Determinants of Urbanization in Different Size/Class Distribution of Cities/Towns in India

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Abstract:
While there are several studies that have investigated the determinants of urbanization in India by considering all the cities/towns together or only large cities, this paper tries to investigate it by considering different class/size of cities of major states separately. For the analysis we use OLS regression model by considering latest Census data in 2011. Urbanization is conventionally measured by size/growth/density of city population. On the other hand, this study considers environmental effect (rain fall and temperature), spatial interaction effect (road distance to state headquarters/subdivision headquarters/ nearest city with population 1 lakh/ 5 lakh or more) and basic infrastructural facilities (number of school/colleges/universities/electricity connections/road length) to investigate the determinants of urbanization in different class/size cities in India. The results show that though overall environment and infrastructural facilities have a positive effect and spatial interaction has negative effect on urbanization, the results obtained here differ from earlier ones in respect of different size/class of cities/towns as also different measurements of urbanization. Finally, the paper suggests that for promotion of urbanization in India different urban policies have to be evolved to suit different size/class of cities/towns. Otherwise, India will face the problem of unbalanced urbanization which may not unlock the full potential contribution of urbanization on economic growth in India.

Key Words: Urbanization, city size classes, India

JEL Classification: O18, R11, R12

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I. Introduction

In recent years, most of the developing countries in the world are experiencing rapid urbanization compared to the developed countries. As per the United Nation's report, by 2050 around 64% of developing world and 86% of the developed world will get urbanized. Rapid urbanization is one of the most important factors that are counted upon to promote urban lead economic growth in India in the days to come. Urbanization can be described as a transition from agricultural based economy to urban based industry and service lead (i.e., non-agricultural) economy. According to 2011 census, out of total population of 121 crore about 37.7 crore (i.e., 31%) live in urban areas and 83.3 crore (i.e., 69%) live in rural areas in India. The total population has increased from 102.9 crore in 2001 to 121 crore in 2011, whereas the population residing in urban areas increased from 28.6 crore in 2001 to 37.7 crore in 2011, which accounts for about 32% increase. It reflects a rapid increase of urbanization. Most importantly, increase in urban population of India is also associated with increase in the size of national GDP. In 1981, when the urban population of India was 23.3 % its contribution to national income was about 47%, but in 2011, with 31.2 % of urban population, its contribution to national income increased to 65%. This indicates that increasing urbanization is the major cause of higher national income in Indian economy. Urbanization being the main engine of higher productivity and higher economic growth in all over the world, its contribution to India's national income also has been increasing in tandem with urbanization.

The fast pace of urbanization can be attributed to many factors such as rural to urban migration, re-classification of cities, and natural growth rate of urban population. For example, in 1991-2001, 21% rural farmers migrated to urban sector for livelihood because of the expectation of higher employment opportunities, higher wages better lifestyle, etc. in urban areas. Second reason is rural- urban reclassification of cities. However, the natural growth in population accounted for about 59.4% rise in urban population in 1991-2001 which decreased to 44% in 2001-11. Higher productivity in urban area, more employment opportunities, and better lifestyle, etc. attract more firms and also people towards urban areas. Large scale migration from rural to urban areas increases the urban GDP and economic growth rate, which in turn helps to reduce dependency on agriculture and poverty in rural areas.

Recently, government of India has launched various policies and progremmes to promote urban lead development in India as urban areas contribute higher level of GDP than rural areas. Among the various schemes introduced by governments to promote urbanization in India in recent years, 100 Smart Cities Programme, AMRUT (Atal Mission for Rejuvenation and Urban Transformation), JNNURM (Jawaharlal Nehru National Urban Renewal Mission), UIDSSMT (Urban Infrastructure Development Scheme for Small and Medium Towns), NERUDP (North Eastern Region Urban Development Programme), NUIS (National Urban Information System), Capacity Building for Urban Local Bodies, Lump Sum Provision Scheme for the benefit of North East Region (NER) including Sikkim, Brihan Mumbai Storm Water Drainage (BRIMSTOWAD) project at Mumbai, PPP (Public Private Partnership), Clean India Mission are the major ones.

The above discussion clearly indicates that India is experiencing a fast pace of urbanization and a corresponding high contribution to national income from the urban segment. This is also indicative of the transformation the economy is undergoing from a predominantly agricultural based economy into an industry and service lead urban-centered economy. In a welcome measure, government has initiated and implemented various urban related policies and programs to promote urbanization in India in recent years. However, the country need better policies/programmes/schemes in the coming days in order to promote planned urbanization in India and to absorb the large economic potential that urban areas can provide for higher and sustainable economic growth in India. In this perspective, it is important to know the factors that contribute to rapid urbanization in India. Recently some studies e.g., Sridhar (2010), Tripathi (2013), Tripathi and Mahey (2016) have identified various factors responsible for the rapid urbanization in India. However, these studies have considered all the cities/towns in India (Sridhar, 2010), or large agglomerations (Tripathi, 2013) or all the cities/towns in a state/province (Tripathi and Mahey, 2016) in India together and not separately. However, India's urbanization pattern is disparate and governed solely by type of class/size of urban population in India. It is also different for different states, geographies in India. This calls for a systemic examination of determinants of urbanization in different class/size and different states of India. This paper therefore attempts to fill this serious research gap by analyzing the differences in urbanization pattern across the different class/size cities/towns and different states of India. It is hoped that results of this study will help the authorities to prescribe appropriate urban policies

