Estimating Urban Agglomeration Economies for India: A New Economic Geography Perspective

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Abstract: The main objective of this paper is to provide answer to an important question: Are Indian firms or industries in urban areas operating under decreasing returns to scale or increasing returns to scale? Scale economies are one of the main assumptions of new economic geography models that posit the formation of agglomeration economies. For this purpose, we use Kanemoto et al. (1996) model for estimation of aggregate production function and to derive the magnitude of scale economies. Using firm level data in 2004-05 from the Annual Survey of Industry, we find that urban firms in Indian industry operate under decreasing returns to scale.

JEL classification: F23; R0

Keywords: Economic geography, Urban agglomeration, Firm level analysis, Manufacturing industry, India.

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1. Introduction

In contemporary economic studies, theoretical models of "New Economic geography" (pioneered by Krugman, 1991), have been found to be the most successful in explaining the uneven allocation of economic activity across space, principally due to its emphasis on the "second nature geography" (i.e., the distance of the economic agents relative to one another in space). Previous studies of neoclassical economies, particularly on the issue of distribution of economic activity, were based on "first-nature geography" (i.e., endowment of resources, the physical geography of climate, and topology). The core assumptions of new economic geography (hereafter, NEG) are product differentiations such as, a) modeled through a love of variety assumption, b) increasing returns to scale at firm level (so that firms have an incentive to produce in one place) and c) reduction of transport costs (so that it matters where you produce). These assumptions together create pecuniary externalities in agents' location choice (Redding, 2010) and also guide the forces of cumulative causation and agglomeration with the aid of mixed factor mobility or tradable intermediate inputs. However, unlike the earlier location theories, the NEG comprises of a general equilibrium framework with imperfect competition.

Several academics (such as, Marshal, 1890; Weber, 1909; Hotelling, 1929; Lösch, 1940; Isard, 1956; Greenhut and Greenhut, 1975; for an excellent review, see Ottaviano and Thisse, 2005) have in the past dealt with agglomeration economics, i.e., examination of the location and geographic concentration of economic activity. But, of the stress on increasing returns for agglomeration economics mainly came from the Starrett's (1978) 'Spatial Impossibility Theorem'.[1]

Indian studies on industrialization related urban agglomeration include the following: Chakravorty et al. (2005) use the disaggregated industry location and size data from Mumbai, Kolkata, and Chennai, to analyze eight industrial sectors. Their indicative results suggest that general urbanization economies are more important than localization economies for firm's location decisions. Lall et al. (2004) suggest that the access to market through -

[1] The theorem states that if space is homogeneous (i.e., each region is same in terms of consumer preferences, endowments and firm's production possibilities) and transportation is costly, there does not exist a competitive equilibrium involving goods being traded between regions. Perfect competition combined with transport costs and homogeneous space would produce at small scale or each region will produce for itself (i.e., so-called backyard capitalism) [see Ottaviano and Thisse, 2004, for detailed discussion]. Therefore, substantial localization or spatial concentration of economic activity may be seen as sign of agglomeration economies (Puga, 2010).

improvements in inter-regional infrastructure is an important determinant of firm level productivity, whereas benefits of locating in dense urban areas do not offset associated costs. Lall and Mengistae (2005a) find that both the local business environment and agglomeration economies significantly influence business location choices across Indian cities. Lall and Mengistae (2005b) study at plant level from India's major industrial centers shows large productivity gaps across cities due to differences in agglomeration economies, degree of labor regulation, severity of power shortages, and market access. Lall et al. (2003) find that generalized urbanization economies (manifested in local economic diversity) provide the agglomeration externalities that lead to industrial clustering in metropolitan and other India's urban areas. Chakravorty's (2003) findings provide evidence both of inter-regional divergence and intra-regional convergence, and suggest that 'concentrated decentralization' is the appropriate framework for understanding industrial location in post-reform India. Lall and Chakravorty (2005) examine the contribution of economic geography factors to the cost structure of firms in eight industry sectors and show that local industrial diversity is an important factor with significant and substantial cost-reducing effects. Mukherjee (2008) finds evidence to support the hypothesis that the trade liberalization of 1991 has resulted in agglomeration based on increasing returns in India, and four industries, namely, Iron and Steel, Chemical, Textile and Non-electrical have experienced some locational shifts after the trade liberalization.

Other studies identify various causative factors for firm location choice. These are abundant power (Rajaraman, et al., 1999); power availability (rather than its price), reliable infrastructure and factors of production (Mani, et al., 1996); sales tax incentive (Tulasidhar and Rao, 1986); and labour regulation (Besley and Burgess, 2004 and Lall and Mengistae, 2005b). Sridhar and Wan (2010), using the World Bank's Investment Climate Survey (ICS) data for India, find that more labour-intensive firms tend to refrain from locating in medium-sized cities relative to smaller cities in India and that Indian firms find capital cities attractive. This reinforces that public investments are biased in favour of capitals where policy makers live (Henderson, et al., 2000). In addition, they find that firm efficiency has a significant positive impact on the log odds of a firm locating in the large cities of India. Sridhar (2005) argues that infrastructure, power, telecom, roads and banking are important determinants of firm location in the growth centres of India. Fernandes and Sharma (2012) find that large plants led to lower spatial concentration and FDI liberalization and delicensing caused small plants to disperse while trade liberalization had the opposite effect. Most importantly, Ghani et al. (2012) find that plants in the formal sector are moving away from urban and into rural locations, while the informal sector is moving from rural to urban locations and the secular trend in India's manufacturing urbanization has slowed down.

There are few international studies on urban agglomeration that includes India as well. Investment Climate and Manufacturing Industry report (2004) by World Bank shows that the two main factors affect the individual firm's location decision. First, "business environment" includes access to inputs (quality and cost of labor and capital); access to markets; provision of basic infrastructure; institutional environment; and industry-specific subsidies or tax breaks. Second, "agglomeration economies" increase returns to scale.

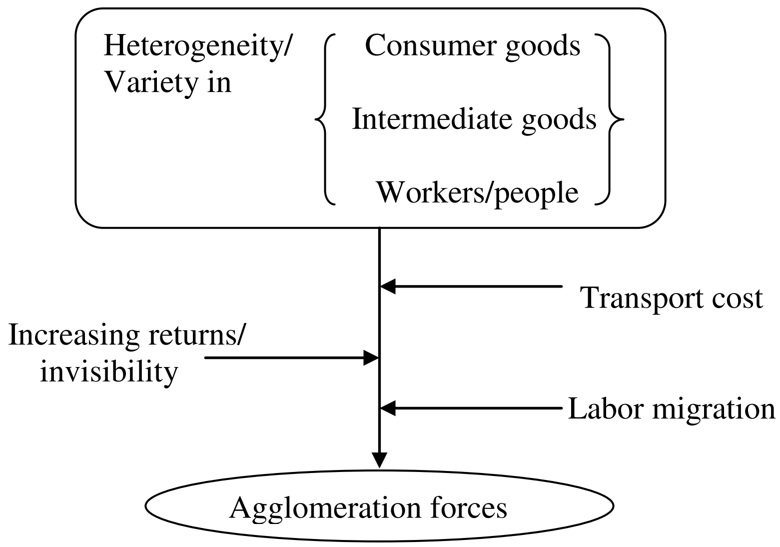
In essence, the above cited review of an exhaustive collection of Indian studies identifies the relevant determinants of firm locational choice, and the different levels of productivity a firm experiences when it operates in Indian cities or towns. In this perspective, in line with the prediction of NEG models, the main focus of this paper is to estimate the firm or industry level economies of scale which drives agglomeration economies in the absence of technological externalities as also when accompanied by significant market failure (Fujita et al. 2004). More specifically, we examine the following question in this paper: whether Indian firms or industry in urban areas (or in cities) are operating under the decreasing returns to scale or increasing returns to scale. Using the firm level data 2004-05 from the Annual Survey of Industry, our main finding is that urban firms in Indian industry operate under the decreasing returns to scale, which offers no evidence of increasing returns to scale for agglomeration economics as predicted in the NEG models. .

The organization of this paper is as follows. In section 2, we have described the basic framework of the new economic geography. In section 3 and 4, we explain the aggregate production functions for metropolitan areas in order to estimate the agglomeration economies. In section 5, we summarize the results, and in section 6 we discuss possibilities for elaboration and extension.

2. The basic framework of the new economic geography

The NEG models explain the spatial pattern of economic activity as the outcome of a process involving two opposite types of forces, i.e., agglomeration (or centripetal) forces and dispersion (or centrifugal) forces. Krugman (1999) explains the centripetal forces as market size effect (linkages), thick labour markets, and pure external economies, and centrifugal forces as immobile factors, land rents, and pure external diseconomies that affect geographic concentration or geographic dispersal as the case may be.

