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Spatial location of Industries – Factors influencing locational choice

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Abstract:

This study attempts to analyze the agglomeration of manufacturing firms for the Indian context using an agglomeration measure given by Ellison and Glaeser for 66 manufacturing industries in 21 major States. The analysis yields that the extractive industries like Iron and Steel and Cement, Lime and Plaster, are highly agglomerated and are found in those States where the raw material is in abundance. The analysis indicates that the agglomerated industries are mostly located in few States thereby pointing that the attempts made by the Government to disperse the industrial units have not been quite successful. Taking one step further, this study also looks at the reasons that could be attributed to this clustering. The econometric results indicate that the policy related factors that affect the agglomeration in the case of India's manufacturing Industries, are not alone, enough to create clusters. These along with other non-policy related factors having spillover potential also contribute to agglomeration.

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1. Introduction

The spatial location of industries has always been a matter of concern to policy makers all over the world. India is not different in this respect. Ever since the planning era, efforts have been made, by devising incentive policies to influence firm's location decisions. Location theory gives a theoretical framework for studying the location decisions made by firms and households based on transportation cost and spatial differences in the accessibility of inputs and markets for outputs.

In the past, the creation of wealth used to depend, to a large extent, on the local availability of natural resources and on physical assets (mainly equipment and finance). As the economy evolves, prosperity of the modern economy and competitiveness of output depends increasingly on intangible assets such as knowledge, information processing, as well as on organizational and control potentials and capabilities. In the current scenario, when a number of economic activities have become 'footloose' and highly mobile, an intricate question is where firms and industries would locate, re-locate or stay (Jovanovic, 2003)?

How do businesses decide where to locate? What makes one location more attractive to a firm, vis-à-vis another? The literature has identified a number of factors influencing these location decisions (see for example, Erdman, 1991; Murphy, 1989 among others). Krugman (1991) in an influential work has summarized five factors: a) Costs of production and marketing i.e. all transaction costs inclusive of transport costs, local wages, taxes, subsidies and incentives; b) Economies of scale; c) Activity-specific backward and forward linkages, proximity to buyers and sellers, and local amenities; d) Innovation and knowledge spillovers; and e) Unpredictable chance events and historical accidents.

Any location, having the optimum of all the above factors, would be the ideal one for a firm to locate. This process of 'agglomeration' (or cluster formation) concentrates many firms into industrial regions or zones. The phenomenon occurs because these firms realize monetary benefits from sharing specialized input factors. A large geographic concentration of similar firms can also provide scale economies in the production of shared inputs. Apart from this, the firms that utilize the same technologies are more likely to collaborate with one another to share information on the similar problems faced by them and ways to develop new technologies.[1] Thus we can say that clusters are a geographically concentrated and interdependent network of firms linked through buyer-supplier chains and/or shared factors (Lall and Chakravorty, 2003). This idea of a 'cluster' hinges on the inter-firm relations that lowers cost of production through the reduction of transaction costs faced by firms. Therefore, for profit maximizing firms, the presence of a well-developed network of similar firms in a region is an important factor for their location decisions. The success of this 'cluster' depends on how well the local linkages (business associations, education, research and development (R&D), etc.) among firms can be developed.

At the other end of the spectrum is 'industrial inertia'. As changes occur in the production process and suitability of particular raw materials shift,[2] the decline of locational advantages and transport infrastructure takes place; old industrial areas subside gradually over a very long period[3] and may regenerate with new footloose industry.

[1] Of late, the concept of IT park or bio-technology park exploits these very characteristics of agglomeration. For an evidence of the role of bio-technology park, refer Kathuria and Tewari (2005).

[2] The two interesting examples of these are substitution of Aluminum by copper in electrical installations and copper cable being replaced by fibre-optics in telecommunication.

[3] The decline of textile industry in Manchester (U.K.) and Ahmedabad (India) are classical examples of this.

This issue of agglomeration is particularly important for developing countries as they have relatively lower levels of overall investment and economic activity is concentrated in one or a few growth centers. The regions failing to attract dynamic industries are not only characterized by low productivity, but also by lower relative incomes and standards of living. In India, there is severe agglomeration of industries. Although, there have been several moves made to achieve spatial dispersal of industries through policy interventions such as incentives, taxes, subsidies, licenses etc,[4] the results have not been desired.[5] Growth biases continue to exist despite these policy incentives to locate.

Prior to Independence, industries were mostly located in and around port cities like Bombay, Calcutta or Chennai and to cities like Kanpur, Agra etc. to supply to British Army needs. After Independence, few centres of industries developed such as Baroda, Coimbatore, Bangalore, Pune, Hyderabad and Faridabad. These new centres grew in those States that already had established clusters i.e. Baroda grew out of the clustering in Bombay and Coimbatore out of Chennai etc. Thus, cluster formation at a number of places was an outcome of the existing clusters rather than a consequence of the infrastructural facilities, made available by the respective State Governments. The various efforts by different governments did not result in equi-proportional pay-offs in terms of the growth of under-developed or backward areas in different States. In fact, the backward States remained so and most of the growth continued to be imbalanced.[6]

Under this backdrop, two crucial questions arise. Why do these growth obscurities exist today, inspite of the massive emphasis given by the Government to overcome these? How significant are policy incentives in attracting firms? In this study we try to answer these questions.

The remaining paper is organized as follows; the literature review is given in the next section (Section 2). Section 3 discusses the methodology employed. In order to see whether clustering exist in Indian industry, one needs to find out a measure of agglomeration for the industry. The calculation of the agglomeration measure is the central objective of this paper. The measure can be used to identify local clusters of specific industry groups and examine the patterns of industrial clustering (i.e. which industries are clustered and in which States). The secondary objective of this study is to explain these patterns. This however, is undertaken on a more exploratory scale and is elaborated in Section 4, where an account of the data and variables are given, along with the issues encountered. The results are given in Section 5. Section 6 concludes, with the summary and policy implications of this study.