and programmes in India to suit the apparent diversity in terms of class/size distribution of urban population in India. For this analysis, the study considers the following 15 major Indian states namely, Andhra Pradesh, Tamil Nadu, Kerala, Maharashtra, Gujarat, Karnataka, Punjab, West Bengal, Madhya Pradesh, Rajasthan, Haryana, Uttar Pradesh, Odisha, Assam and Bihar. These 15 major states accommodate almost 90% of total urban population in India and cover about 74% of total geographical area of the country. Among these 15 states, the most urbanized states are Goa (62.17%), Mizoram (51.51%), Andhra Pradesh (49.8%), Tamil Nadu (48.45%) and Kerala (47.72%) as of 2011. On the other hand, the least urbanized states are Himachal Pradesh (10.04%), Bihar (11.3%), Assam (14.08 %), Odisha (16.68%) and Meghalaya (20.08 %) as of 2011.

The rest of the paper is organized as follows. The second section provides trends and patterns of urbanization in major states of India. Section 3 provides a brief review of literature. Empirical framework and results are presented in section 4. Finally, the final section presents the conclusions and policy implications.

II. Trends and Patterns of Urbanization in major states in India

In this section, trends and patterns of urbanization in India of the recent past is analyzed. Table 1 provides the trends and patterns in the most urbanized states of India. In 1981, the highest percentage urban population was recorded in Maharashtra (35%) and the lowest urban population was recorded in Assam (9.9%). In contrast, in 2011, the highest percentage of urban population was registered in Tamil Nadu (48.5%) and lowest in Bihar (11.3%). In 1981, the all-India urban population was 23.3% which increased to 31.2% in 2001. According to census 2001, the number of statutory towns in India was 3799 which increased to 4041 in 2011census.[1] The number of Census towns increased from 1362 in 2001 to 3894 in 2011 and the number of urban agglomeration increased from 384 in 2001 to 475 in 2011. [2]

[1] All places within municipality, corporation board or notified town area committee etc. are recorded as statutory towns.

[2] All places which satisfy the following criteria (known as census towns): a) a minimum population of 5000 b) at least 75% of the male main workers engaged in non agricultural pursuits c) a density of population of at least 400 sq. km.

Table 1: Trends and patterns of urbanization in India and its major states

	1981		1991		2001		2011	
	% of urban population	CAGR	% of urban population	CAGR	% of urban population	CAGR	% of urban population	CAGR
Maharashtra	35.0	1.2	38.7	2.3	42.4	2.1	45.2	1.5
Tamil Nadu	33.0	0.9	34.2	1.4	44.0	1.1	48.5	1.5
Gujarat	31.1	1.0	34.5	1.9	37.4	2.0	42.6	1.8
Karnataka	28.9	1.7	30.9	1.9	34.0	1.6	38.6	1.5
Punjab	27.7	1.6	29.5	1.9	33.9	1.8	37.3	1.3
West Bengal	26.5	0.7	27.7	2.2	28.0	1.7	31.9	1.3
A. P.	23.3	1.9	26.9	2.2	27.3	1.3	33.5	1.1
Haryana	21.9	2.2	24.6	2.5	28.9	2.5	34.8	1.9
Rajasthan	21.0	1.8	22.9	2.5	23.4	2.5	24.9	2.0
M.P.	20.3	2.2	23.2	2.4	26.5	2.2	27.6	1.9
Kerala	18.7	1.4	26.4	1.3	26.0	0.9	47.7	0.5
U.P.	18.0	2.5	19.8	2.3	20.8	2.3	22.3	1.9
Bihar	12.5	2.2	13.1	2.1	10.5	2.5	11.3	2.3
Orissa	11.8	3.4	13.4	1.8	15.0	1.5	16.7	1.3
Assam	9.9	1.1	11.1	2.2	12.9	1.7	14.0	1.6
All India	23.3	2.2	25.7	2.2	27.8	2.0	31.2	1.6

Source: Authors' calculation using various years of census data
Note: A.P. (Andhra Pradesh), M.P. (Madhya Pradesh), and U. P. (Uttar Pradesh)

Very large urban agglomerations with more than 10 million or more population are known as mega cities.[3] According to this definition, the mega cities in India are Greater Mumbai (18.4 million), Delhi (16.3 million), and Kolkata (14.1 million). Greater Mumbai recorded a population growth of 30.47% in the decade 1991-2001 which declined to 12.05% in the next decade of 2001-2011. Delhi recorded population growth of 52.24% in the decade 1991-2001 which declined to 26.69% in the decade 2001-2011; similarly Kolkata recorded population growth of 19.60% in the decade 1991-2001 which declined to 6.87% in the decade 2001-2011. This indicates that the population growth of these Mega cities has slowed down during the recent decades.

[3]An urban agglomeration is a continuous urban spread constituting a town and its adjoining out growths, or two or more physically contiguous towns together with or without out growths of such towns.

