chosen by the employees of apparel industry. These areas are historically important for apparel industry and many leading apparel manufacturers are located in these areas.

The other textiles division have negative values implying that the location decision became more random than expected. This division includes various sectors like wool, silk, laces, zaris, waterproof textiles and others they all are not driven by same factors and hence, natural advantage and spillovers do not play an important role in the location decision.

The full table showing the modified EG index values for all states in 2001 and 2022 is given in the appendix. It is observed that cotton, man-made fibre and others textile have a lower value of the index for all states implying that employees in these divisions choose location independent of natural advantages and spillovers and these divisions can locate randomly. The value for the index is higher for some states in case of jute and apparel industry implying that natural advantages and spillovers affects the location decision of this industry and few states provides a more suitable location for these industries. The index value for man-made fibre is higher in few states in 2001, but, in 2022 the values fell implying a decreased importance of natural advantage and spillover in the location decision. It is further observed Haryana, Madhya Pradesh, Gujarat, Maharashtra, Kerala, Andhra Pradesh, West Bengal and Tamil Nadu have relatively higher value for all the division implying an industrial agglomerated. While, West Bengal has a concentration of jute and Karnataka has concentration of apparel.

Hence, the location decision of MMF and other textiles is not driven by the natural advantage and spillovers. However, the location decision of cotton is slightly driven by availability of raw materials, experience of manufacturers and market demand. The location decision of jute and apparel is driven by natural advantage and spillovers.

4.2. Analyzing locational choice: the spatial panel regression for each division of textile

The effect of neighboring states characteristics is observed as an explanatory factor for the locational choice of the industry. It explains how the states are correlated which each other and analyzes whether the clustering of firm in a location is due to heteroscedasticity or due to spatial autocorrelation. In other words, this section will observe how the similarity of the employment concentration from textile industry coincides with the locational similarity implying whether similar locational traits attract similar kind of textile divisions. This study analyzes whether locations have positive spatial auto correlation (high or low employment clustered among few closely related states) or negative autocorrelation (neighboring states having opposite level of employment). So, the spatial econometrics is followed from a renewed focus on spatial spillover, Marshallian externalities, copy-catting, and other forms of behavior where an economic actor reacts or mimics to the action of other actors. This section will focus on the importance of spatial dependence and spatial heterogeneity in explaining the location decision of various division of textile.

Table 2: Spatial Panel Regression considering EG index of employment as the dependent variable

Sectors	Cotton	Jute	Man-Made fibre	Apparel	Other textiles
Direct Effect:					

IRIC of Output	-0.005	4.81***	0.007***	-0.013	0.15***
IRIC of emolument	0.133***	-2.77**	-0.002	0.22***	-0.069***
IRIC of Profit	-0.0004**	-0.03	-0.00004***	0.002***	-0.0004
IRIC of net income	0.002	0.79	0.013***	-0.008	0.0008
IRIC of Plant and machinery gross closing value	-0.009	-2.63***	-0.01***	-0.014	-0.03***
Spillover Effect:					
EG index of output	0.008	0.33	0.004	-0.01	0.027
IRIC of emolument	0.33***	0.63	-0.05	0.057**	-0.041
IRIC of Profit	-0.0001	0.016	-1.62e-06	0.003**	0.001
IRIC of net income	-0.015**	-0.42	0.00004	-0.015	-0.003
IRIC of Plant and machinery gross closing value	-0.05***	-0.47	-0.0005	-0.05*	-0.018
Total Effect:					
EG index of output	0.003	5.14	0.01***	0.022	0.04**
IRIC of emolument	0.47***	-2.14	-0.049	0.27***	-0.11***
IRIC of Profit	-0.0005	-0.013	-0.00004***	0.004***	0.0008
IRIC of net income	-0.012**	0.37	0.013***	-0.023	-0.002
IRIC of Plant and machinery gross closing value	-0.059***	-3.10*	-0.01***	-0.065*	-0.048***
Spatial Autocorrelation	-2.04***	0.65***	-0.35	-1.27***	-0.11
Spatial Heteroscedasticity	1.38***	-1.08***	0.26	-0.84***	0.55***

Note: *** significant at less than 1 per cent level, ** significant at 5 per cent level, the rest are statistically insignificant