2. Literature Review

Location theory is developed with noted contributions from Weber, Thunen, Christaller, Isard among many others. The current literature is overwhelmed with a static view of region specific agglomerations.[7] This is because the analysis stems from case studies of existing agglomerations at one period. There is little investigation into how agglomerations dissolve over time. This leaves us with the shortcoming of not having a sound perspective of the dynamics of agglomeration over time (Wolter, 2003). With this fallback in mind we proceed with the existing literature at hand.

[4] Appendix A gives a synoptic view of these and other such policies formulated to achieve industrial dispersal.

[5] Given India's federal system, the politics at the Center and State level has also played a key role in industrial location. For an interesting overview of this in the case of fertilizer industry, kindly refer Erdman (1992).

[6] Source: Government of India, Ministry of Industry: Statement on Industrial Policy (1991).

[7] Two examples of region-specific agglomerations are the automobile manufacturers in Detroit and the Silicon Valley cluster in California.

There has been a growing literature both empirical as well as theoretical, to establish the causes of agglomeration as well as the effects of agglomeration on productivity of the industry. In that direction, recent contributions attempt to provide strong economic foundations for the plant location decision. Important studies include Ellison and Glaeser (henceforth E-G), (1997) and Maurel and Sedillot (1997). The E-G paper theoretically develops an agglomeration measure and applies this to the United States data. The paper attempts to find the relation of the measure with natural advantage and spillovers (agglomeration externalities).

There have been similar studies conducted for the United Kingdom (Devereux *et al.*, 2002) and France (Maurel and Sedillot, 1997). The latter, develops an index based on the E-G agglomeration measure. Their measure too attributes the location decision of plants, to the benefits accrued from natural advantage and/or spillovers generated by proximity of other plants in the industry.

Once a precise quantitative measure is developed for agglomeration, one can assess the relevance of different factors. Rosenthal and Strange (2001) econometrically estimate the determinants of agglomeration for the U.S. manufacturing industries using the E-G index as a measure of agglomeration. This study has been carried out at three levels; zipcode, county and State. The study finds that the labor market pooling[8] has the most robust effect at all three levels.

Aharonson, Baum and Feldman (2004) study the effects of the determinants of agglomeration for the Biotechnology industry in Canada. The study finds that R&D externalities increase as proximity increases, thereby influencing productivity positively.

The study by Dohse and Steude (2003) utilizes the 'dartboard' approach developed by Ellison and Glaeser to analyze the spatial concentration of 216 knowledge-based firms publicly listed in the German *Neuer Markt* (New Market) with other firms. The analysis shows that the *Neuer Markt* firms tend to be located in the existing agglomerations of the other firms, i.e. they tend to cluster in rich regions with high labor productivity and high density of economic activity.

For developing countries, such as India, there hardly exists any study looking into factors affecting agglomeration. One such study is by Resende and Wyllie (2003) for the Brazilian industrial situation. The study analyzes the effects of local infrastructure and local incentives. The study finds that the former has positive effects while the latter is insignificant in affecting location decision. Input utilization and knowledge spillovers appear to have positive impact on agglomeration.

In the Indian context, the only study that exists is by Lall and Chakravorty (2003). The study analyzes the agglomeration of the manufacturing industries in the metropolitan regions of Mumbai, Kolkata and Chennai. The results show that the theoretically expected spatial relationships are not supported by empirical evidence i.e., industries with same labor profiles and strong input-output relationships, do not necessarily co-locate. The study finds that intra-metropolitan location decisions are influenced by land market and State actions in the land market.

Limitations of existing work

The studies mentioned above are robust, however, there are avenues for further research. The role of the determinants of agglomeration such as local infrastructure and policies etc, in explaining this phenomenon is still not entirely clear. In any case, industrial agglomeration cannot be solely explained in

[8] Labour market pooling is a phenomenon where clusters of firms create a pooled market for workers with highly specialized skills that are required by these firms (Krugman, 1991). Such a market works to the advantage of producers (less labor shortages) as well as workers (less unemployment). However, such a labour market pooling may have a detrimental effect on the long-term employment, as attrition rate may be higher. This is being presently felt in the software industry in Banagalore, where units are shifting to smaller places like Chandigarh so as to stem this attrition.

terms of sector-level variables. The empirical literature has recognized that the latter class of variables has only partial explanatory power but the analysis was not taken forward in terms of the inclusion of additional explanatory factors.

The only study for India (Lall and Chakravorty, 2003) is in fact at a highly aggregated level (three-digit), when cluster formation is mainly at four-digit or even at five-digit level. Moreover, their study concentrates only on three cities. The clustering in India is not only at a much more disaggregated level, but also in different States. The present study takes care of all these limitations. There exists no study for India that is as extensive as this one, taking 21 States and 66 manufacturing industries at the four-digit level.[9]

3. Methodology

Using plant (factory) level data for the year 1997-98, from the Annual Survey of Industries (ASI), this paper investigates the locational choices of 66 manufacturing industries at the four-digit level.[10] The locational choice of these industries is studied in 21 States in the Indian sub-continent.[11] In order to find the locational choice the paper first calculates the degree of agglomeration in each of the industries and ascertains in which States they are clustered. This is followed by testing the significance of different factors affecting agglomeration. Thus, the primary objective requires compiling an agglomeration measure, whereas the secondary objective makes use of this measure and builds an econometric model, to find out what factors influence this agglomeration.