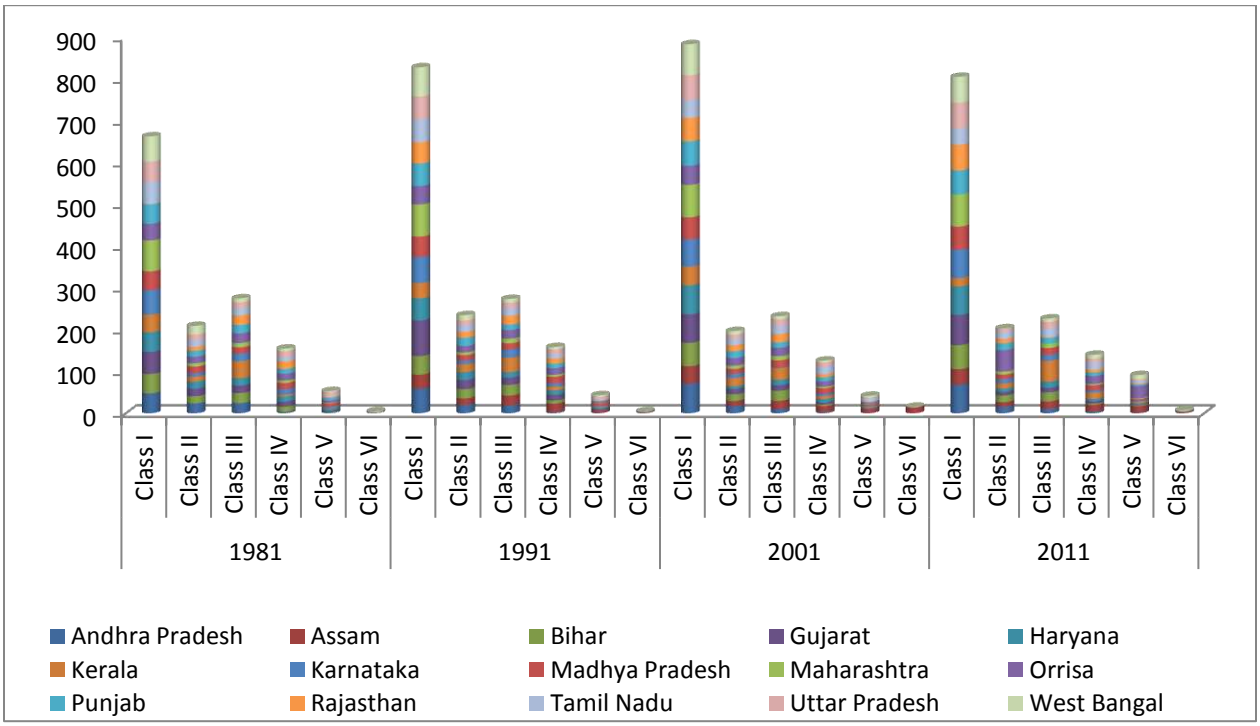
Table 2: State wise statutory towns and census towns (in 2001 & 2011)

States	No. of Towns (2001)		No. of Towns (2011)		CAGR (2001 to 2011)	
	Statutory Towns	Census Towns	Statutory Towns	Census Towns	Statutory Towns	Census Towns
Maharashtra	251	127	256	279	0.2	8.2
Tamil Nadu	721	111	721	376	0.0	13.0
Gujarat	168	74	195	153	1.5	7.5
Karnataka	226	44	220	127	-0.3	11.2
Punjab	139	18	143	74	0.3	15.2
West Bengal	123	252	129	780	0.5	12.0
A.P.	117	93	125	228	0.7	9.4
Haryana	84	22	80	74	-0.5	12.9
Rajasthan	184	38	185	112	0.1	11.4
M.P.	339	55	364	112	0.7	7.4
Kerala	60	99	59	461	-0.2	16.6
U.P.	638	66	648	267	0.2	15.0
Bihar	125	5	139	60	1.1	28.2
Orissa	107	31	107	116	0.0	14.1
Assam	80	45	88	126	1.0	10.8
All India	3799	1362	4041	3894	0.6	11.1

Source: Authors' calculation using various years of census data

Table 2 gives the- state wise number of statutory towns and census towns as of 2001 and 2011. In 2001, the highest number of statutory and census towns was in Tamil Nadu (721) followed by West Bengal (252). In the same year, the lowest number of statutory and census towns was in Kerala (60) followed by Bihar (5). In contrast, in 2011, the highest number of statutory and census towns was in West Bengal (780) followed by Tamil Nadu (721). In the same year, the lowest number of statutory and census towns was in Bihar (60), followed by Kerala (59).