Figure 1 Generation of agglomeration forces

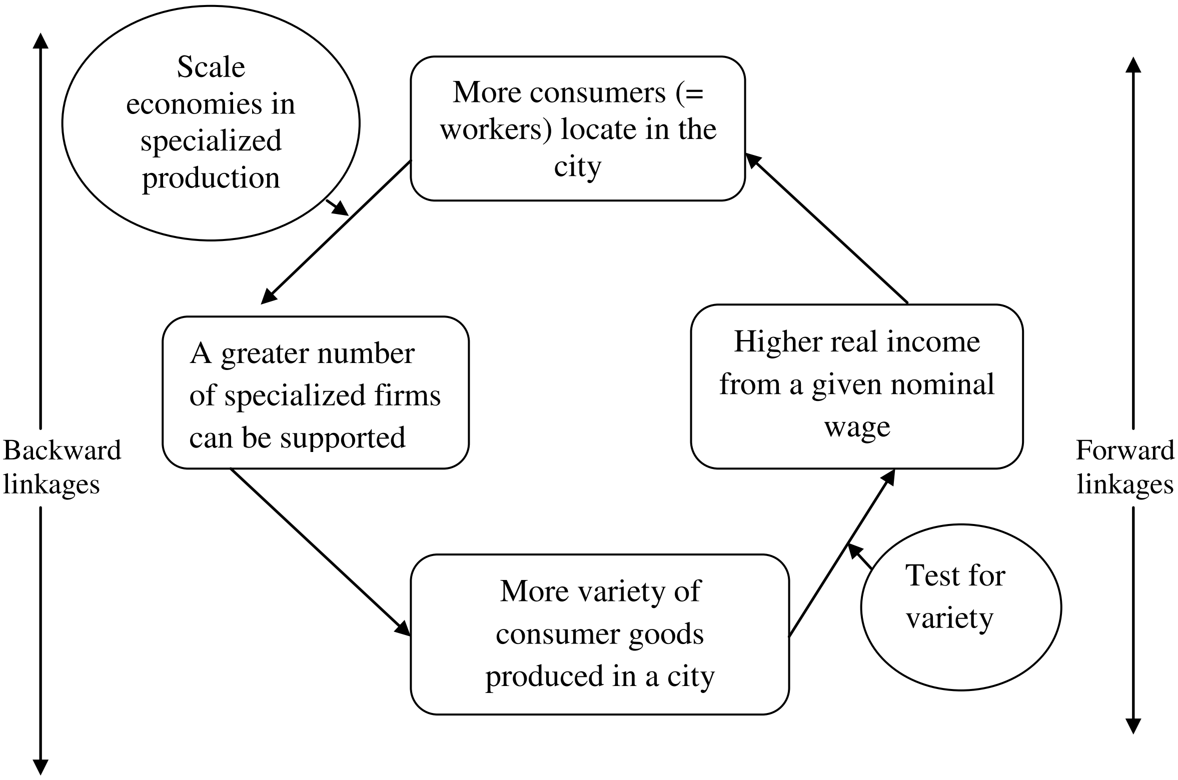


Source: Fujita, 2007.

Figure 1 presents the main elements behind the creation of agglomeration forces. It can be seen from the figure that given sufficient heterogeneity in goods or work-force, by way of interaction among increasing returns (at the individual firm level), transport costs, and migration of workers (= consumers), an agglomeration of consumers and suppliers of these goods and services come into being. The main assumption of the creation of agglomeration economics is the differentiation in goods, which incentivizes suppliers to locate in proximity to the market to avoid severe price competition, and consumers to increase their real wage by reducing transportation cost by locating close to their suppliers (see for details explanation in Fujita, 2007).

Figure 2 explains the heterogeneity in consumer goods more elaborately. The bottom square of this figure represents the large variety of consumer goods that are produced in a city. Then given a nominal wage in the city, with the love of verity assumption (or taste of variety), the real income of workers tends to rise as they purchase goods at lower prices in the city in preference to more distance places. This leads to migration of consumers (= workers) and increases the demand of goods in the city. Furthermore, due to home market effect (i.e., the benefits of locating near a large market) more specialized firms will emerge and produce

Figure 2: Circular causality in spatial agglomeration of consumer-goods producers and workers (= consumers).



Source: Fujita, 2007.

a new variety of goods in the city. Thus, through the forward linkages (the supply of greater variety of goods increases the workers' real income) and backward linkages (a greater number of consumers attract more firms) the agglomeration of firms and workers in the city occurs. Finally, through these linkages, pecuniary externalities occur, scale economies (at the firm level) emerge and increasing returns occur at the city level (see for more details explanation Fujita, 2007).

The above explanation shows that the circular causation leading to agglomeration economies depends mainly on scale economies in the form of increasing returns to scale. For that reason, the measurement of scale economies at firm levels in urban industry is important, and hence constitutes the main focus of this paper.

3. Theoretical frame work

We estimate an aggregate production function for urban India to derive estimates of the nature and magnitude of urban agglomeration economies. For this purpose we use Kanemoto, et al. (1996) model. The model is also used by Fujita, et al. (2004) and Kanemoto, et al. (2005). The significance of using this model is that it considers the traditional production function by incorporating the assumption of NEG models (i.e., increasing labour force in a large agglomeration leads to higher production of city output) to estimate the economies of scale for firms (or industry) level.

An aggregate neoclassical production function for a city (or urban area) is given by:

$Y = F(N,K,G,M)$ ------------------ (1)

where N,K,G, M and Y are respectively employment, the private capital, social overhead capital, materials and the total production in an urban area. All the factors of production are finite and non-negative. The importance of introducing the social overhead capital for measuring agglomeration economics has been established by many researchers (see Fujita et al. 2004, for a review). The main assumption is that, in the absence of agglomeration economies, the production function exhibits constant returns to scale with respect to labor and capital inputs. Therefore, the degree of agglomeration economies can be measured by the degree of increasing returns to scale of the estimated production function.

To capture the non-market interaction between firms combined with transportation and communication costs (i.e., heterogeneity of final and/or intermediate goods combined with transportation cost), we use the following Cobb-Douglas production function in the form of structural equation [Kanemoto, 1990 and Krugman, 1991].[2]

[2] Original model of Kanemoto, et al., (1996) used the following different Cobb-Douglas production functions to estimate the agglomeration economics for Japan:

$Y = AK^{\alpha}N^{\beta}G^{\gamma}$ ------ (i)

$Y = AK^{\alpha}N^{1-\alpha}N^{\gamma lnG}$ ----- (ii)

The specification of equation (2) is used in case of India, as it provides the best results in terms of measuring positive agglomeration economies for organized manufacturing firms (or industries).

$Y = A\,(K + G)^{\alpha} N^{\beta} M^{\gamma}$ ----------------------- (2)

The main assumption for this production function is that an individual firm produces at constant returns to scale with respect to labour, capital and materials. In equation (2) we define capital as the sum of private capital and social overhead capital.

Equation (2) is estimated in per capita terms and logarithmic form,

$Y/N = A\,\{(K + G)/N\}^{\alpha}\; N^{\alpha+\beta+\gamma-1}\; (M/N)^{\gamma}$

Taking logarithm in both sides we get,

$ln\,(Y/N) = ln\,A + \alpha\; ln\; \{(K + G)/N\} + (\alpha + \beta + \gamma - 1)\; ln\,N + \gamma\; ln(M/N)$

Or, $ln\,(Y/N) = A_0 + a_1\; ln\; \{(K + G)/N\} + a_2\; ln\,N + a_3\;\; ln(M/N)$ --------- (3)

Equation (3) is the reduced form equation of the Cobb-Douglas production function.
The relationship between the estimated parameters in equation (3) and the coefficients in the Cobb-Douglas production function (2) is as follows.

$\alpha = a_1\,, \qquad \beta = a_2 + 1 - a_1 - a_3\,, \qquad \gamma = a_3$

A positive coefficient a_2 indicates the degree of increasing returns to scale in urban production, and represents the elasticity of urban agglomeration, i.e., the percentage increase in urban production due to a unit increase in labor force in an urban area. In the absence of urban agglomeration economies, however, the production function is homogeneous at degree one with respect to capital and labor.

4. Estimation framework

The econometrics specification of equation (3) is the following;

$ln\,(Y/N) = A_0 + a_1\; ln\; \{(K + G)/N\} + a_2\; ln\,N + a_3\;\; ln(M/N) + \varepsilon$ ---------- (4)

We assume that $ln\,\{(K + G)/N\}$, $ln\,N$, $ln(M/N)$ are independent of ε (error term). This model predicts not just the sign of the coefficients but also the magnitudes of the coefficients on per capita capital (i.e., sum of per capita private and per capita social overhead capital) and per capita materials used. The double-log linear specification gives the direct measure of elasticity. This version of the model is linear in parameters and is estimated by OLS. The predicted sign of the all the coefficients (i.e., a_1, a_2, a_3) is positive. Standard growth literature assumes that there is a positive effect of per capita capital and materials on production. Finally, following the literature of NEG models the positive value of a_2 (i.e., increasing returns to scale) is predicted.

4.1 Measurement of variables and data sources

We have used the firm level data in 2004-05 from Annual Survey of Industries (ASI), conducted by the Central Statistical Office (CSO) of the Government of India.[3] Data on output, employees, private capital, and materials are used in the estimation (Table 1).

Table 1: Firm level variables used in the study

Variables	Description (as definitions are given by ASI)
Output	Factory value of products and by-products manufactured as well as other receipts from non industrial services rendered to others, work done for others on material supplied by them, value of electricity produced and sold, sale value of goods sold in the same conditions purchased, addition in stock of semi- finished goods and value of own construction.
Private Capital	Private capital is the sum of total value/ depreciated value of fixed assets owned by the factory as on the closing day of the accounting year. Fixed assets are those that have a normal productive life of more than one year. Fixed capital includes land including lease- hold land, buildings, plant and machinery, furniture and fixtures, transport equipment, water system and roadways and other fixed assets such as hospitals, schools etc. used for the benefit of factory personnel.
Labour	Total man-day employees, which is the total number of days worked and the number of days paid for during the accounting year. It is obtained by summing-up the number of persons of specified categories attending in each shift over all the shifts worked on all days.
Materials	Material input for each firm is defined as the total delivered value of all items of raw materials, components, chemicals, packing materials and stores, that has actually entered into the production process of the factory during the accounting year. This includes the cost of all materials used in the production process of the factory during the accounting year as also the cost of all materials used in the production of fixed assets including construction work for factory's own use.