Computation of Agglomeration Measure – E-G Index

The Ellison-Glaeser index is used as the agglomeration measure.[12] It is a measure of the agglomeration in a region within one industry.[13] The measure takes into account, both the natural advantage gains (for example Tea industry requires a certain climate) and the spillover gains that accrue to a firm by locating near another firm (e.g., Chemical industry agglomeration in Gujarat due to backward and forward linkages).[14] This index is developed, by observing the increase or decrease in profits of the firms depending on the effect of agglomeration externality.[15] The calculation of this index requires the estimation of the Gini spatial coefficient (G) and the Herfindahl index (H) of concentration for each industry. In order to compute G and H, employment data for each industry in the different States is

[9] Another fallback of the recent contributions in this field is that all the studies are static in nature. There is little exploration into how clusters form and dissolve over a stretch of time. Rather than assessing the determinants of a cluster at one period in time, it might be more useful to understand the changes in the explaining power of the determinants of agglomeration from cluster to cluster, over a time period. Thus, the dynamics of agglomeration is an issue, which has not been adequately tapped as yet. Unfortunately, given the data constraint, the present study could not explore this aspect and hence suffers from the same limitation.

[10] Appendix B gives a list of these manufacturing industries at a two-digit level.

[11] The States and Union Territories selected are: Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal, Chandigarh, Damn & Diu, Delhi, and Pondicherry.

[12] The index proposed by Maurel and Sedillot is a minor variation of E-G Index. A brief comparison of the two is given in Appendix C.

[13] Ellison and Glaeser (1997) also provide an index for coagglomeration i.e., the agglomeration externalities that exist between industries.

[14] It must be noted that both papers that develop the measure, i.e. Ellison and Glaeser as well as Maurel and Sedillot, state that the natural advantage and spillovers effects cannot be identified separately as yet. Thus, there is scope for research in the area.

[15] For a detailed description of the construction of the E-G measure, refer Ellison and Glaeser (1997).

needed. The index is obtained by modeling the interaction between the location decisions of a pair of plants within an industry. If 'l' and 'm' are plants of a particular industry 'j' in region 'i', then index will be Corr (u_{li} , u_{mi}) = γ , for 'l' not equal to 'm'. Thus, u_{li} =1 if the business unit 'l' of a particular industry 'j', locates in area 'i', 0 otherwise.

The E-G index for a particular industry 'j' is: $$\gamma_j = \frac{G - \left(1 - \sum_i X_i^2\right) H}{\left(1 - \sum_i X_i^2\right)(1 - H)},$$

Where, G = Gini coefficient i.e. $\sum_i (S_i - X_i)^2$

X_i = share of aggregate manufacturing employment in area i.

S_i = share of the industry's employment in area i.

H = Herfindahl Index, $\sum_k Z_k^2$

Z_k = kth plant's share on industry's employment.

The Gini coefficient is the raw geographical concentration measure. From above, it is clear that with increases in G, gamma (γ) increases, i.e. they are positively related. This is conceptually clear to understand since the more manufacturing units located in one region, the higher the agglomeration strength.

H, the Herfindahl concentration index of the industry, on the other hand varies inversely with gamma. The intuitive explanation for this is as follows. If we take the extreme case of an industry having only one plant, its location would have to be in a single region. This, as per the Gini coefficient would portray the industry as being highly agglomerated even though its choice of location might have been completely random. The value of the Herfindahl in this case would be high and as a result, lower the agglomeration index gamma (γ). Thus in order to avoid classifying an industry as agglomerated just because it has a few numbers of plants; the inverse role of the Herfindahl index is crucial.

The gamma (γ) can be represented as the excess of raw geographic concentration (G) on productive concentration (H). In other words, it is an index of the industry geographic concentration, controlling for the size distribution of the plants.

In general, the index describing the strength of the agglomeration externalities that exist within an industry, takes values between minus one and plus one. A highly agglomerated industry is that which has Gamma (γ) larger than 0.05. Between 0.05 and 0.02 is a moderately agglomerated industry and less than 0.02 is a completely randomly dispersed industry.

Factors Affecting Agglomeration

The literature review (section 2) indicates that the agglomeration in a region is because of two specific factors - those that are associated with the agglomeration externalities and those that comprise natural and cost advantages. The natural and cost advantages are at the State-level whereas the agglomeration externalities usually pertain to the industry. Factors like State Domestic Product (NSDP), infrastructure availability (INFRA), kind of governance (GOV) and labour unionism (LABUN) in a State are manifestation of its natural and cost advantages; whereas existence of firms in a particular industry type (say software or machine tool or biotechnology etc.) indicate presence of innovation spillovers (INSP). Thus, the model will be:

$\gamma_j = f(NSDP_i, INFRA_i, INSP_{ji}, LABUN_i, Gov_i)$

where 'j' is the industry and 'i' is the State

A more detailed account of these variables is given in Section 4, which deals with the data and variables. The econometric model used to find out the role of policy-induced variables is through multiple linear regression using Ordinary Least Squares Estimates.

4. Data Issues

The data requirements for calculation of the E-G Index are the distribution of employment of each industry in each State. This is available from the ASI publication, but only for industries at a two-digit level. Using data at such an aggregated level would render the results meaningless, as, for example, it clubs two different industries like plastics and rubber into one aggregate industry. Calculations of results, using data pertaining to a more dis-aggregated level such as five-digit or even four-digit level is required for robustness. In absence of data on employment at higher disaggregated level, the value of manufacturing output for each industry (15 industries at two-digit level) in each State is used as a proxy instead of employment. This data is available from the ASI, published by the CSO. Thus, the present study has used the value of manufacturing output for the year 1997-98.[16]

Rationale for use of Proxy

The reason why employment data has been used by EG and MS to estimate industrial agglomeration is to arrive at an accurate measure for agglomeration of the labor employed in industry. The usage of value of data instead of employment shifts the focus away from labor alone, towards other factors of production. Since the calculation of the index is in terms of ratios, the actual working of the equation is not affected. However, the interpretation of gamma is not straight-forward. The gamma obtained using value of output yields gives us the concentration of manufacturing output in a spatial location rather than the concentration of the industrial labor in a particular location. While the gamma that uses employment data attributes the agglomeration solely to labor market pooling and information spillovers through labor, this cannot be said for the gamma computed using value of output. The agglomeration as computed using value of output, accounts for a mix of labor market pooling, spillovers related to labor markets as well as the spillovers with respect to capital technology or one of the two.