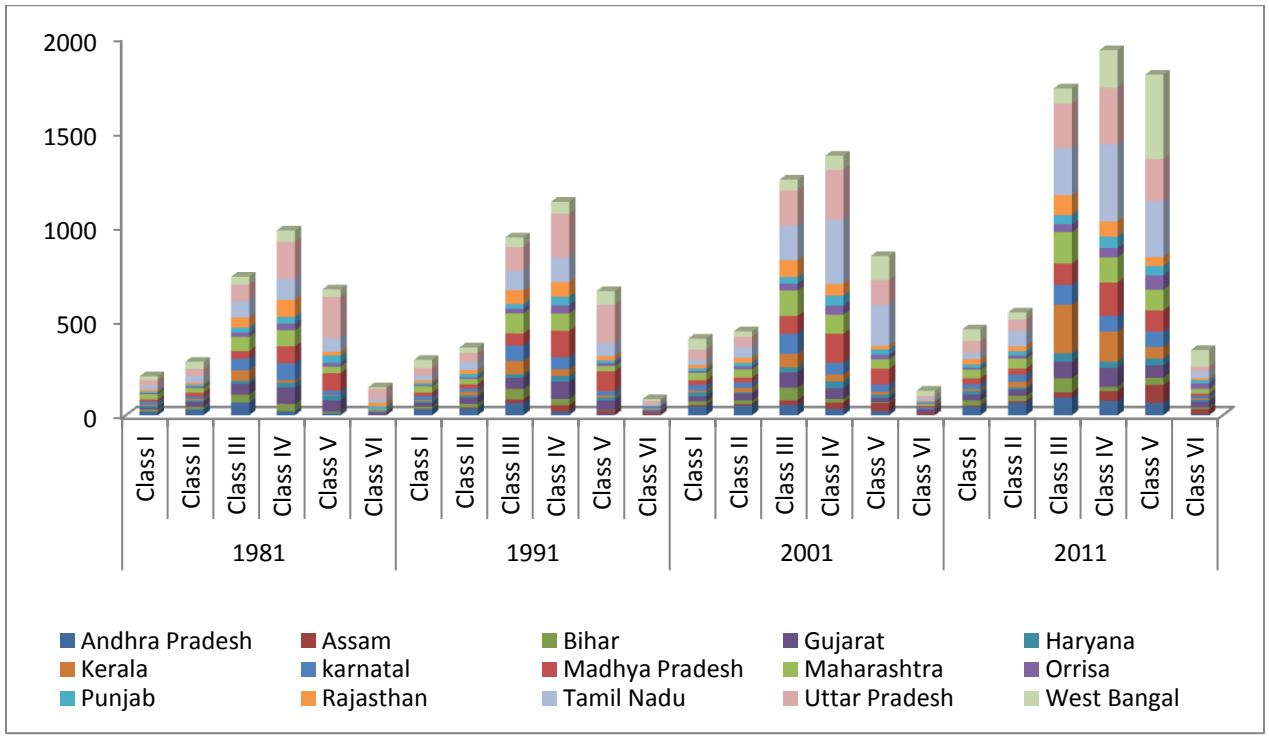
Figure 1: Class wise percentage of urban population in major states of India



Source: Author's using different census years, Notes: According to census of India, 2011
Urbanization is divided into six categories, Class I (100,000 or more population), Class II (50,000 to 99,999), Class III (20,000 to 49,999), Class IV (10,000 to 19,999), Class V (5000 to 9999), Class VI (below 5000).

Figure 1 illustrates the class- wise urban population in different states of India for various years. As can be observed from the figure, there is an increase in urban population (from 1981 to 2011) of class I towns as compared to class II, III, IV, V, and VI towns. In Andhra Pradesh, the percentage of urban population in class I cities increased from 47% in 1981 to 68% in 2011. In Maharashtra, urban population of class I cities increased from 74.2% in 1981 to 76.4% in 2011. Similarly, in other urbanized states like Uttar Pradesh, urban population in class I cities towns increased from 48 % 1981 to 68% 2011. In contrast, in Kerala, urban population in class I cities decreased from 42% in the census year 1981 to 20% in the census year 2011. Most interestingly, Rajasthan registered the highest percentage increase of urban population in class I cities, i.e. an increase from 0.5% in 1981 to 61% in 2011. In Haryana, the percent of urban population in class I cities increased from 47% to in 1981 to 68.02% in 2011. However, there was a decline in the share of urban population of class III, IV, V and VI in all the major urbanized states of India between the two census years. The results show that the major population movement is towards class I cities as compared to class II, III, IV, V and VI.

Figure 2: Class wise number of cities/towns in major states of India



Source: Author's using different census years

Figure (2) represents the class wise- cities number of towns in different states of India for various years. The above figure illustrates the increase or decrease in the number of towns or cities in different census periods. The number of class I towns/cities in Andhra Pradesh increased from 20 in 1981 to 46 in 2011 and number of class VI cities increased from 1 in 1981 to 5 in 2011. In Maharashtra, number of class I cities increased from 28 in 1981 to 45 in 2011, and number of class VI towns/cities increased from 91 in 1991 to 134 in 2011. In Rajasthan, the number of class I cities increased from 11 in 1981 to 29 in 2011 and number of class III towns/cities increased from 61 in 2001 to 105 in 2011. In Kerala, number of class III towns/cities increased from 56 in 1981 to 256 in 2011 and class VI towns increased from 14 in 1981 to 159 in 2011. In Tamil Nadu, number of class I towns increased from 21 in 1981 to 32 in 2011 and number of class VI towns increased from 18 in 1981 to 35 in 2011. In West Bengal, number of class I cities increased from 22 in 1981 to 62 in 2011 and class VI increased from 8 to 88 during the similar period of time. The result shows that the number of class I cities is increasing continuously because most of the population movement is towards class I towns but here one point to be noted

is that the total number of class III, IV and V cities/towns is more than the total number of Class I and VI cities and towns in India.