Source: Author's compilation

[3] The ASI covers factories registered under sections 2m(i) and 2m(ii) of the factories Act 1948, employing 10 or more workers and using power, and those employing 20 or more workers but not using power on any day of the preceding 12 months.

Following Lall et al. (2004), we consider the total output as production of a firm, and total man-day employees are used as a proxy of labour. Most specifically, we define production function excluding intermediate consumption. Therefore, total output is considered as a measure of output than gross value added. In addition, private capital and materials are used as important variables in the estimation of firm level production function. Doms (1992) argues that defining capital as a gross stock is a reasonable approximation for capital. For that reason, our measurement of private capital (and in the ASI dataset) is defined as the gross value of plant and machinery. It also includes the book value of installed plant and machinery and the approximate value of rented-in plant and machinery. We also measure material as per the definition of ASI.

The geographic attributes allows us to identify each firm at the state level (or district level) with rural urban distinction.[4] Available information allows us to categorize firms by their location in urban areas of a state (or district) as well as the total urban area in the country, but not in any specific urban centre.[5] The analysis is carried out for 25 states in India for the entire industry sector at five-digit National Industry Classification (NIC) codes of 2004.[6,7] For our analysis we have considered all types of ownership of the firm, which includes wholly central government, wholly state and/or local government, central government and state and/or local government jointly, joint sector public, joint sector private, and wholly private ownership. This also includes those firms that are using foreign direct investment (FDI) for production. This is very important because FDI flow is one of the main factors behind firm location choice for different regions as well as different states.

[4] The ASI data allows the identification of the firms at the state level with rural-urban distinction, but these data are not made available for district level due to confidentially concern. However, on special request, CSO has provided information only for some large city districts which is used in this study.

[5] Population Census of India categorizes urban centres into six based on population size. Class I (100,000 or more), Class II (from 50,000 to 99,999), Class III (from 20,000 to 49,999), Class IV (from 10,000 to 19,999), Class V (from 5000 to 9999) and Class VI (below 5000)

[6] Although in India there are 35 states (including Union Territories), we consider 25 of them due to non-availability of information or due to very small number of observations.

[7] National Industry Classification (NIC) codes of 2004 do not include India's best known "industrial" export-software (which embodies high levels of human capital) in the data.

4.1.1 Measurement of Social overhead capital

Construction of Social overhead capital variable at firm level is described here. Kenemoto, Ohkawara and Suzuki (1996) have defined social overhead capital by allocating industrial infrastructure investment with capital stock in telecommunication and railway industries. Aso (2008), in the study "Social overhead capital development and geographical concentration" have used traffic infrastructure investment which includes railroad, automobile, ship and airplane. In the Indian context, data for the above variables are not available for urban areas at state level as well as for district (or city) level.

For that reason, firm level share of public Net Fixed Capital Stock (NFCS) is used as proxy of Industry (or firm) level social overhead capital. Public NFCS comprises administrative departments, departmental commercial undertakings (DCUs) and non-departmental commercial undertakings (NDCUs). The social overhead capital expenditure includes mainly the physical infrastructure which is dominated by the public sector. Therefore, the public NFCS is used as proxy to measure the Social overhead capital. However, firm level NFCS is estimated by allocating the state (or district) wise urban share of NFCS, multiplied by the ratio of a firm's expenditure on electricity consumption to the total expenditure on electricity by all the firms operating in an urban area (i.e., state or district).[8,9]

i.e., $$NFCS_{jk} = \left(\frac{E_{jk}}{\sum_j E_{jk}}\right) \times NFCS_i^{P,U} \qquad \text{------------ (5)}$$

Where $NFCS_{jk}$ stands as urban share of Public NFCS value of j^{th} firm operating in k^{th} urban (which may be state or district) area, E_{jk} stands as total expenditure on electricity by j^{th} firm operating in k^{th} urban (which may be state or district) area. $\sum_j E_{jk}$ stands as total expenditure on electricity by all the firms operating in k^{th} urban (which may be state or district) area. $NFCS_i^{P,U}$ stands as public (denoted by *P*) urban (denoted by *U*) NFCS value of i^{th} state (or district).

[8] For the measurement of social overhead capital for firm level, initially, we allocated total urban public NFCS with the share of individual firm's private capital stock to total private capital stock by all the urban firms in a state (or by the ratio of individual firm's output to total output by all the urban firms in a state). Then we encountered the problem of multicolliearity, as correlation coefficients between private capital (or firm's output) and social overhead capital were unity. For that reason we have considered firm's electricity expenditure data for allocation of state public capital.

[9] The firm's expenditure on electricity which is considered as output of public sector is used as input of a firm's production function. This is typically a Leontief case of input-output model (i.e., how the output of one industry is an input to each other industry). However, as input output data are available only at sector level and not at any industry (or firm) specific level, we do not construct (or analyze) input-output model.

Total NFCS in public sector is available only at the national level. The public NFCS in 2005 is Rs. 2909398 (Crore) at current prices as given in CSO (2008). We take the value of public NFCS at current prices as in the case of other variables (such as public sector Gross Fixed Capital Formation (GFCF) is only available in current prices).

For the calculation of public urban NFCS value of a state (or district), following two steps are considered:

Step 1: Estimation of state (or district) wise total public NFCS:
To estimate the state level NFCS, we multiply the value of national level NFCS with the ratio of state level GFCS share. i.e.,

$$NFCS_i^P = \frac{GFCF_i^P}{\sum_i GFCF_i^P} \times NFCS^P \qquad \text{-------------------- (6)}$$

Where $NFCS_i^P$ stands as public NFCS of i^{th} state (or Union Territory), $GFCF_i^P$ refers to total public sector GFCF value of the i^{th} state, $\sum_i GFCF_i^P$ stands as total public sector GFCF of all the states (or Union Territory) of India, and $NFCS^P$ refers to total national level public NFCS. We also add expenditure on Supra-regional expenditure in calculation of total public GFCF as Supra-regional sectors include railways, banking and insurance, communications and central Government administration (see Table 2 for details).

Social overhead capital is a stock concept. As long time series data on state level public GFCF are not available, we could not measure the capital stock using perpetual inventory method (PIM). Therefore, the national public NFCS is distributed on the basis of share of state level GFCF.

Step 2: Estimation of state (or district) wise total public urban NFCS:
For state level: We allocate state wise total public NFCS with share of national level urban NDP, i.e.,

$$NFCS_i^{P,U} = \frac{NDP^u}{NDP} \times NFCS_i^P \qquad \text{--------------------- (7)}$$

Where NDP stands as All India level Net Domestic Product, NDP^u refers to the urban NDP.

Total public sector GFCF for 2004-05 was collected from the report of Government of India (GOI, 2009). NDP of urban area for the year 2004-05 was collected from CSO (2010). The

NDP for total urban areas in current prices is Rs. 1376653(Crore) and for total rural areas is Rs. 1269717 (Crore). Total urban NDP as percentage of total is 0.52.

At the district level: We allocate state wise total public NFCS with share of district level DDP to state level total GSDP. i.e.,

$$NFCS_i^{P,U} = \frac{GDDP_i}{GSDP_i} \times NFCS_i^{P} \quad \text{-------------------- (8)}$$

Where $GDDP_i$ stands as Gross District Domestic Product of a particular district in which the sample city is located, $GSDP_i$ refers to the Gross State Domestic Product of a particular state in which the district is located. We consider GSDP and GDDP, as city output and state level rural urban distinction GSDP are not available.

4.1.2 Importance of using social overhead capital as one of the explanatory variables

Regional connectivity is determined by the status of transport infrastructure, and market access increases with increase in regional connectivity. By lowering transportation cost of output and input, transport infrastructure increases real income (even if the price of the commodity remains same) of the workers and also consumer surplus leading to increase in productivity. It also increases interaction and spillovers between firms, firms and research centers, government and regulatory institutions, etc. Therefore, improvements of transport network increases the potential size of agglomeration by attracting private investment (see Lall et al., 2004 for more details)

To construct the social overhead capital, we have used public GFCF which includes two types of fixed assets, namely construction (buildings) and machinery and equipment which in turn include transport equipment, software and breeding stock, draught animals, dairy cattle, etc. Construction activity covers all new constructions and major alternations and repairs of buildings, highways, streets, bridges, culverts, railroad beds, subways, airports, parking area, dams, drainages, wells and other irrigation sources, water and power projects, communication systems such as telephone and telegraph lines, land reclamations, bunding and other land improvements, afforestation projects, installation of wind energy system etc. Machinery and equipments comprise all types of machineries like agricultural machinery, power generating machinery, manufacturing, transport equipment, furniture and furnishing.