For example, in computing gamma with value of output data we could have a situation of high agglomeration which is due to highly capital intensive production techniques, with very little labor as in the case of the Jamnagar (Gujarat) refinery. In this case the agglomeration externalities would be high due to reasons other than labor spillovers, since there is little labor involved. This however need not always be the case, as in the case of Textile industry in Tamil Nadu, where the high agglomeration due to high value of output can also be attributed to labor. In using the gamma as proposed by E-G, the high agglomeration implies high labor employment in industries, and those agglomeration externalities are due to labor spillovers rather than any other, which is not the case, when output data is used, as in the present study.

To put this clearly, the reasons for agglomeration externalities can be classified into two, those spillovers attributed to labor mobility and those attributed to spillovers due to capital technology (such as demonstrative spillovers etc). In the case of the gamma calculated using employment, the agglomeration if solely due to the former (i.e. labor spillovers) and in the case of the gamma calculated with manufacturing output, the agglomeration is due to both reasons and cannot be identified separately.

[16] The choice of 1997-98 is not arbitrary. It is governed by availability of data for other variables supposed to have an impact on agglomeration.

Computing industry-wise agglomeration

Upon deciding to use output as a proxy, the ASI publication in the print form is used.[17] This data is at the five-digit industry level, falling in 15 two-digit industries (as per the ASI classification) for each State falling in approximately 5000 industries for 21 States.

In the next step, the five-digit level ASI industries are clubbed into the four-digit level NIC (National Classification of Industries). The clubbing reduced the industries to 79 four-digit level industries, which can be classified into 12 two-digit level industries as per the NIC. From this, the Gini coefficient is calculated for these 79 industries using the method given in Section 3.

The CMIE (Centre for Monitoring Indian Economy) publication gives 'product-wise' information regarding the Herfindahl index. To make this compatible with the requirements of the agglomeration measure, each product is matched with the industry and the average is taken as the Herfindahl for that particular industry. Due to non-availability of H-index for a number of products groups, the agglomeration index could be computed for only 66 industries instead of 79 four-digit level industries.

Factors influencing Agglomeration

There are a number of factors that are expected to have an effect on the agglomeration. On one hand, with the availability of Infrastructure Availability, say roads, electricity (Elect), tele-density (Tele), availability of loan (Idbi) etc. the expectation of agglomeration rises. Similarly, a rich State (as measured by its NSDP) is likely to attract more industries. On the other hand, presence of strong Labor Unions indicates huge bargaining power in the hands of the workers, which would exert a negative effect on industrial location in a State and hence agglomeration. The two variables accounting for this labour unionism as used in the study are - average number of disputes per factory (Dispute) and average number of workers involved in disputes per factory (Disworker). Since labour unionism raises input costs, the study expects that the higher the input costs in a particular State, the less likely the firm is to agglomerate in that State. A more skilled labour force engenders large spillovers. This has been computed in the study as a ratio of employees to workers (Mgtstaff). Similarly, industries like electronics, pharmaceuticals, etc., which are more R&D intensive tend to have a larger spillovers. This is measured as R&D intensity of the industry (Rdi). With respect to governance, three variables have been used – a State's share of crime vis-à-vis all India crime (Crimeshare); crime rate (Crimerate); and kind of governance (socialist and else) (Social). For some of the factors like ratio of invested capital to physical capital (capital) and number of factories per square Km. (Fact), a priori it is difficult to envisage a particular relation. This is because the effect could go either way. If a state has already large number of factories per unit area, it may attract more due to spillover and other externalities. On the other hand, a large agglomeration may increase labour mobility and hence increase the cost for the unit (also refer footnote 8). Similarly arguments can be given for a State having high ratio of invested capital to physical capital.

Thus, a number of variables are used to see their impact on agglomeration. Table 1 gives the definition, source and expected sign of variables used in the analysis.

Table 1: Factors influencing Agglomeration – Definition and expected sign

Category	Variable	Source	Sign
E-G Index (γ)		CMIE/ASI	
NSDP per capita	The log values of the State Domestic Products (Nsdp)	Indiastat	+

[17] Despite making enquiries in Delhi and Calcutta from the government publication distributors and the CSO also, we could not get hold of the data in electronic format.

Infrastructure availability (INFRA)	Teledensity (Tele) – No. of telephones per 100 persons	Indiastat	+
	Assistance by IDBI in Rs. crores (Idbi)	Indiastat	+
	Electricity tariff for Industrial users in paise/Kwh (Elect)	Indiastat	–
	No. of ITI's in each state (ITI)	Indiastat	+
	Ratio of invested capital to physical capital (capital)	ASI data	?
	Number of factories per square Km. (Fact)	ASI data	?
	Surfaced to total roads per square Km. (Roads)	Press Information Bureau	+
	Number of Seaports per square Km. (Sea)	Development of Coastal Shipping	+
Innovations and Spillovers (INSP)*	R&D intensity per industry, per State (Rdi)	Capital line.	+
	Employees to worker ratio (Mgtstaff)	ASI data	+
Labor unions (LABUN)	No. of disputes per factory (Dispute)	ASI data	–
	No. of workers involved in disputes per factory (Disworker)	ASI data	–
Governance in the State (Gov)	Percentage share of crime to all-India level (Crimeshare)	Indiastat	–
	Crime rate (Crimerate)	Indiastat	–
	Socialist state (Social) – (dummy variable which takes the value 1 for West Bengal and Kerala, 0 for all others.)		–

Note: * refers to those factors that are associated with agglomeration externalities. All the other factors comprise the natural and cost advantages.

Table 2 gives the summary statistics of different variables.