Source: As for Table 1

Table 2 shows the estimated coefficients of fixed effect spatial panel where the EG index of employment is the dependent variable. The EG index measures the location decision as a combined effect of natural advantage and spillovers in a particular location. In order to incorporate the size, the density is considered, the dependent variable and the independent variables are calculated based on density. The direct effect in the table implies the characteristics of state j affecting the location decision of a firm in state j, the spillover effect implies the neighboring state (i's) characteristics affecting the location decision of firm in state j and the total effect implies the overall effect on the location decision in state j. Spatial autocorrelation is the neighboring state EG index of employment and spatial heteroscedasticity is the neighboring state error term. The employment concentration in neighboring state also affect the location decision of a firm in state j and the neighboring state unobserved variables that is the error term also affect the location decision. Here, the location decision is based on the employment concentration (EG index) where a higher (lower) index value implies more (less) spillovers and natural advantages. Each division of the industry is considered individually to observe the factors which affect the location decision of various division of textile industry.

Cotton division is observed to be positively and significantly affected by concentration of emolument in own state. This implies that higher emolument attracts more employees to the region. It is negatively and significantly affected by profit this implies that if entrepreneurs receive higher profit implies the market is away from perfect competition, so there is entry barriers and fewer firms implies fewer employment opportunities. It is also observed that employment concentration is positively and significantly affected by emolument in neighboring states. This implies that if the neighboring region offers higher emolument then in order to stop migration to neighboring region, the particular region should also offer a higher pay. Employment is attracted and gets concentrated in an area having high emolument areas as neighbor. The net income and plant & machinery in neighboring state negatively and significantly affects employment concentration. This implies that if net income is higher in neighboring state the wages are also likely to be higher leading to an out migration reducing employment concentration in particular state. Plant & machineries represent capital so if neighboring region have more capital the firms will move towards those regions reducing employment concentration is a particular region. The employment concentration in the neighboring states affects the employment concentration negatively and significantly. This implies that if employment concentration is higher in neighboring state then more employment is attracted to those states reducing the concentration in a particular region. When neighboring states offer better job opportunities labors migrate to neighboring regions reducing the attraction and concentration in a particular region. This implies that a regional divergence is formed. The tropical climate of India provide wide availability of raw cotton which provokes producers to either locate in states having higher concentration or away from high concentrated regions. According to Krugman (1991) theory a regional divergence is formed due to low transport cost or strong economies of scale or higher share of manufacturing in total expenditure leading to concentration in few states. If employment is high in neighboring state, then a particular state is less attractive because firm gains more by either locating in the neighboring region (due to spillovers of technology and knowledge) or by locating in a far-away location (due to lower cost of production). The error/unobserved variable of neighboring state do significantly and positively affect the concentration of employment. This implies that unobserved factors like neighboring state infrastructure, political environment, cultural characteristics and type of government affect employment concentration positively. In Jute division the direct effect suggests a positively significant effect of output concentration and negatively significant effect of emoluments concentration and plant and machinery in own state. This implies that higher concentration of output attracts more employment because jute is a labor intensive and higher output implies more requirement of labor. Higher emoluments lead to exploitation of labor where workers are paid higher compared to other regions but the workload is even higher. In such a situation the demand for the labor will be less because 1 labor does the work of 2 labor but gets the wage of 1.5 labor. This will lead to a reduction in employment concentration. Higher value of plant and machinery implies more capital hence, regions having more capital are less attractive for employment, and higher investment in capital implies lower returns to employees. The employment concentration in neighboring region positively and significantly affect the employment concentration in a particular region. The core-periphery structure is not formed leading to a regional convergence. According to Krugman (1991) regional convergence occurs due to high transport cost, weak economies of scale or lower share manufacturing in total expenditure in the economy. Since jute required a specialized input (raw jute) which cannot be grown in all parts of India so, the industry is concentrated in the areas having higher raw jute production which is the eastern part of India. It is unlikely that a jute manufacture will defect this region to open a firm in Maharashtra because that will lead to a fall in profit of the defecting firm. The error/unobserved variable

of neighboring state do significantly and negatively affect employment concentration. This implies that higher spatial heteroscedasticity leads to lower employment distribution. If the characteristics of two neighboring states are opposite (one very rich and other very poor, one having high political stability and another having very low political stability) then the employment distribution will be lower in the particular state.

The MMF is observed to be significantly and positively affected by concentration of output and net income and negatively and significantly affected by concentration of profit and plant and machinery among own state characteristics. Higher output generates more job opportunities making the region attractive to the employees. If the net income earned is higher, then the region becomes attractive to other workers leading to in-migration in search of better job opportunities and higher standard of living. The higher concentration of profit distorts perfect competition generating entry barriers making the region less attractive. This implies that since MMF can be produced anywhere and does not require much specialized inputs, the labor input is exploited where they are paid a lower wage compared to their effort. The negative coefficient for concentration of plant and machinery implies that as MMF is a more mechanized industry, if the capital concentration is higher, the demand for labor will be lower leading to lower employment concentration. There is no significant spatial autocorrelation or spatial heteroscedasticity.