Table 2: Estimation of state wise urban share of Public Net Fixed Capital Stock (NFCS)

Sr. No.	Name of the States	Public GFCF (Rs. Crores)			GFCF Share	Total Public NFCS (Rs. Crore)	Total Public Urban NFCS (Rs. Crore)
		Public sector Total	Supra Regional	Total			
1	Andhra Pradesh	11219	1456	12675	0.0629	182961	95140
2	Arunachal Pradesh	1962	66	2028	0.0101	29274	15222
3	Assam	6636	346	6982	0.0346	100783	52407
4	Bihar	4858	1157	6015	0.0298	86825	45149
5	Chhattisgarh	4503	473	4976	0.0247	71827	37350
6	Goa	718	81	799	0.0040	11533	5997
7	Gujrat	12498	1160	13658	0.0678	197150	102518
8	Haryana	5659	376	6035	0.0299	87114	45299
9	Himachal Pradesh	3537	168	3705	0.0184	53481	27810
10	Jharkhand	2746	1628	4374	0.0217	63138	32832
11	Jammu & Kashmir	5051	556	5607	0.0278	80936	42087
12	Karnataka	10307	1626	11933	0.0592	172250	89570
13	Kerala	3603	900	4503	0.0223	65000	33800
14	Madhya Pradesh	10434	760	11194	0.0555	161583	84023
15	Maharashtra	20866	2970	23836	0.1183	344067	178915
16	Manipur	1136	63	1199	0.0059	17307	9000
17	Meghalaya	716	63	779	0.0039	11245	5847
18	Mizoram	2002	51	2053	0.0102	29635	15410
19	Nagaland	1048	67	1115	0.0055	16095	8369
20	Orissa	5424	715	6139	0.0305	88615	46080
21	Punjab	3073	999	4072	0.0202	58778	30565
22	Rajasthan	5659	954	6613	0.0328	95457	49638
23	Sikkim	1377	13	1390	0.0069	20064	10433
24	Tamil Nadu	13103	1444	14547	0.0722	209982	109191
25	Tripura	963	78	1041	0.0052	15027	7814
26	Uttar Pradesh	15579	1951	17530	0.0870	253041	131581
27	Uttarkhand	4775	202	4977	0.0247	71842	37358
28	West Bengal	9592	1732	11324	0.0562	163459	84999
29	Andaman & N.I.	198	39	237	0.0012	3421	1779
30	Chandigarh	175	78	253	0.0013	3652	1899
31	Dadra & Nagar H.	35	1	36	0.0002	520	270
32	Daman & Diu	12	2	14	0.0001	202	105
33	Delhi	5526	3933	9459	0.0469	136538	71000
34	Lashadweep	391	2	393	0.0019	5673	2950
35	Punducherry	49	15	64	0.0003	924	480
	Total	175430	26125	201555	1	2909398	1512887

Source: GOI (2009) and Author's calculation.

For that reason Social Overhead Capital is taken as a proxy of transport infrastructure investment, because urban agglomeration depends on scale economies associated with reduction in transportation cost. For obvious reasons, the trade-off between increasing returns and transport costs is fundamental to the understanding of the geography of economic activities.

4.1.3 Description of Data

A total of 60825 firms are considered for the entire analysis by five main variables, namely, output, labour, private capital, social overhead capital, and materials. Table 3 gives the descriptive statistics of the five variables. It shows that mean of output, social overhead capital, private capital, and materials is Rs. 456000000, Rs. 753000000, Rs. 147000000, and Rs. 262000000 respectively. Mean labour is 61003. The coefficient of variation of output, labour, social overhead capital, private capital and materials is 999, 211, 1173, 1312, and 808, respectively. As the coefficient of variation is a pure number and highest (or lowest) for private capital (or labour), it can be said that the relative variability is highest (or lowest) in data on private capital (or labour) then the other variables. The positive skewness values for all the variables indicate that the distribution is right-skewed or right-tailed, which means the values of the variables tend to cluster to the lower end of the scale (i.e., smaller number) with increasingly fewer values of the variables at the upper end of the scale (i.e., the large numbers). In addition, positive kurtosis for all the variables indicates heavy tails and peakedness relative to the normal distribution.

Table 3: Descriptive Statistics: All India Urban Firms

Variables	Mean (in Millions)	Std. Dev. (in Millions)	Mini-mum	Maximum (in Billions)	Ske w-ness	Kurto-sis	Coefficient of Variation
Output(Rs.)	456	4550	42	436	58	4624	999
Labour	0.061	0.129	30	0.005	11	222	211
Social overhead Capital(Rs.)	753	8830	7114	846	70	5912	1173
Private capital(Rs.)	147	1930	158	214	74	7617	1312
Materials	262	2120	493	162	45	2643	808

Source: Author's calculation

5. Estimation Result

5.1 All India level analysis for all the firm together: Urban

The coefficient a_2 (=α+β+γ-1) in equation (4) measures the economies of scale in urban production. The sign and value of this coefficient explains whether the urban firms in Indian industry operate under increasing returns to scale or decreasing returns to scale.

Table 4: Estimates of Cobb-Douglas Production Function

	All India Urban	**52 large cities**	**Mega cities (6 cities)**	**Total all India urban (except 52 cities)**
	(1)	(2)	(3)	(4)
Constant	10.34*** (0.19)	11.53*** (0.291)	12.69*** (0.471)	9.74*** (0.239)
Capital	0.0934*** (0.007)	0.095*** (0.011)	0.089*** (0.017)	0.093*** (0.009)
Labour	-0.52*** (0.013)	-0.576*** (0.019)	-0.612*** (0.032)	-0.492*** (0.016)
Materials	0.264*** (0.008)	0.185*** (0.012)	0.116*** (0.019)	0.304*** (0.009)
R^2	0.28	0.25	0.28	0.31
No. of Obs.	60825	25871	8422	34971

*Note: Figures in parentheses represent robust standard errors. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.*
Source: Estimated by equation (4).

Table 4 reports the Ordinary Least Square (OLS) regression estimates of equation (4) for all India level urban firms in different categories of cities (cities are categorized as per their population size). The result shows that the value of a_2 is statistically significant and negative across different categories of cities, which explains that urban firm in Indian industry operate under decreasing returns to scale, and the estimate of a_2 ranges between -0.492 to -0.612. At the all India level, the value of a_2 is -0.52, i.e., the 10 percent increase in labor force in urban area decreases urban production by 5.2 percent. The result runs counter to the main expected hypothesis. The coefficients of per capita capital and materials are statistically significant and positive. In particular, a 10 percent increase in capital (or materials) is associated with 0.9 percent (or 2.6 percent) increase in urban production. The explanatory power of the regression (1) to (4) is satisfactory (R^2 values lies between 0.25 and 0.31).

5.2 State level analysis for all the industry together: Urban

At the state level, for all the urban firm analysis, again Cobb-Douglas production function of equation (4) is used by considering 25 states in India, separately. Table 5 presents the individual OLS regression estimation results for the 25 states of India. The result shows that the value of a_2 is statistically significant and negative for 23 states, which explains again that urban firm in Indian industry, operates under decreasing returns to scale in these states. Most importantly, the value of a_2 is positive but statistically insignificant for Haryana and Chandigarh. Moreover, the estimates of a_2 range between 0.007 to -1.29. The coefficient of per capita capital is statistically significant and positive for Andhra Pradesh, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Punjab, Tamil Nadu, Uttar Pradesh, Uttaranchal, and Chandigarh. This implies that capital has a positive effect on urban production. This coefficient is positive and statistically insignificant for Chhattisgarh, Goa, Tripura, and West Bengal. Most remarkably, it is negative and statistically significant for Jharkhand, Maharashtra and Delhi which comes at surprise. The coefficient of material is statistically significant and positive for Andhra Pradesh, Bihar, Chhattisgarh, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Punjab, Uttar Pradesh, Uttaranchal, Chandigarh, and Pondicherry. This result implies that use of material has a positive and significant effect on urban production. The results also show that the value of R^2 is the highest (i.e., 0.58) for Manipur and the lowest (i.e., 0.22) for Punjab among the other states.