III. Review of Literature

Among the Indian empirical studies that focus on the issues of trends and pattern of urbanization, Bose (1973, 1978) using census data explained the specific factors which contributed to changes in India's urbanization patterns in different decades. According to him, each decade had a dominant theme which affected the growth of urban population and during the first half of the twentieth century, when there was never a 'normal' decade of growth of urban population. Factors like famines, plague, influenza epidemic, war and partition dominated the urban scene. He also showed that the stagnation of small and medium towns in the face of overall rapid urbanization persisted from colonial times and in spite of new strategies like development of growth poles, dispersal of industries, etc. The big cities continue to dominate the urban scene. He deliberated on the effect of migration on urbanization in India by introducing 'push-back factor' which is responsible for attracting migrants from rural areas to urban areas. In addition, he recommended several policy options by analyzing various disturbing urban issues such as basic urban services (i.e., water, sanitation), slum development, supply of energy, urban poverty, land use patterns, etc.

Mills and Becker (1986) analyzed and estimated city growth in India, first using a national sample of large Indian cities and then using a sample of cities in the large Indian state of Madhya Pradesh. They reasoned that the rapid growth of a city's manufacturing employment and the natural growth of the country's population are the factors responsible for the fast growth of urban population. It was further found that a large initial population discourages further city growth and that if the initial population is somewhere below 1 million, then such cities stand to grow faster in higher income states than they would do in lower income states.

More recently, Bhagat (2011) found that the declining trend in the urban population growth rate observed during 1980s and 1990s reversed at the national level, and the rate of urbanization increased at a faster pace during 2001–2011. However, the contribution of natural increase in urban growth has declined in terms of proportions over time. Kalamkar (2009) analyzed the relationship between urbanization and agriculture growth in India. According to him, population growth has resulted in a downward trend in per capita availability of forest and agricultural land

since the 1950s. Also, the faster growth in urban population is largely on account of migration from rural areas. Mundhe and Jaybhaye (2014) examined the trends and patterns of urbanization in Maharashtra for the decade 1991–2011. The authors describe urbanization within Maharashtra as very lopsided. Western Maharashtra is more urbanized than some extreme parts of Vidharbha and Marathwada which regions have the lowest level of urbanization in the state. Rhoda (1983) suggested that governments should reconsider policies which rely solely on rural development to curb rural–urban migration and alleviate problems of urban poverty and underemployment in rural areas. Making improvements in urban areas is the most promising approach to slowing rural– urban migration, according to Rhoda. Mathur (2005) argued that post-liberalization urban growth was driven by the substantial growth of the urban population and changes in the share of employment in the manufacturing and service sectors. However, a recent study by Tripathi (2015), on the recent trends and patterns of India's urbanization and urban economic growth finds evidence of rapid urbanization in India in terms of number of cities/towns, urban population size, urban area and urban population growth rate. Sridhar (2010) in their analysis of the links between urbanization and economic growth in India, estimated the determinants of city growth and output both at the district and city levels and found that factors such as proximity to a large city and the process of moving from agriculture to manufacturing, determine the size of a city. Cali (2009) explored the various possible implications of the urbanization process on development outcomes in India. The author found that the level of urbanization and that of economic development seem to go hand in hand within Indian states over time. The study by Tripathi (2013) tried to see whether a positive link exists between urban agglomeration and economic growth in India. Despite data constraints, the paper considering 59 large agglomerations and applying the recursive econometrics model, found a strong positive relationship between urban agglomeration and economic growth in India.

Table 3 describes the major agglomeration studies in details by giving objectives of the different studies, estimation models, major data used, and main findings of the study. The enumeration of different studies in Table 4 is intended to find the research gaps and also to draw methodological lessons for this study. Some important studies relevant to the present them are listed in the Table 3 below.

Table 3: Review of literature

Author(s)	*Main objective*	*Econometric model/Variables*	*Major data used*	*Main source of data*	*Main finding and policy implication*
Krishan (1993)	To identify the reason for slowing down of urbanization in India.	Urbanization and agricultural growth.	Data on urbanization and related indicators, urban economic growth	Census of India 1991, Economic survey 1991-92, rural & urban distribution of paper-2 of 1991.	The reason of slowing down of urbanization is decline in rural- urban migration because of agricultural development.
Kundu and Gupta (1996)	Trends and Processes of urbanization in India	Time series and Panel data	Number of towns, percentage and growth rate of urban population, Internal migrants in various categories.	Census of India of various years and NSS data.	Urban population in India has been modest and fluctuating over the past few decades. This is because of higher demographic growth in large cities, in addition to the factor of upward movement of towns.
Das (2013)	To study the levels and trends of urbanization in India by size class distribution. To study the inequality and distribution of urban population by size class distribution.	Gini coefficient to investigate inequality of urban population.	Data on Urbanization in different region of India, growth rate of population, number of UA and Outgrowths.	Census of India of various years	Since independence the absolute increase in urban population has been higher than the increase in the rural population, which is highly significant.
Kalamkar (2009)	To analyze the relationship between agriculture and urbanization in India.	Urbanization, Agriculture	Data is used on urban population growth, production of major crops	Census of India of various years, FAO	Faster growth of urban population is due to migration from rural areas.
Sridhar (2010)	To investigate what determines urban population and economic growth, the determinants of urban population growth and economic output in	Ordinary least square	Data at district and town level	Town directory, 2011	The district level, manufacturing has a positive impact on city size, and proximity to large cities causes nearby Cities to be larger, reflecting agglomeration effects.