Table 2: Summary Statistics of Variables (N = 1386)

	Variable	Mean	Standard Deviation	Minimum	Maximum
1	Idbi	7.606	2.072	2.434	10.369
2	Elect	4.926	0.368	3.842	5.352
3	Dispute	0.0074	0.0086	0	0.0382
4	Disworker	5.921	7.322	0	24.127
5	Roads	0.0006	0.0019	0	0.0088
6	Crimerate	24.9	9.764	11.8	48.7
7	Capital	1.524	0.246	1.248	2.109
8	mgtstaff	1.342	0.121	1.194	1.712
9	Rdi	0.176	1.028	0	23.13
10	ITI	4.553	1.653	0.693	6.524
11	Nsdp	9.147	0.386	8.343	9.844

5. Results and Interpretations

This section gives the results for both the objectives. Sub-section 5.1 gives the E-G index for 66 industries. Sub-section 5.2 gives the pattern of location of these industries in different States. This is followed by the results of the econometric model in subsection 5.3 that investigates the impact of policy on the agglomeration of Indian industries.

5.1 Agglomeration of Industries - Results

Table 3 gives the E-G measure of 15 most and least agglomerated industries. The E-G measure shows that at the State level, the most localized four-digit industry is the Services Activities related to Printing. Following close are the extractive industries in which location decisions are based on the availability of the raw materials, like metals and certain chemicals etc. Another expected result is the localization pattern of the traditional industries whose locations are more or less determined by the historical specialization of some regions: leather, footwear, wearing apparel and carpentry. For example, the leather industry in Chennai and Kanpur attributes its origin mainly to Britishers so as to supply leather to its Army. The agglomeration of the fishing industry can be seen by the fact that they have to be located near coastal areas and so on. This general trend in Indian industry is similar to the trends found in the U.S. manufacturing industries and the French manufacturing industries as found by Ellison and Glaeser (1997) and Maurel and Sedillot (1999).

Table 3: Comparison of Gamma and Gini indices

COMPARISON OF GINI AND E-G INDICES:				
Industry Code	**Description**	**Gamma value**	**Gamma Rank**	**Gini Rank**
15 Most localized Industries				
2222	Service activities related to printing	0.583	1	1
2891	Forging, pressing, stamping and roll-forming of metal; powder metallurgy	0.581	2	2
2892	Treatment and coating of metals; general mechanical engineering on a fee or contract basis	0.290	3	4
1920	Manufacture of footwear	0.212	4	9
2022	Manufacture of builders' carpentry and joinery	0.212	5	7
1722	Manufacture of carpet and rugs	0.183	6	6
1911	Tanning and dressing of leather	0.181	7	5
2519	Manufacture of other rubber products	0.143	8	8
1532	Manufacture of starches and starch products	0.142	9	12
1810	Manufacture of wearing apparel, except fur apparel	0.130	10	17
1512	Processing and preserving of fish and fish products	0.122	11	21
2811	Manufacture of structural metal products	0.116	12	11
2732	Casting of non-ferrous metals	0.103	13	20
2423	Manufacture of pharmaceuticals, medicinal chemicals and botanical products	0.09	14	26
15 Least Localized Industries				
1532	Manufacture of grain mill products	-0.177	52	37
2411	Manufacture of basic chemicals except fertilizers and nitrogen compounds	-0.203	53	32
2691	Manufacture of non-structural non-refractory ceramic ware	-0.204	54	13
1513	Processing and preserving of fruit and vegetables	-0.207	55	23
1712	Finishing of textile.	-0.225	56	34
1912	Manufacture of luggage, handbags, and the like, saddlery and harness	-0.231	57	35

2899	Manufacture of other fabricated metal products n.e.c:	-0.266	58	64
2520	Manufacture of plastic products	-0.271	59	66
2699	Manufacture of other non-metallic mineral products n.e.c.	-0.367	60	40
2720	Manufacture of basic-precious and non-ferrous metals	-0.381	61	42
1554	Manufacture of soft drinks; production of mineral waters	-0.418	62	62
1541	Manufacture of bakery products	-0.473	63	56
2893	Manufacture of cutlery, hand tools and general hardware	-0.489	64	45
1600	Manufacture of tobacco products	-0.502	65	29
2813	Manufacture of steam generators, except central heating hot water boilers	-0.513	66	31

From above table, it is clear that the extractive industries and the traditional industries are the most localized industries. The industries with high technologies, like the pharmaceutical industries also come within this category. The least localized industries are mainly food products like fruits and vegetables, bakery products, grain mill products etc. Other industries that fall into this category are plastics, ceramics etc. This too follows the pattern found in the U.S. and the French manufacturing industries. Table 3 also compares the rank as obtained from agglomeration measure (γ) with the ranks as given by the Gini coefficient.

Table 4 given below shows in what proportion each of the industries at a two-digit level is agglomerated. From the table, it is clear that the food industry (i.e., industry code 15) is not highly agglomerated on the whole since approximately 90% of the industry comes under the less that 0.02 category (i.e. least agglomerated).[18] On the other hand, apparel industry (i.e., industry code 18) is highly agglomerated as it has a gamma value greater than 0.05. Accordingly one can interpret other industries too.

Table 4: Degree of agglomeration of the industries at a two-digit level

Two digit Industry code	No. of four digit Industries	Number of four digit industries with		
		$\gamma < 0.02$	γ (0.02,0.05)	$\gamma > 0.05$
15	16	14	0	2
16	1	1	0	0
17	4	1	2	1
18	1	0	0	1
19	3	1	0	2
20	4	1	0	3
21	3	3	0	0
22	2	1	0	1
23	1	1	0	0
24	9	5	1	3
25	3	2	0	1
26	8	4	0	4
27	4	3	0	1
28	7	4	0	3
TOTAL	**66**	**41 (62%)**	**3 (5%)**	**22 (33%)**

Note: The industry codes are given along with the description in Appendix B. Figure in parenthesis gives percentage of total industries.

From above table, it is clear that nearly one third of industries are highly agglomerated, whereas nearly $3/5^{th}$ industries are dispersed. Figure 1 using a histogram gives a synoptic view of the range of agglomeration in which most industries lie.