Table 5: Estimates of Cobb-Douglas Production Function: State Level Urban Firm

Sl. No.	Name of the states or Union Territories	Constant	Independent Variables			R^2	No. of factories
			Capital	Labour	materials		
1	Andhra Pradesh	13.43*** (0.51)	0.115*** (0.02)	-0.689*** (0.034)	0.1*** (0.02)	0.34	9103
2	Assam	17.41*** (2.35)	-0.116 (0.0719)	-0.952*** (0.141)	-0.006 (0.092)	0.43	134
3	Bihar	14.16*** (2.15)	-0.03 (0.084)	-0.88*** (0.156)	0.149* (0 .083)	0.30	149
4	Chhattisgarh	13.11*** (0.964)	0.056 (0.049)	-0.661*** (0.066)	0.169*** (0.048)	0.35	1119
5	Goa	10.14*** (2.33)	0.114 (0.091)	-0.456*** (0.148)	0.169 (0.108)	0.40	122
6	Gujrat	19.511*** (1.169)	-0.042 (0.045)	-1.09*** (0.075)	-0.01 (0.036)	0.40	726
7	Haryana	0.349 (0.835)	0.373*** (0.046)	0.078 (0.062)	0.419*** (0.028)	0.32	3477
8	Himachal Pradesh	11.47*** (1.7)	0.175** (0.073)	-0.6*** (0.109)	0.162*** (0.05)	0.43	375
9	Jharkhand	19.15 (1.97)	-0.128* (0.071)	-1.09*** (0.14)	-0.069 (0.064)	0.31	276
10	Jammu & Kashmir	12.28*** (1.59)	-0.02 (0.065)	-0.529*** (0.102)	0.221*** (0.051)	0.27	239
11	Karnataka	14.97*** (0.539)	0.044** (0.02)	-0.786*** (0.038)	0.101*** (0.022)	0.34	6595
12	Kerala	12.53*** (0.885)	0.072* (0.039)	-0.6*** (0.061)	0.145*** (0.039)	0.26	2164
13	Madhya Pradesh	12.29*** (0.73)	0.118*** (0.029)	-0.662*** (0.049)	0.197*** (0.034)	0.41	2731
14	Maharashtra	17.73*** (0.835)	-0.072** (0.029)	-0.989*** (0.0548)	0.038 (0.029)	0.42	1507
15	Manipur	20.47*** (5.82)	-0.044 (0.157)	-1.29*** (0.374)	-0.099 (0.26)	0.58	33
16	Orissa	15.99*** (2.43)	-0.033 (0.065)	-0.953*** (0.193)	0.087 (0.083)	0.30	167
17	Punjab	7.12*** (0.969)	0.288*** (0.041)	-0.451*** (0.068)	0.276*** (0.029)	0.22	6685
18	Tamil Nadu	17.87*** (0.439)	0.045*** (0.016)	-1.003*** (0.031)	0.009 (0.016)	0.33	14995
19	Tripura	17.07*** (3.88)	0.086 (0.119)	-1.084*** (0.255)	-0.052 (0.136)	0.46	51
20	Uttar Pradesh	12.11*** (0.457)	0.131*** (0.021)	-0.593*** (0.033)	0.141*** (0.02)	0.30	7647
21	Uttaranchal	6.66*** (2.01)	0.273*** (0.078)	-0.435*** (0.119)	0.236*** (0.08)	0.39	286
22	West Bengal	16.92*** (1.21)	0.037 (0.043)	-1.12*** (0.09)	-0.052 (0.042)	0.33	575
23	Chandigarh	1.04 (2.21)	0.355*** (0.104)	0.007 (0.154)	0.462*** (0.079)	0.28	276
24	Delhi	23.32*** (1.93)	-0.152** (0.077)	-1.21*** (0.109)	-0.049 (0.057)	0.33	636
25	Pondicherry	12.96*** (1.44)	-0.015 (0.071)	-0.576*** (0.1004)	0.157*** (0.054)	0.28	313

*Note: Figures in parentheses represent robust standard errors. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.*
Source: Estimated by equation (4).

5.3 District level analysis for all the industry together: Urban

At the district level, again for all urban firms' analyses, Cobb-Douglas production function as used in equation (4) is estimated by considering 52 large cities in India, separately. Due to non-availability of city level information, city districts (where the sample city is located) are used as proxy of cities. We have thus included 52 large cities in the sample as bigger cities are found to be more representative of city districts as they cover bigger portion of districts as compared to smaller cities.[10] Table 6 presents the individual OLS regression estimation results for 50 large cities in India. Again, the estimated results show that the value of a_2 is statistically significant and negative for 49 districts, which implies that urban firms in Indian industry operate under decreasing returns to scale. Most importantly, though Jabalpur shows the positive value of a_2, the coefficient is not statistically significant. The results show that the estimate of a_2 ranges between 0.105 to -2.034. The coefficient of per capita capital is statistically significant and positive for Hyderabad, Bangalore, Mysore, Bhopal, Indore, Jabalpur, Jalandhar, Ludhiana, Chennai, Agra, Aligarh, and Meerut. On the other hand, Guwahati, Mumbai, and Asansol show negative and statistically significant coefficients of per capita capital. The coefficient of per capita materials used is statistically significant and positive for Hyderabad, Vijayawada, Visakhapatnam, Durg-Bhilainagar, Raipur, Bangalore, Kochi, Indore, Jabalpur, Jalandhar, Ludhiana, Agra, Kanpur, Moradabad, and Asansol. In contrast, Ranchi shows negative and statistically significant coefficient of per capita materials used. The explanatory power of the regressions (i.e., R^2 values) lies between 0.04 and 0.64.

[10] As Delhi and Chandigarh are considered as a whole proxy of a city, the results of this two cities are presented in Table 3 (presents the state level analysis).

Table 6: Estimates of Cobb-Douglas Production Function: District Level Urban Firm

Sr. No.	Name of the City	Constant	Independent variables			R^2	No. of factory
			Capital	Labour	Materials		
1	Hyderabad	10.828*** (1.552)	0.177*** (0.067)	-0.528*** (0.119)	0.210*** (0.070)	0.36	696
2	Vijayawada	9.445*** (2.944)	0.157 (0.096)	-0.446** (0.190)	0.241*** (0.103)	0.28	429
3	Visakhapatnam	11.077*** (2.373)	0.087 (0.087)	-0.580*** (0.152)	0.288** (0.131)	0.32	373
4	Guwahati (Gauhati)	17.332*** (2.731)	-0.134* (0.079)	-0.943*** (0.168)	-0.004 (0.117)	0.46	89
5	Patna	11.169** (5.015)	0.049 (0.195)	-0.752** (0.308)	0.269* (0.155)	0.32	74
6	Durg-Bhilainagar	10.325*** (1.375)	0.096 (0.103)	-0.511*** (0.109)	0.299*** (0.077)	0.39	209
7	Raipur	13.050*** (2.218)	0.084 (0.081)	-0.714*** (0.145)	0.198** (0.096)	0.38	523
8	Dhanbad	22.344* (7.663)	-0.218 (0.286)	-1.410** (0.561)	0.027 (0.194)	0.31	22
9	Jamshedpur	17.288*** (4.849)	-0.266 (0.177)	-0.855*** (0.299)	0.133 (0.211)	0.21	84
10	Ranchi	22.422*** (4.204)	0.051 (0.099)	-1.497*** (0.422)	-0.448** (0.195)	0.40	30
11	Bangalore	14.678*** (0.676)	0.049* (0.028)	-0.765*** (0.047)	0.109*** (0.028)	0.33	3943
12	Hubli-Dharwad	14.208*** (2.291)	-0.061 (0.069)	-0.706*** (0.152)	0.179 (0.122)	0.41	242
13	Mysore	13.206*** (3.326)	0.169* (0.086)	-0.707*** (0.244)	0.070 (0.123)	0.32	295
14	Kochi (Cochin)	8.289*** (2.200)	0.118 (0.099)	-0.313** (0.140)	0.248** (0.108)	0.14	482
15	Kozhikode (Calicut)	16.485*** (2.352)	-0.003 (0.058)	-0.906*** (0.174)	0.047 (0.070)	0.58	201
16	Thiruvananthapuram	13.637*** (4.246)	-0.109 (0.263)	-0.629*** (0.200)	0.325 (0.298)	0.37	59
17	Aurangabad	17.471** (7.035)	0.114 (0.301)	-1.186*** (0.382)	0.162 (0.144)	0.64	21
18	Bhiwandi	14.801*** (2.102)	-0.037 (0.077)	-0.763*** (0.134)	0.062 (0.072)	0.22	326
19	Mumbai (Bombay)	18.667*** (1.273)	-0.101** (0.041)	-0.988*** (0.091)	-0.010 (0.040)	0.37	752
20	Nagpur	29.642*** (4.574)	-0.193 (0.155)	-2.034*** (0.344)	0.029 (0.135)	0.52	38
21	Nashik	18.235** (7.907)	0.082 (0.344)	-1.110** (0.455)	-0.012 (0.181)	0.24	41
22	Pune (Poona)	12.852*** (3.086)	0.138 (0.110)	-0.709*** (0.192)	-0.024 (0.104)	0.34	135
23	Solapur	16.202*** (2.111)	-0.088 (0.135)	-0.946*** (0.140)	0.064 (0.103)	0.64	24
24	Bhopal	11.523*** (2.564)	0.275** (0.136)	-0.642*** (0.173)	0.159 (0.109)	0.39	180
25	Gwalior	14.436*** (3.973)	-0.057 (0.164)	-0.778*** (0.282)	0.245 (0.234)	0.26	111
26	Indore	12.573*** (1.248)	0.112** (0.048)	-0.737*** (0.092)	0.244*** (0.057)	0.51	750

Table 6 (Continued)