	India.				
Bhagat (2011)	To analyze trends in urbanization in India	Descriptive statistic	rural-urban population growth	Census of India, various years	A large number of new towns emerged in the last decades, contributing significantly to the speeding up of urbanization.
Tripathi (2013)	To analyze the recent past trends and patterns of urbanization.	Urbanization, economic growth, Inequality, poverty	Data on Trends on India's urbanization, CAGR of city population, per cent of poor population in different class size.	National accounts statistics, census of India in various years	Higher rate of urbanization is associated with higher economic growth, lower level of poverty and higher extent of inequality in urban India.
Kadi and Nelavigi (2015)	To analyze the trends of growth of urbanization in India	Urbanization, population growth, metropolitan cities and tempo of urbanization.	Data on urban population, Towns and cities, variation rate of urban agglomeration, average annual exponential growth rate .	Data sources are Census of India of various years.	Cities in India become very populated and over crowed as result of increase in population over the decades and partially account of migration.
Thongkhanthang P.(2015)	Attempts to analyze the growth pattern of towns and cities in the north-east region of India.	Exponential models, Composite index	Level and growth of urbanization,	Town directory 1981, 1991, 2001	Finding of this study is: Availability of urban amenities such as good electrification, medical facility, recreation, cultural facility play significant role in attracting people to migrate to urban centers that lead to increasing dominance of class- I cities.
Tripathi and Mahey (2016)	To analyze the impact of urbanization on economic growth in Punjab.	Ordinary Least Square model	Data on number of towns, share of urban population	Town directory, 2011	The study brings out the positive link between urbanization and economic growth in Punjab.

Source: Authors' compilation

IV. Empirical Framework and Results of the Estimation of Determinants

To empirically investigate the determinants of urbanization in different class size cities and towns in major state of India the following OLS regression model is used.

$$UA = \alpha_o + \sum_{i=1}^{9} \alpha_i X_i + \epsilon \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Here, UA is dependent variable (urban agglomeration) which is measured by size of city/town population, city/town population density and city/town population growth and X_is are independent variables i.e. city-wise rainfall, temperature difference, number of schools, colleges, universities, road distance to State H.Q., road distance to subdivision H.Q., road distance to nearest city with population of 1 lakh or more, road distance to nearest city with population of 5 lakh or more, total number of electricity connections and total road length. Table (3) presents the expected sign of independent variables used in equation (1).

Table 4: Details of independent variables used in equation (1)

Independent variables	Explanation	Expected sign
X_1	Rainfall	-
X_2	Temperature differences	-
X_3	Number of schools, colleges, universities	+
X_4	State H.Q. road distance	-
X_5	Subdivision H.Q. road distance	-
X_6	Nearest city with population of 1 lakh or more road distance	-
X_7	Nearest city with population of 5 lakh or more road distance	-
X_8	Electricity connection	+
X_9	Road length	+

Source: Authors' compilation

Rainfall and Temperature differences come under the category of environmental effect and it may have positive influence on urban population in a large city by way of encouraging in-migration of population due to favorable climatic conditions (Sridhar, 2010). The fact is that higher rainfall and higher temperature discourage population concentration in the large urban agglomerations. Road distance to State H.Q., road distance, nearest city with population of 1 lakh or more, road distance to nearest city with population of 5 lakh or more road etc. have negative effect on urbanization because bigger cities become primary magnets of economic activity and longer distance to a bigger city indicates lower market potential. Higher economic activities are performed in larger cities than in small towns; if distance is more then there is a

negative correlation (Tripathi 2013; Ades and Glaeser 1995). Public services or basic infrastructural variables like road length, schools, colleges and universities attract more firms or residents because these services are used by the entire population. On the other hand, if the condition of public services is good in big cities, then people will move to such cities due to the better living conditions there. For example, availability of 24 hour water and electricity supply encourages population to move in to the cities.

Appendix Table 1 represents the descriptive statistics (means, standard deviation, minimum and maximum) variables used for the regression equation model. Coefficient of variance is high for population growth in all classes of urban settlements. Table 2 in Appendix shows the correlation coefficient of variables used in regression model 1, 2 and 3. City density is positively correlated with electricity. However, it is negatively correlated with number of schools, colleges, universities, rainfall, temperature, road distance to state H.Q., subdivision H.Q., and nearest city with population of 1 lakh. Population growth is positively correlated with temperature, and it is negatively correlated with road distance to State H.Q., schools, colleges, universities and nearest city with population of 5 lakh. On the other hand, size of total population is positively related with road length, electricity and temperature and negatively related with road distance to subdivision H.Q.

Table 5-10 present the estimated results of regression models 1-18. To find out the problem of heteroskedasticity we have used Breusch- Pagon and Koenker (BPK) test statistics. BPK test is a large sample test and assumes the residuals to be normally distributed and if p vale is less than 0.05 then it indicates that there is problem of heteroskedasticity and we have solved the problem of heteroskedastictiy with robust standard errors in parenthesis taking care of the problem of multicollinearity problem. In the regression results no multicollinearity problem is found as the variance inflation factor (VIF) is less than 10. The significant F value indicates that overall, the model is statistically significant. The higher value of R^2 presents a good percentage of total variation in the dependent variables.

The regression estimations are done for six classes/sizes of cities separately which are classified depending on the size of populations. The dependent variable is urbanization which is measured by size of city populations, growth rate of city populations and density of city populations.