The apparel division is observed to be positively and significantly affected by own state emolument and profit. Neighboring state characteristics like concentration emolument and profit have positive significant effect. However, neighboring state concentration of plant and machinery negative significant effect. Higher return in the form of emolument attracts more labor as apparel requires specialized inputs and skills. The profit concentration implies that entrepreneurs are willing to provide a better working condition and more employee benefits, hence, states having higher concentration of profit are more attractive for the employees. Higher emolument in neighboring regions leads to increase employment concentration in a particular region because employees can bargain for higher emoluments. Higher profit concentration in neighboring state increases employment concentration. Higher capital concentration in neighboring states attracts employment from a particular region leading to out migration. The neighboring state employment concentration negatively and significantly affect employment concentration implying that if employment concentration is high in neighboring region then the returns and opportunities must be higher there compared to the particular region leading to higher concentration in neighboring region. The unobserved characteristics of neighboring state negatively and significantly affect the employment concentration implying that the unobserved characteristics of neighboring state makes a particular location less attractive for the employees reducing the concentration.

The other textile is observed to be positively and significantly affected by output concentration and negatively and significantly by emolument and plant and machinery concentration in own state. All other factors both own state specific and neighboring state specific do not have any significant effect. Since, this division includes various division like silk, wool, waterproof materials which are not produced in a single region and each division requires different specialized input. Higher output attracts more employment. Labor is exploited if they are offered a higher wage so, states offering higher wage is less attractive to the potential employees. If the particular state has more capital, then the demand for labor will be less. Spatial heteroscedasticity is positive and significant. Since, these divisions are not closely related, neighboring states do not reduce the employment concentration in a particular state, instead they gain by technological and knowledge spillovers.

Overall it is observed that spatial autocorrelation state plays an important role in location decision of potential employees for cotton, jute and apparel division of textile industry. The spatial heteroscedasticity also significantly affect the employment decisions in all division except MMF. The neighboring state characteristics do not play important role mostly for jute industry because it is concentrated in a particular region due to availability of raw materials and historical technical know-hows, other factors are not significant. The own state characteristics are important specially the concentration of output, emolument and net income.

5. Conclusion

The paper uses a modified version of Ellison and Gleaser index to observe the agglomeration of Indian textile industry. The overall change in the importance of various division of the industry during 2001-2022 is observed. It provides a glimpse of geographical distribution of textile industries in India at the beginning of 21st century (2001) and at 2022. Earlier evidences reveal the importance of Mumbai in Maharashtra for cotton textiles and West Bengal for jute textiles. The locational pattern of jute industry did not change drastically, though its importance fell while, the locational pattern of cotton textile experienced a huge change. The tropical climate of India provides suitable conditions for cotton production. Availability of raw materials combined with higher demand for cotton fabrics spread cotton textiles all over India. Tamil Nadu, Delhi and Karnataka have a concentration of apparel industry.

The spatial variation of textile industry suggests that Tamil Nadu remained the most agglomerated state. Gujarat, Punjab, Haryana, Maharashtra, West Bengal and Rajasthan continued to hold their moderate agglomeration. Though, the agglomeration in Gujarat is higher than that of West Bengal and Maharashtra. West Bengal have an industrial concentration of jute textiles but the production fell due to decline in demand in face of competition from MMF. Apparel experiences industrial concentrated in Karnataka and Delhi.

It is observed that the location decision of cotton, MMF and other textiles are not driven by natural advantages and spillovers. Though cotton have a higher concentration in major cotton producing states due to experience and a well-established market, MMF and other textiles chose location randomly by throwing dart on scaled map. The agglomerated locations were historically well known for these divisions suggesting the importance of historical experience and access to global and local demand in location decision along with availability of raw materials. Gujarat, Tamil Nadu, Punjab, Haryana, Uttar Pradesh, Madhya Pradesh and Maharashtra have a spatial concentration of textile manufacturing. The location decision is mostly guided by lower cost of production and technological and intellectual spillovers. The location choice of MMF and other textiles are purely random so neighboring state characteristics are mostly insignificant. However, jute experiences a positive spatial autocorrelation and a negative spatial heteroscedasticity, while, cotton and apparel experiences a negative spatial autocorrelation and a positive spatial heteroscedasticity.

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