Sr. No.	Name of the City	Constant	Independent variables			R^2	No. of factory
			Capital	Labour	Materials		
27	Jabalpur	-0.584 (3.996)	0.503*** (0.141)	0.105 (0.289)	0.361* (0.209)	0.56	86
28	Bhubaneswar	17.249*** (1.916)	0.047 (0.099)	-1.109*** (0.148)	0.085 (0.131)	0.61	46
29	Amritsar	16.087*** (2.119)	-0.012 (0.102)	-0.786*** (0.158)	0.055 (0.072)	0.24	514
30	Jalandhar	13.635 (1.368)	0.205*** (0.056)	-0.764 (0.101)	0.046* (0.053)	0.33	1383
31	Ludhiana	2.595 (1.779)	0.434*** (0.074)	-0.196 (0.127)	0.317*** (0.052)	0.21	2631
32	Jaipur	17.858*** (2.586)	0.036 (0.075)	-0.887*** (0.162)	0.080 (0.104)	0.48	109
33	Jodhpur	16.611 (15.314)	0.030 (0.223)	-0.776 (1.215)	-0.052 (0.205)	0.04	28
34	Kota	9.142 (8.877)	0.242 (0.345)	-0.433 (0.520)	0.296 (0.249)	0.55	13
35	Chennai (Madras)	15.254*** (1.235)	0.184*** (0.039)	-0.826*** (0.084)	-0.017 (0.049	0.30	2069
36	Coimbatore	18.290*** (0.782)	0.005 (0.030)	-0.994*** (0.056)	0.021 (0.030)	0.33	3829
37	Madurai	20.936*** (3.338)	-0.158 (0.103)	-1.074*** (0.215)	-0.071 (0.111)	0.20	628
38	Salem	16.192*** (2.477)	-0.073 (0.086)	-0.837*** (0.163)	0.139 (0.096)	0.25	650
39	Tiruchirappalli	15.960*** (2.607)	-0.010 (0.102)	-0.790*** (0.170)	0.007 (0.078)	0.20	543
40	Agra	8.155*** (1.474)	0.129* (0.072)	-0.313** (0.119)	0.207*** (0.078)	0.21	442
41	Aligarh	6.159** (2.320)	0.383*** (0.136)	-0.099 (0.139)	-0.035 (0.247)	0.20	159
42	Allahabad	7.487 (4.567)	0.083 (0.141)	-0.220 (0.298)	0.250 (0.200)	0.21	85
43	Bareilly	25.501*** (5.845)	-0.148 (0.156)	-1.438*** (0.429)	-0.152 (0.208)	0.24	144
44	Kanpur	15.724*** (1.592)	-0.022 (0.069)	-0.919*** (0.123)	0.160** (0.063)	0.36	753
45	Lucknow	15.715*** (3.328)	0.042 (0.103)	-0.872*** (0.242)	-0.006 (0.102)	0.28	337
46	Meerut	7.558*** (2.007)	0.310*** (0.096)	-0.272* (0.161)	0.022 (0.101)	0.22	367
47	Moradabad	16.415*** (2.066)	-0.081 (0.129)	-0.812*** (0.127)	0.203** (0.099)	0.34	271
48	Varanasi (Benares)	6.286 (10.604)	0.443 (0.345)	-0.245 (0.695)	-0.082 (0.685)	0.26	82
49	Asansol	15.159*** (3.837)	-0.005* (0.160)	-1.114*** (0.263)	0.198*** (0.117)	0.52	41
50	Kolkata (Calcutta)	19.729** (8.275)	0.064 (0.174)	-1.277** (0.574)	-0.231 (0.287)	0.37	50

*Notes: 1. Figures in parentheses represent robust standard errors. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.*
Source: Estimated by equation (4).

5.4 Comparison across all India, state level and district level results: Urban

The estimated results of OLS regression of equation (4) for all India level, state level, and district level are presented in Table 4, 5, and 6. These results clearly show that the coefficient (i.e., a_2) which represents the degree of returns to scale in urban production is statistically significant and negative, except for Haryana, Chandigarh, and Jabalpur. Most importantly, the estimate of a_2 ranges between 0.007 to -2.034. The results imply that urban firms in Indian industry are operating under decreasing returns to scale. The coefficient of per capita capital is positive and significant for all India level as well as for Andhra Pradesh, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Punjab, Tamil Nadu, Uttar Pradesh, Uttaranchal, and Chandigarh. In addition, Hyderabad, Bangalore, Mysore, Bhopal, Indore, Jabalpur, Jalandhar, Ludhiana, Chennai, Agra, Aligarh, and Meerut districts also show the positive and statistically significant coefficients of per capita capital. The results confirm that per capita capital has a significant and positive effect on urban production. In contrast, Jharkhand, Maharashtra, Delhi, Guwahati, Mumbai, and Asansol show negative and statistically significant coefficient of per capita capital. As the per capita capital is the sum of private capital and social over head capital, the negative and significant effects of capital on production indicate that the investment of social over head capital is more heavily allocated to low income regions or smaller cities. The coefficient of material is statistically significant and positive for all India level as well as for Andhra Pradesh, Bihar, Chhattisgarh, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Punjab, Uttar Pradesh, Uttaranchal, Chandigarh, and Pondicherry. On the other hand, Hyderabad, Vijayawada, Visakhapatnam, Durg-Bhilainagar, Raipur, Bangalore, Kochi, Indore, Jabalpur, Jalandhar, Ludhiana, Agra, Kanpur, Moradabad, and Asansol districts show the positive and significant effect of per capita materials used on urban production. However, for Ranchi, the negative and statistically significant coefficient of per capita materials used comes as surprise.

5.5 All India level analysis for different industry separately: Urban

In section 5.1, 5.2, and 5.3, we have considered all the urban firms together for all India level, state level, and districts level for the OLS regression estimation without taking different industrial group separately. But different industries operate with different technology, i.e., inter-industry differences may affect the estimates of scale economies. Therefore to allow, for industry fixed (or specific) effects in the model, we estimate Cobb-Douglas production function for different categories of industries, separately.

The analysis is carried out for 29 industry sectors, grouping firms by their two-digit National Industry Classification (NIC)-2004 codes: 14 (other mining and quarrying), 15 (manufacture of food products and beverages), 16 (manufacture of tobacco products), 17 (manufacture of textiles), 18 (manufacture of wearing apparel), 19 (tanning and dressing of leather), 20 (manufacture of wood and of products of wood and cork), 21 (manufacture of paper and paper products), 22 (publishing, printing and reproduction of recorded media), 23 (manufacture of coke, refined petroleum products and nuclear fuel), 24 (manufacture of chemicals and chemical products), 25 (manufacture of rubber and plastic products), 26 (manufacture of other non-metallic mineral products), 27 (manufacture of basic metals), 28 (manufacture of fabricated metal products), 29 (manufacture of machinery and equipment), 30 (manufacture of office, accounting and computing machinery), 31(manufacture of electrical machinery and apparatus), 32 (manufacture of radio, television and communication), 33(manufacture of medical, precision and optical instruments, watches and clocks), 34 (manufacture of motor vehicles, trailers and semi-trailers), 35(manufacture of other transport equipment), 36(manufacture of furniture; manufacturing), 37 (recycling of metal waste and scrap), 40(electricity, gas, steam and hot water supply), 50 (sale, maintenance and repair of motor vehicles and motorcycles), 63 (supporting and auxiliary transport activities; activities of travel agencies), 92 (recreational, cultural and sporting activities), and 93 (other service activities).[11]

[11] Although it is possible for grouping into two digit NIC-2004 code for 61 industry sector for all India level, some of the industry sectors have not been taken into consideration because either these industries sector do not operate in urban area, or due to small number of observations.

Table 7: Estimates of Cobb-Douglas Production Function for Different Industry

Sr. No.	Two digit Industry code	Constant	Independent variables			R^2	No. of factory
			Capital	Labour	Materials		
1	14	17.174*** (1.407)	-0.025 (0.057)	-1.001*** (0.100)	0.122 (0.050)	0.29	1577
2	15	11.642*** (0.520)	0.034* (0.020)	-0.611*** (0.035)	0.269*** (0.020)	0.30	9927
3	16	11.154*** (1.124)	0.136*** (0.046)	-0.544*** (0.074)	0.166*** (0.048)	0.27	1527
4	17	10.729*** (0.534)	0.063*** (0.021)	-0.533*** (0.036)	0.272*** (0.021)	0.29	6978
5	18	12.237*** (0.784)	0.113*** (0.028)	-0.633*** (0.050)	0.219*** (0.030)	0.34	2925
6	19	12.235*** (1.208)	0.099** (0.042)	-0.637*** (0.081)	0.169*** (0.050)	0.26	1595
7	20	10.661*** (1.395)	0.031 (0.062)	-0.565*** (0.096)	0.296*** (0.047)	0.30	1086
8	21	11.999*** (1.454)	0.025 (0.057)	-0.594*** (0.097)	0.228*** (0.062)	0.26	1545
9	22	10.167*** (0.986)	0.134*** (0.038)	-0.500*** (0.067)	0.230*** (0.040)	0.32	1918
10	23	9.40*** (1.970)	0.008 (0.090)	-0.271** (0.135)	0.190** (0.083)	0.15	183
11	24	9.418*** (0.685)	0.144*** (0.027)	-0.466*** (0.045)	0.255*** (0.027)	0.32	3673
12	25	12.158*** (1.056)	0.126*** (0.041)	-0.629*** (0.072)	0.146*** (0.037)	0.29	2888
13	26	11.969*** (0.921)	0.043 (0.042)	-0.584*** (0.063)	0.206*** (0.038)	0.26	2717
14	27	9.901*** (0.775)	0.060* (0.033)	-0.493*** (0.053)	0.299*** (0.031)	0.28	2962
15	28	10.376*** (0.802)	0.025 (0.034)	-0.513*** (0.056)	0.336*** (0.029)	0.26	4617
16	29	9.449*** (0.699)	0.123*** (0.029)	-0.482*** (0.048)	0.268*** (0.029)	0.25	4470
17	30	8.689*** (2.185)	0.255*** (0.088)	-0.379** (0.147)	0.105 (0.109)	0.28	149
18	31	9.504*** (0.878)	0.163*** (0.039)	-0.528*** (0.060)	0.283*** (0.036)	0.34	1869
19	32	8.042*** (1.600)	0.126*** (0.058)	-0.307*** (0.104)	0.285*** (0.060)	0.24	651
20	33	6.798*** (1.624)	0.164*** (0.059)	-0.322*** (0.093)	0.360*** (0.090)	0.25	486
21	34	9.822*** (1.081)	0.131*** (0.036)	-0.533*** (0.073)	0.315*** (0.050)	0.34	1569
22	35	6.942*** (1.276)	0.232*** (0.048)	-0.439*** (0.091)	0.370*** (0.049)	0.33	1357
23	36	12.618*** (1.093)	0.054 (0.042)	-0.601*** (0.074)	0.124*** (0.046)	0.27	1177
24	37	1.640 (4.466)	0.234 (0.155)	-0.056 (0.265)	0.566** (0.224)	0.44	37
25	40	11.491*** (2.777)	0.042 (0.129)	-0.601*** (0.176)	0.273* (0.147)	0.29	91
26	50	11.483*** (1.322)	0.122*** (0.046)	-0.578*** (0.091)	0.153*** (0.052)	0.20	2145
27	63	15.939*** (1.935)	-0.043 (0.083)	-0.901*** (0.131)	0.161* (0.085)	0.42	496
28	92	9.052* (4.877)	0.121 (0.121)	-0.577 (0.368)	0.539** (0.229)	0.40	24
29	93	12.970*** (4.290)	0.139 (0.177)	-0.710 (0.313)	0.107 (0.155)	0.37	72