Table 5: Determinants of urbanization in class I cities of India in 2011

Independent Variables	Log of Total population(2011)	Log of Population growth(2001-11)	Log of City density
	(1)	(2)	(3)
Intercept	5.896*** (0.229)	-1.041** (0.522)	6.961** (2.134)
Log of Rainfall	-0.017 (0.012)	-0.005 (0.028)	-0.095 (0.114)
Log of Temperature	-0.12 (0.028)	0.176** (0.065)	-0.777** (0.265)
Log of State H.Q. road distance	-0.056*** (0.012)	-0.008 (0.028)	-0.281*** (0.115)
Log of Subdivision H.Q. road distance	0.090*** (0.019)	0.118** (0.044)	-0.653** (0.178)
Log of Nearest city with population of 1 lakh or more road distance	0.025** (0.009)	0.079** (0.021)	-0.279** (0.086)
Log of Nearest city with population of 5 lakh or more road distance	-0.051*** (0.012)	-0.018 (0.028)	0.219** (0.113)
Log of Number of school, colleges or universities	0.316*** (0.027)	-0.030 (0.061)	-0.871** (0.249)
Log of Electricity connection	0.476*** (0.025)	0.087 (0.057)	0.836** (0.231)
Log of Road length	0.031*** (0.12)	0.011 (0.028)	0.082 (0.116)
No. of observations	455	450	380
R^2	0.861	0.099	0.164
Adjusted R^2	0.858	0.079	0.148
F statistic	306.567***	5.585***	9.731***
VIF	1.67	1.677	1.677

Source: Estimated by using equations (1). Figures in the parentheses are standard errors. ***, **and* indicates statistical significance at 1%, 5% and 10% level

Table 5 presents the determinants of urbanization in Class I cities in India. Regression 1, 2 and 3 explains 86%, 09% and 16% of the total variation in the dependent variables, respectively. The regression model 1 shows that electricity connection, number of schools, colleges, universities and road length has a positive (as predicted) and significant (at 1%) effect on total population of the Class I cities in the major states. In particular, a 10% increase in the amount of electricity increases total population by 4.76% and on the other hand, a 10% increase in number of schools, colleges, universities increases total population by 3.16%. Variables like road distance to Subdivision H.Q. and nearest city with population of 1 lakh and above have positive and significant (at 1% and 5%) effect on total population. In Regression 2, temperature has a positive impact on population growth and on the other hand in Regression 3, temperature (or road distance to state H.Q. or subdivision H.Q. or road distance or nearest city with population of 1

lakh) has a negative effect (5% or 1% or 5% or 5%) effect on city population density of the Class I cities in India. In particular, a 10% increase in the temperature reduces city population density by 7.77% and on other hand, a 10% increase in road distance to state H.Q reduces 2.81% of city density.

Table 6: Determinants of urbanization in class II cities of India in 2011

Log of Independent variables	Log of Total population(2011)	Log of Population growth(2001-11)	Log of City density
	(4)	(5)	(6)
Intercept	10.266** (0.136)	2.066** (0.591)	8.105** (1.955)
Log of Rainfall	-0.019** (0.009)	-0.037 (0.039)	0.242** (0.128)
Log of Temperature	0.020 (0.015)	0.259** (0.065)	-1.317** (0.214)
Log of State H.Q. road distance	0.002 (0.009)	-0.151** (0.039)	-0.367** (0.130)
Log of Subdivision H.Q. road distance	-0.001 (0.009)	0.060* (0.037)	-0.677** (0.122)
Log of Nearest city with population of 1 lakh or more road distance	-0.019 (0.010)	-0.050 (0.045)	-0.123 (0.149)
Log of Nearest city with population of 5 lakh or more road distance	-0.014 (0.011)	0.010 (0.048)	0.433** (0.159)
Log of Number of school, colleges or universities	0.099** (0.017)	-0.085 (0.074)	-0.772** (0.244)
Log of Electricity connection	0.053** (0.011)	-0.113** (0.049)	0.775** (0.163)
Log of Road length	0.022** (0.010)	0.002 (0.043)	-0.383** (0.142)
No. of observations	544	512	466
R^2	0.151	0.099	0.201
Adjusted R^2	0.137	0.083	0.187
F statistic	10.550***	6.483***	14.913***
VIF	1	1	1

Source: Estimated by using equations (1). Figures in the parentheses are standard errors. ***, **and* indicates statistical significance at 1%, 5% and 10% level

Table 6 represents the regression results for class II cities in India. Regression model 4 shows that rainfall has a negative (as expected) and significant (at 5%) effect on total population in class I cities in Indian major states. In particular, a 10% increase in amount of rainfall reduces total population by 0.19%. Number of schools, electricity connection and road length has positive (as expected) and significant (at 5%) effect on total population. In particular, a 10% increase in number of schools increases total population by 0.99% and a 10% increase in electricity connection increases total population by 0.53%. In regression model 5, road distance

to state H.Q. has a negative (as expected) and significant (at 5%) impact on population growth. In regression model 6, temperature has a negative (as expected) and significant (at 5%) effect on city density. In particular, a 10% increase in state temperature reduces city density by 13.17%. Electricity has a positive (as expected) and significant (at 5%) effect on city density and in particular, a 10% increase in electricity increases city density by 7.75%. In regression model 15.1%, 09.9% and 20.1% total variations in total population, population growth and city density are determined by regression line.