[18] This categorization based on γ is same as used by Ellison and Glaeser and Maurel and Sedillot in their studies.

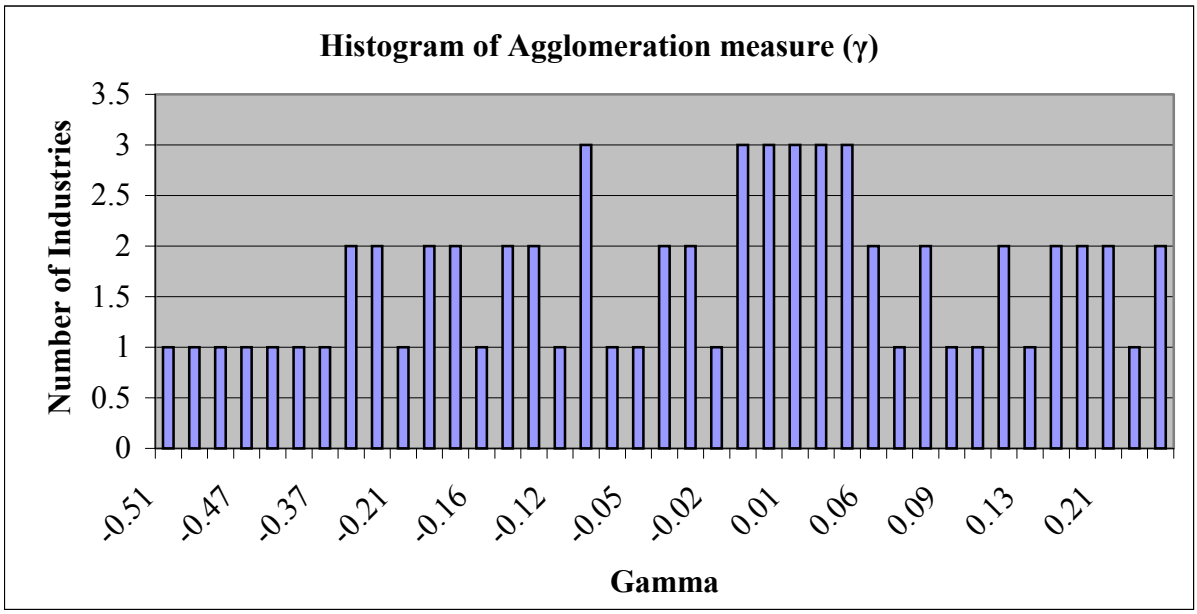

Figure 1: Histogram of Agglomeration Measure of Different Industries

5.2 Pattern of Location – First 5 States

The pattern of location of each of the industries is obtained through the product of each industry's agglomeration index (i.e., gamma) and the industry's share of manufacturing in each State (i.e., $\gamma_i * S_i$). The product of the two can facilitate in examining the patterns of industrial clustering i.e. which industries are clustered in which States.

Table 5 gives a summary of the top five States where 20 highly localized industries are located in. The manufactures of fish products are found in greater proportion near the coastal regions. The industries like textile and wearing apparel are most clustered in Tamil Nadu. Pharmaceuticals are found mostly in Maharashtra and Gujarat. The rubber products industry is located in mainly in Kerala and Delhi, while the extractive industries like Iron and Steel and Cement, Lime and Plaster are found in those States where the raw material is found in abundance.

Table 5: Pattern of Location

Industry Code/Description	State 1	State 2	State 3	State 4	State 5
Processing and preserving of fish and fish products	Kerala	A.P.	Gujarat	T.N.	Maharashtra
Manufacture of starches and starch products	T.N.	A.P.	Gujarat	Maharashtra	M.P.
Manufacture of prepared animal feeds	A.P.	Gujarat	Maharashtra	U.P.	Punjab
Preparation and spinning of textile fiber including weaving of textiles.	T.N.	Gujarat	Maharashtra	Rajasthan	M.P.
Manufacture of carpet and rugs	W.B.	Kerala	Haryana	Rajasthan	Gujarat
Manufacture of cordage, rope, twine and netting	T.N.	Maharashtra	Punjab	Gujarat	M.P.
Manufacture of wearing apparel, except fur apparel	T.N.	Delhi	Karnataka	Maharashtra	Punjab
Tanning and dressing of leather	T.N.	U.P.	Punjab	W.B.	M.P.
Manufacture of footwear	T.N.	Haryana	U.P.	W.B.	Punjab
Saw milling and planing of wood	W.B.	Maharashtra	U.P.	Kerala	Gujarat
Manufacture of builders' carpentry and joinery	T.N.	Maharashtra	Bihar	W.B.	Gujarat
Service activities related to printing	Maharashtra	Haryana	Kerala	A.P.	Assam
Manufacture of plastics in primary forms and of synthetic rubber.	Gujarat	Maharashtra	U.P.	Kerala	Rajasthan
Manufacture of pesticides and other agro chemical products	Gujarat	Maharashtra	A.P.	T.N.	Rajasthan
Manufacture of pharmaceuticals, medicinal chemicals & botanical products	Maharashtra	U.P.	Gujarat	A.P.	M.P.
Manufacture of other rubber products	Delhi	Kerala	Haryana	Maharashtra	A.P.
Manufacture of cement, lime and plaster	Rajasthan	A.P.	T.N.	Gujarat	Karnataka
Casting of iron and steel	Maharashtra	W.B.	Gujarat	T.N.	M.P.
Casting of non-ferrous metals	Punjab	T.N.	Gujarat	U.P.	W.B.
Forging, pressing, stamping and roll-forming of metal; powder metallurgy	Maharashtra	H.P.	A.P.	Assam	Bihar

Note: A.P.- Andhra Pradesh; T.N. - Tamil Nadu; U.P. - Uttar Pradesh; M.P.- Madhya Pradesh; H.P.- Himachal Pradesh; W.B.- West Bengal;

Based on EG measure, it can easily be seen that Indian manufacturing industry is highly agglomerated. The location of six most agglomerated industries – Tanning and dressing of leather; processing of fish, manufacturing of pharmaceuticals and chemicals; footwear, iron and steel; and rubber products indicate that the agglomerated industries are mostly located in few States, namely Tamil Nadu, Maharashtra, Gujarat and Andhra Pradesh. This implies that the policies adopted since early fifties to disperse the industry has not been quite successful.