*Note: Figures in parentheses represent robust standard errors. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively. Source: Estimated by equation (4).*

For the two digit industry level analysis, again, Cobb-Douglas production function of equation (4) is used by considering 29 industry groups of all India urban firms. Table 7 presents the regression result for these industrial groups, separately. The results show that the value of a_2 is statistically significant and negative for 26 industrial groups. However, the coefficient is negative but statistically insignificant for 37 (recycling of metal waste and scrap), 92 (recreational, cultural and sporting activities), and 93 (other service activities). This implies that urban firms in Indian industry operate under decreasing returns to scale and the values of the coefficient a_2 range between -0.056 to -1.001. The coefficient of per capita capital is statistically significant and positive for the industry group 15 (manufacture of food products and beverages), 16 (manufacture of tobacco products), 17 (manufacture of textiles), 18 (manufacture of wearing apparel), 19(tanning and dressing of leather), 22 (publishing, printing and reproduction of recorded media), 24 (manufacture of chemicals and chemical products), 25 (manufacture of rubber and plastic products), 27 (manufacture of basic metals), 29 (manufacture of machinery and equipment), 30 (manufacture of office, accounting and computing machinery), 31(manufacture of electrical machinery and apparatus), 32 (manufacture of radio, television and communication), 33 (manufacture of medical, precision and optical instruments, watches and clocks), 34 (manufacture of motor vehicles, trailers and semi-trailers), 35(manufacture of other transport equipment), and 50 (sale, maintenance and repair of motor vehicles and motorcycles). The coefficient of per capita materials used also show positive and statistically significant effect on urban production, except for industry groups14 (other mining and quarrying) and 93 (other service activities). The estimated results indicate that per capita capital and materials used have a positive and statistically significant effect on urban production.

5.6 Analysis for different industry located in 52 large city districts: Urban

In section 5.5, we estimate the Cobb-Douglas production function for different categories of industries located in all India urban areas, separately. However, as Krugman (1991) core-periphery model explains, the realization of economies of scale through minimizing transportation cost occurs in the region with larger demand, i.e., "Core region". Therefore, we consider 52 large cities in India as a proxy of "core regions" and measure the agglomeration economies for different industries located in these 52 larger cities in India.

Table 8: Estimates of Cobb-Douglas Production Function for different industries located in 52 Large Cities

Sr. No.	Two digit industry code	Independent variables			Constant	R^2	No. of factory
		Capital	Labour	Materials			
1	14	-0.070 (0.189)	-1.273** (0.491)	-0.470** (0.208)	24.155*** (6.303)	0.26	160
2	15	-0.015 (0.037)	-0.560*** (0.064)	0.147*** (0.037)	12.620*** (0.912)	0.18	2436
3	16	0.123 (0.103)	-0.732*** (0.210)	0.123 (0.104)	13.513*** (2.853)	0.37	187
4	17	0.012 (0.034)	-0.694*** (0.056)	0.162*** (0.033)	13.614*** (0.826)	0.23	4154
5	18	0.113*** (0.037)	-0.688*** (0.065)	0.139*** (0.038)	13.450*** (1.035)	0.32	1765
6	19	0.029 (0.055)	-0.724*** (0.109)	0.132* (0.068)	14.181*** (1.613)	0.29	731
7	20	0.136 (0.102)	-0.323* (0.173)	0.214** (0.086)	8.503*** (2.281)	0.18	278
8	21	-0.044 (0.112)	-0.691*** (0.161)	0.123 (0.089)	13.955*** (2.499)	0.21	565
9	22	0.204*** (0.050)	-0.526*** (0.094)	0.140** (0.061)	10.664*** (1.405)	0.31	974
10	23	-0.061 (0.143)	-0.152 (0.213)	0.440*** (0.114)	7.380** (2.943)	0.27	56
11	24	0.123*** (0.046)	-0.520*** (0.083)	0.199*** (0.047)	10.613*** (1.245)	0.30	1283
12	25	0.248*** (0.065)	-0.535*** (0.118)	0.047 (0.058)	11.091*** (1.742)	0.26	1043
13	26	0.267*** (0.090)	-0.449*** (0.143)	0.122 (0.086)	9.632*** (2.040)	0.30	581
14	27	0.043 (0.049)	-0.472*** (0.082)	0.320*** (0.051)	9.772*** (1.194)	0.24	1322
15	28	0.049 (0.047)	-0.637*** (0.070)	0.254*** (0.043)	12.141*** (1.048)	0.26	2580
16	29	0.112** (0.044)	-0.693*** (0.075)	0.131*** (0.047)	12.574*** (1.097)	0.23	2277
17	30	0.053 (0.126)	-0.822*** (0.238)	-0.088 (0.180)	16.150*** (3.620)	0.45	74
18	31	0.185*** (0.053)	-0.611*** (0.090)	0.128** (0.052)	11.289*** (1.318)	0.35	987
19	32	-0.011 (0.077)	-0.559*** (0.166)	0.126 (0.086)	12.862*** (2.362)	0.20	347
20	33	0.020 (0.081)	-0.645*** (0.135)	0.024 (0.099)	14.277*** (2.161)	0.22	225
21	34	0.127** (0.060)	-0.579*** (0.115)	0.165** (0.070)	11.221*** (1.651)	0.30	644
22	35	0.295*** (0.065)	-0.437*** (0.135)	0.390*** (0.070)	6.106*** (1.931)	0.32	973
23	36	0.002 (0.044)	-0.672*** (0.087)	0.054 (0.054)	14.360*** (1.211)	0.30	708
24	37	0.021 (0.742)	-0.157 (0.758)	0.788 (0.918)	2.722 (12.437)	0.41	7
25	40	-0.113 (0.191)	-0.894*** (0.314)	0.220 (0.281)	16.579*** (5.307)	0.29	40
26	50	0.180*** (0.063)	-0.460*** (0.138)	0.204** (0.083)	9.436*** (1.952)	0.19	1169
27	63	-0.185 (0.235)	-0.725** (0.319)	0.277 (0.250)	14.590*** (4.698)	0.28	132
28	93	-0.024* (0.184)	-0.675 (0.378)	0.167 (0.144)	13.731** (5.327)	0.37	59

*Note: Figures in parentheses represent robust standard errors. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.*
Source: Estimated by equation (4).

Table 8 presents the regression result of equation (4) for 28 industrial (two digit level) groups, separately. The results show that the value of a_2 is negative for 28 industrial groups and statistically significant for 26 industrial groups, except for industrial groups 23 (manufacture of coke, refined petroleum products and nuclear fuel) and 93 (other service activities). The results imply that urban firms in Indian industries those are located in 52 largest cities operating under decreasing returns to scale and the values of a_2 ranges between -0.152 to -1.273. The regression results also find that the coefficient of per capita capital is positive and statistically significant for industry groups18 (manufacture of wearing apparel), 22 (publishing, printing and reproduction of recorded media), 24 (manufacture of chemicals and chemical products), 25 (manufacture of rubber and plastic products), 26 (manufacture of other non-metallic mineral products), 29 (manufacture of machinery and equipment), 31(manufacture of electrical machinery and apparatus), 34 (manufacture of motor vehicles, trailers and semi-trailers), 35(manufacture of other transport equipment), and 50 (sale, maintenance and repair of motor vehicles and motorcycles). The coefficients of per capita materials used are statistically significant and positive for industry groups15 (manufacture of food products and beverages), 17 (manufacture of textiles), 18 (manufacture of wearing apparel), 19 (tanning and dressing of leather), 20 (manufacture of wood and of products of wood and cork), 22 (publishing, printing and reproduction of recorded media), 23 (manufacture of coke, refined petroleum products and nuclear fuel), 24 (manufacture of chemicals and chemical products), 27 (manufacture of basic metals), 28 (manufacture of fabricated metal products), 29 (manufacture of machinery and equipment), 31(manufacture of electrical machinery and apparatus), 34 (manufacture of motor vehicles, trailers and semi-trailers), 35(manufacture of other transport equipment), 36(manufacture of furniture; manufacturing), and 50 (sale, maintenance and repair of motor vehicles and motorcycles). The results indicate that per capita capital and materials used have a positive and significant effect on urban production. However, the coefficient of per capita capital for industry group 93 (other service activities) and the coefficient of per capita materials used for industry group14 (other mining and quarrying) are negative and statistically significant.