5.3 Factors determining Agglomeration - Results

A simple OLS model is run to test for the significance of different factors affecting agglomeration. The tests show the presence of heteroscedasticity. To solve for this econometric problem, the weighted least squares (WLS) method is used. It is to be noted that model could not use all the variables as variables like crime rate and crime share are found to be correlated. Variables such as Idbi, Elect, ITI and Nsdp being in absolute numbers, introduce bias in estimates, hence have been converted to the logarithm form. Table 6 reports the results of the final model.

Table 6: Determinants of Industrial Agglomeration -Econometric results (N = 1386)

S.N.	Variable Name		Co-efficient	Standard Error
1	INFRA			
	(a)	Idbi	-0.00056*	0.00009
	(b)	Elect	-0.00174*	0.00029
	(c)	Roads	-0.47010*	0.05610
	(d)	Capital	0.00252*	0.00063
	(f)	ITI	0.00038*	0.00006
2	LABUN			
	(a)	Disworker	-0.00003*	0.00001
	(b)	Dispute	-0.05969*	0.01883
3	Nsdp		0.00270*	0.00033
4	INSP			
	(a)	Rdi	0.00042*	0.00024
	(b)	Mgtstaff	0.00479*	0.00115
4	Gov			
	(a)	Crimerate	0.00002*	0.00001
	R^2		0.3573	
	F-statistic		43.62	

Note: * indicates significance of variable at 10% level

As expected it is found that, factors such as the R&D intensities of the industries (Rdi) and proportion of high skilled workers (Mgtstaff) are highly significant in affecting agglomeration. The crime rates (Crimerate) and labor unions also have bearing on the agglomeration. The coefficients of the LABUN variables (Disworker and Dispute) are negative which implies that with more labor disputes in a State, it is less conducive for an industry to cluster. Some of the policy related variables within INFRA like electricity tariffs (Elect), number of ITIs (ITI) indicate that a State having high electricity tariff and less number of ITIs will have less agglomerated industries. Similarly Capital invested indicates larger possibilities of Spillovers and hence agglomeration. Surprisingly, disbursement of funds by IDBI has a negative influence on the agglomeration. This implies that providing funds may not induce firms to locate in an area, other factors influence may be more.

The analysis, thus indicates that the policy related factors that affect the agglomeration in the case of India's manufacturing Industries, are not alone, enough to create clusters. These along with other non-policy related factors like nature of industry (as proxied by R&D intensity) or proportion of skilled workers (Mgtstaff) etc. contribute to agglomeration.

6. Conclusions and Policy Implications

This study attempts to analyze the agglomeration of manufacturing firms for the Indian context. It measures the degree of agglomeration using an agglomeration measure given by Ellison and Glaeser (1997) for 66 manufacturing industries in 21 major States of India. The question of where these industries are clustered is also answered through this study. The analysis yields that the extractive industries like Iron and Steel and Cement, Lime and Plaster, are highly agglomerated and are found in those States where the raw material is in abundance. On the other hand, the industries like textile and wearing apparel are mostly clustered in Tamil Nadu. Pharmaceuticals firms are located mainly in Maharashtra and Gujarat and the rubber products industry is located mainly in Kerala and Delhi. The analysis indicates that the agglomerated industries are mostly located in few States, namely Tamil Nadu,

Maharashtra, Gujarat and Andhra Pradesh. The evidence thus points out that the attempts made by the Government to disperse the industrial units have not been quite successful. Even with respect to 41 industries, which are found to be highly dispersed, the results need to be looked with caution. This is because some of the policies like backward area development etc. are at the district level. Even if a State may be showing high industrialization and having all the industries, they may be spread over few districts only, as in the case of Gujarat, Maharashtra or Tamil Nadu.

Taking one step further, this study also looked at the reasons that could be attributed to this clustering in the Indian sub-continent using a simple econometric model. The econometric results indicate that the policy related factors that affect the agglomeration in the case of India's manufacturing Industries, are not alone, enough to create clusters. These along with other non-policy related factors having spillover potential also contribute to agglomeration.

Modern economic growth is spurred by productivity increases, which, in turn, is driven by industrialization. Does industrialization follows the classic 'virtuous cycle' principle i.e. new industries locate where other industries already exist. This clustering is mainly to avail of productivity advantages in the existing industrial regions. However, not all industries seek such profit maximizing locations. Considerations of regional balance, national security, and political gains are also included in location decisions. Thus, it is clear to see that, there is a spectrum of ingredients that go into the making of an industrial cluster.

In the recent years, the role of the State as industrial owner and industrial location regulator has been substantially curtailed under the regime of liberalization and structural reforms. The effect of policy-related factors that influence agglomeration are on the decline. Therefore, with the increasing dominance of private sector led industrialization, we expect that industries will be more spatially concentrated in leading industrial regions, which will lead to higher levels of spatial inequality.

From the Government's point of view, State Governments can implement those policies that are efficient for increasing the competitiveness of the State. The factors that contribute most to agglomeration externalities, whether policy-related or not, can be observed from this study and kept in mind while formulating policies.

The study though sheds light on industrial clustering, has a number of avenues for further research. As mentioned, while computing agglomeration index, study uses output data. Use of employment data instead of output values will be first improvement of the present work. Similarly, the analysis elsewhere so far could not separately identify the agglomeration externalities and the natural cost advantage. An exercise identifying the contribution of the two would be a significant addition to the literature. Another channel of future research is to delve into the dynamics of agglomeration over time to learn more about what induces a cluster to be formed and then eventually dissolve in different regions.

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Appendix A – Policies towards Industrial Dispersal

Since independence, there have been mammoth attempts, made by the Central Government and the State Governments to aid the economy in the growth and development of industries. The Industrial Policy Resolution of 1956 and the Statement on Industrial Policy of 1991 provide the basic framework for the overall industrial policy of the Government in regard to the manufacturing industries.[19]

In 1956, the Freight Equalisation policy on steel and coal was formulated. This was a means of making the industrially backward States more competitive. The Central Government of India absorbed any differences in transport costs, for different locations. This plan however backfired. It benefited the Northern States, like Punjab, in the country, at the cost of the Eastern States, like West Bengal, that are thought to have lost their natural advantage. This scheme was later withdrawn by the Government of India in 1992 under the New Economic Policy.

In the initial stages of the country's development, growth of industry was regulated through the granting of industrial licences and other industrial approvals. There was evident discrimination in favor of the backward States. The Industries (Development and Regulation) Act, 1951 was the principal legislation providing the legal basis for industrial licencing. In practice, licenses were granted to encourage geographical diversity, rather than industrial efficiency. Apart from the use of licenses, both the Central Government and the State Governments tried to follow a deliberate policy of encouraging industries in backward areas.

The Central Government selected a few backward districts and offered 25% capital subsidy for industries that were set up in these areas. The Freight Equalisation policy was intended to increase competitiveness among States. Various State Governments also offered similar capital incentives, exemption from sales tax levy, subsidies on power rates, cheap developed land, sales tax, loans and other facilities for the growth of industries in these areas.

In July 1969, an Industrial Licensing Inquiry Committee was appointed to examine the shortcomings in licensing policy. The Committee realised that the licensing policy had not succeeded in attaining its goal, instead resulted in inefficiency. Though the Government policies and procedures were aimed at industrial development of the country, procedures laid down for obtaining industrial licensing and various other rules acted as a great deterrent to the growth of industries in the country.

The Industrial Policy Statement drawn in 1973, among other issues, permitted large industries to start operations in rural and backward areas with a view to developing those areas and enabling the growth of small industries around.

In 1980, prompted by the Hazari Committee Report (1977), the Industrial Licensing Policy was set up. This aimed to encourage, with renewed efforts, the dispersal of industry and setting up of units in industrially backward areas. After 1980, an era of liberalisation started, and the trend was gradually to dilute the strict licensing system and allow more freedom to the entrepreneurs. The industrial policy announced on 24th July 1991 substantially dispensed with industrial licensing.[20]

Despite the efforts, there is still concentration of units in few States only. Table A1 gives the concentration of industries in different States.

From the above table, we can see that most manufacturing industries are located in Maharashtra, Tamil Nadu, Gujarat and Andhra Pradesh.

[19] A brief description of industrial policy pursued till the mid-1990's is given in the Handbook of Industrial Policy (2000).

[20] Report of the National Commission on Labor (2000): Industrial Development and Progress after Independence (Source: www.**labour**.nic.in/lcomm2/2nlc-pdfs/Chap3.pdf accessed in April 2005)

Table A1: **Concentration of industries in States.**

Industry Code	Industry (Descriptive)	States in which the concentration of units exist in 2003
15	Food products and beverages	Andhra Pradesh
16	Tobacco products	West Bengal, Uttar Pradesh, Andhra Pradesh
17	Textiles	Tamil Nadu
18	Wearing apparel	Tamil Nadu
19	Tanning	Tamil Nadu
20	Wood	Kerala
21	Paper	Maharashtra
22	Types of media	Maharashtra, Tamil Nadu
23	Coke, petroleum products	Maharashtra
24	Chemicals	Gujarat, Tamil Nadu, Maharashtra
25	Rubber	Maharashtra
26	Non metallic mineral products	Andhra Pradesh
27	Basic metals	Maharashtra, Gujarat
28	Fabricated metals	Maharashtra
29	Machinery & Equipment	Maharashtra, Gujarat
30	Office machinery	Maharashtra
31	Electrical machinery	Maharashtra
32	Radio/ T.V.	Karnataka, Maharashtra
33	Medical instruments	Maharashtra
34	Motor vehicles	Maharashtra
35	Other transport equip	Punjab
36	Furniture	Maharashtra
37	Recycling	Gujarat

Source: ASI Data, 2003.

Appendix B

The list of **Manufacturing Industries**. (Obtained from the latest NIC classification of Manufacturing Industries on the SIA website).

Division 15: Manufacture of food products and beverages

Division 16: Manufacture of tobacco products

Division 17: Manufacture of textiles

Division 18: Manufacture of wearing apparel; dressing and dyeing of fur

Division 19: Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear

Division 20: Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials

Division 21: Manufacture of paper and paper products

Division 22: Publishing, printing and reproduction of recorded media

Division 23: Manufacture of coke, refined petroleum products and nuclear fuel

Division 24: Manufacture of chemicals and chemical products

Division 25: Manufacture of rubber and plastics products

Division 26: Manufacture of other non-metallic mineral products

Division 27: Manufacture of basic metals

Division 28: Manufacture of fabricated metal products, except machinery and equipment

Appendix C – Difference between EG and MS measure of agglomeration

The only difference between the index proposed by Ellison and Glaeser and Maurel and Sedillot lies in the estimation of the Gini coefficient, which is in the numerator of the agglomeration measure.

According to the E-G Index, $G = \mathbf{(s_i - x_i)^2}$

And according to the index by Maurel and Sedillot, $G = \mathbf{(s_i^2 - x_i^2)}$

Both the above G's, computed either way, can be interpreted as a measure of the raw geographic concentration of an industry since they are based on the comparison between the geographic patterns of employment/value of output for one industry (measured by s_i) and the aggregate (measured by x_i).

The difference $\mathbf{(s_i - x_i)}$ is positive when the industry is over-represented in areas (i.e., where the industry is concentrated) and negative when it is under-represented i.e., where the total employment share is small.