5.7 Largest industry of a large city districts: Urban

Finally, in order to measure the scale economies especially for a largest (in terms of number of firms) industry operating in a specific large city (or "core region"), we measure the agglomeration economies for different industries located in different large cities in India.

Here, we consider the industry of a city which has the highest number of firms located in that particular city, and we call this industry as the largest industry of this city. Table 9 presents the regression result of equation (4) for 27 districts.[12] The results show that among 27 large city districts, the largest industries of 18 districts operate under decreasing returns to scale, as the value of coefficient a_2 is negative and statistically significant. However, the value of a_2 is positive for industry groups15 (manufacture of food products and beverages) located in Vijayawada, 27 (manufacture of basic metals) located in Patna, 29 (manufacture of machinery and equipment) located in Mysore and Chandigarh. But the coefficient a_2 is not statistically significant. The values of a_2 range between 0.764 and -1.506. The coefficient per capita capital is positive and significant only for industry group 29 (manufacture of machinery and equipment) located in Jalandhar out of 27 city districts. The coefficients of per capita materials used are positive and statistically significant for industry groups 15 (manufacture of food products and beverages) located in Vijayawada and Indore, 27 (manufacture of basic metals) located in Visakhapatnam and Durg-Bhilainagar, 18 (manufacture of wearing apparel) located in Chennai, 17 (manufacture of textiles) located in Salem, 19 (tanning and dressing of leather) located in Agra and Kanpur, 29 (manufacture of machinery and equipment) located in Chandigarh.

[12] Though we have considered 52 large city districts for the analysis, we report here 27 districts due to small number of observation of a largest industry group of a particular district.

Table 9: Estimates of Cobb-Douglas Production Function for different largest industry located in different Large Cities

Sr. No.	Cities	Two Digit Industry code	Constant	Independent variable			R^2	No. of factory
				Capital	Labour	Materials		
1	Hyderabad	15	14.206*** (4.755)	0.120 (0.141)	-0.742** (0.323)	0.205 (0.205)	0.61	116
2	Vijayawada	15	-0.615 (7.245)	0.381 (0.228)	0.205 (0.508)	0.420** (0.199)	0.36	104
3	Visakhapatnam	27	5.839* (3.069)	0.065 (0.146)	-0.283 (0.233)	0.525** (0.195)	0.49	88
4	Patna	27	-7.364 (13.470)	0.544 (0.502)	0.764 (0.747)	0.179 (0.411)	0.15	12
5	Durg-Bhilainagar	27	11.316*** (2.148)	0.106 (0.121)	-0.568*** (0.168)	0.291** (0.104)	0.60	97
6	Raipur	27	13.200*** (3.391)	-0.028 (0.150)	-0.655*** (0.219)	0.252 (0.192)	0.42	146
7	Bangalore	18	17.851*** (1.794)	-0.048 (0.064)	-0.935*** (0.108)	0.100 (0.063)	0.39	607
8	Mysore	29	2.609 (7.414)	0.270 (0.225)	0.268 (0.606)	0.095 (0.244)	0.16	59
9	Kochi (Cochin)	24	11.933* (5.959)	0.227 (0.236)	-0.748* (0.363)	0.272 (0.209)	0.48	63
10	Bhiwandi	24	9.059* (4.537)	0.138 (0.170)	-0.490 (0.295)	0.205 (0.145)	0.30	73
11	Mumbai (Bombay)	37	19.188*** (1.967)	-0.065 (0.055)	-1.008*** (0.173)	-0.112** (0.059)	0.35	221
12	Pune (Poona)	29	8.530 (7.570)	0.150 (0.238)	-0.521 (0.498)	0.275 (0.209)	0.36	39
13	Indore	15	13.751*** (4.898)	-0.197 (0.148)	-0.699* (0.338)	0.268* (0.151)	0.34	237
14	Amritsar	17	14.185*** (3.354)	0.063 (0.179)	-0.700*** (0.226)	0.092 (0.095)	0.28	212
15	Jalandhar	29	18.552*** (2.302)	0.168* (0.093)	-1.154*** (0.176)	-0.054 (0.078)	0.43	578
16	Ludhiana	17	8.801** (3.520)	0.233 (0.142)	-0.488* (0.261)	0.066 (0.092)	0.12	765
17	Chennai (Madras)	18	16.183*** (2.088)	0.172 (0.064)	-0.920*** (0.135)	0.002*** (0.079)	0.41	540
18	Coimbatore	17	17.811*** (0.994)	-0.014 (0.038)	-0.953*** (0.069)	0.058 (0.043)	0.34	2182
19	Madurai	15	22.570*** (8.194)	-0.183 (0.213)	-1.115* (0.557)	-0.170 (0.206)	0.12	212
20	Salem	17	15.180*** (3.260)	-0.035 (0.114)	-0.774*** (0.210)	0.147** (0.080)	0.37	197
21	Tiruchirappalli	28	15.736*** (5.602)	-0.094 (0.254)	-0.780** (0.308)	0.145 (0.151)	0.32	178
22	Agra	19	5.562*** (2.808)	0.149 (0.098)	-0.201 (0.174)	0.372** (0.162)	0.35	83
23	Kanpur	19	23.654*** (3.132)	-0.138 (0.178)	-1.506 (0.230)	0.040*** (0.163)	0.45	154
24	Meerut	17	11.372*** (2.749)	0.303 (0.216)	-0.605*** (0.193)	0.032 (0.201)	0.41	114
25	Moradabad	29	15.482*** (2.522)	0.022 (0.150)	-0.756*** (0.151)	0.161 (0.121)	0.34	191
26	Chnadigarh	29	0.716 (4.896)	0.346 (0.222)	0.014 (0.393)	0.492** (0.107)	0.44	103
27	Delhi	18	19.152*** 3.712)	-0.096 (0.127)	-0.876*** (0.207)	0.048 0.138)	0.29	186

*Note: Figures in parentheses represent robust standard errors. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.*
Source: Estimated by equation (4).

5.8 Comparison between all India, state level and district level results for different Industry groups: Urban

In sections 5.5, 5.6, and 5.7, we measure the agglomeration economics for firms in different industries those located in all India level urban areas or located in 52 larger cities in India. The results are presented in Table 7, 8, and 9; the results show that the value of a_2 is negative and statistically significant for all the firms in different industries. However, the value of a_2 is positive but statistically insignificant for industry groups 15 (manufacture of food products and beverages) located in Vijayawada, 27 (manufacture of basic metals) located in Patna, 29 (manufacture of machinery and equipment) located in Mysore and Chandigarh. The results confirm that Indian urban firms under different industries are operating under decreasing returns to scale and the estimated values of a_2 range between -0.056 to 0.764. The results also indicate that in many cases the coefficient of per capita capital and materials used have positive and statistically significant effects on urban production. In contrast, the coefficient of per capita capital is negative and significant for industry group 93 (other service activities). Moreover, the coefficient of per capita materials used is statistically significant and negative for industry groups 14 (other mining and quarrying) located in 52 large city districts and 37 (recycling of metal waste and scrap) located in Mumbai district. The result of negative and significant per capita capital and materials used comes as surprise.

Our findings, i.e., the decreasing returns to scale at firm level support the findings of Lall et al. (2004), Lall and Rodrigo (2001), and Ghani et al. (2012) for Indian firms. However, this result does not support the findings of Kanemoto et al., (1996) in regard to Japan and Rinaldi and Nurwita (2011) in regard to Indonesia. However, the result of negative effect of social overhead capital on urban production for some industries (or firms) supports the findings of Kanemoto et al., (1996).

6 Conclusions and Policy Implications

The estimated results show that urban firms in Indian industry operate under decreasing returns to scale in urban production irrespective of at all India urban level and large city level. Economies of scale for all the urban firms together, ranges between -0.492 and -0.612 for all India level, 0.007 and -1.305 for 26 state level, and 0.0105 and -2.034 for 52 large city level. On the other hand, different industries specific analyses show that economies of scale lies between -0.056 and -1.001 for all India level, -0.152 and -1.273 for 52 large city levels and 0.764 to -1.506 for different city specific largest industries level.

The firms located in Haryana, Chandigarh, and Jabalpur show positive and statistically insignificant economies of scale. In addition, industry groups 15 (manufacture of food products and beverages) located in Vijayawada, 27 (manufacture of basic metals) located in Patna, 29 (manufacture of machinery and equipment) located in Mysore and Chandigarh also show statistically insignificant but positive economies of scale. The results indicate that Indian urban firms under different industries are operating under decreasing returns to scale. The results show that for a large numbers of firms (or industries) per capita capital and materials used have a positive and statistically significant effect on urban production.

From this analysis it appears to be counterintuitive about the influence of increasing returns to scale for regional concentration of firms (or industries) in Indian urban sector. Our findings may also support the "folk theorem" of location theory, which says that in the absence of increasing returns, there will be "backyard capitalism," with production potentially locating wherever there is demand. Finally, we conclude that Indian manufacturing urbanization seems to be less important for urban economic growth.

Therefore, we suggest that firm level or industry specific and location specific (aimed at unites operating at different levels such as small towns/metros/large urban agglomerations) policies are required for the promotion of concentration of urban firms to absorb the advantage of increasing returns to scale for higher production.

However, in consideration of different econometric specification and different variables pertaining to different periods of time applied to estimate the economies of scale for urban firms, the estimated results are open to further scrutiny.

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