Table 7: Determinants of urbanization in class III cities of India in 2011

Dependent Variable	Log of Total population(2011)	Log of Population growth(2001-11)	Log of City density
	(7)	(8)	(9)
Intercept	9.343*** (0.081)	1.239*** (0.263)	4.763*** (0.958)
Log of Rainfall	-0.009* (0.005)	-0.077*** (0.018)	0.267*** (0.064)
Log of Temperature	0.000 (0.009)	0.237*** (0.029)	-1.464*** (0.107)
Log of State H.Q. road distance	-0.016** (0.006)	-0.061** (0.020)	-0.312*** (0.073)
Log of Subdivision H.Q. road distance	-0.002 (0.005)	-0.016 (0.015)	-0.422*** (0.055)
Log of Nearest city with population of 1 lakh or more road distance	-0.026*** (0.007)	-0.133*** (0.022)	-0.124 (0.081)
Log of Nearest city with population of 5 lakh or more road distance	0.002 (0.007)	-0.033 (0.023)	0.302*** (0.085)
Log of Number of school, colleges or universities	0.119*** (0.010)	-0.041 (0.033)	-0.028 (0.121)
Log of Electricity connection	0.067*** (0.008)	-0.002 (0.025)	0.856*** (0.090)
Log of Road length	0.054*** (0.007)	-0.013 (0.022)	-0.400*** (0.079)
No. of Observations	1731	1731	1731
R^2	0.240	0.095	0.213
Adjusted R^2	0.236	0.091	0.209
F statistic	60.229***	20.182***	51.726***
VIF	1	1	1

Source: Estimated by using equations (1). Figures in the parentheses are standard errors. ***, **and* indicates statistical significance at 1%, 5% and 10% level

Table 7 presents the regression results of the class III cities/towns in Indian major states. The results show that electricity connection, number of schools and road length have positive (as expected) and significant (at 1%) effect on total class I city's population. In particular, a 10% increase in electricity connection increases total population by 0.67% and on other hand, a 10%

increase in road length increases total population by 0.54%. In regression model 8, rainfall has a negative (as expected) and significant (at 10%) effect on total population. Variables like rainfall, road distance to state H.Q., and distance to nearest city with population of 1 lakh have negative (as expected) and significant (at 1%) effect on population growth rate. In particular, a 10% increase in the nearest city with population of 1 lakh reduces population growth by 0.26%. On the other hand, in Regression model 9, Electricity connection has a positive and significant effect on city density. In particular, a 10% increase in amount of electricity increases city density by 8.56%. Here, 24.3%, 09.5% and 21.3% variations in total population, population growth and city density are determined by the estimated regression results.

Table 8: Determinants of urbanization in class IV cities of India in 2011

Log of Independent variables	Log of Total population(2011)	Log of Population growth(2001-11)	Log of City density
	(10)	(11)	(12)
Intercept	8.534*** (0.129)	0.823*** (0.178)	6.457*** (0.726)
Log of Rainfall(mm.)	0.003 (0.009)	0.016 (0.012)	0.270*** (0.051)
Log of Temperature	-0.030 (0.017)	0.087*** (0.024)	-1.482*** (0.096)
Log of State H.Q. road distance(km.)	0.016 (0.013)	0.060*** (0.017)	-0.273*** (0.071)
Log of Subdivision H.Q. road distance	-0.023*** (0.009)	-0.016 (0.013)	-0.480*** (0.052)
Log of Nearest city with population of 1 lakh or more road distance(km.)	-0.004 (0.012)	-0.022 (0.016)	-0.076 (0.067)
Log of Nearest city with population of 5 lakh or more road distance(km.)	-0.015 (0.013)	-0.003 (0.018)	0.315*** (0.072)
Log of Number of school, colleges or universities	0.161*** (0.018)	-0.025 (0.024)	-0.417*** (0.099)
Log of Electricity connection	0.084*** (0.013)	-0.059** (0.018)	0.761*** (0.074)
Log of Road length	0.011 (0.011)	-0.038*** (0.016)	-0.371*** (0.065)
No. of Observations	1933	1931	1930
R^2	0.098	0.038	0.240
Adjusted R^2	0.094	0.034	0.236
F statistic	23.170***	8.447***	67.438***
VIF	1	1	1

Source: Estimated by using equations (1). Figures in the parentheses are standard errors. ***, **and* indicates statistical significance at 1%, 5% and 10% level

Table 8 presents the regression model 10-12 used for identifying the determinants of population in class IV towns. The results how that number of schools and electricity connections have a positive and significant (at 1%) effect on total population and road distance to subdivision H.Q. has a negative significant impact on total population. It states that a 1% increase in number of schools increases total population by 0.16%, or a 1 % increase in electricity connections increases total population by 0.86%, or with 1 % increase in road distance to subdivision H.Q decreases total population by 0.02%. In regression model 11, road length to State H.Q has positive and significant

Table 9: Determinants of urbanization in class V cities of India in 2011

Log of Independent variables	Log of Total population(2011)	Log of Population growth(2001-11)	Log of City density
	(13)	(14)	(15)
Intercept	9.001*** (0.013)	0.459** (0.131)	6.648*** (0.571)
Log of Rainfall(mm.)	-8.171 (0.001)	0.003 (0.009)	0.178*** (0.040)
Log of Temperature	0.002 (0.002)	0.038** (0.019)	-0.945*** (0.085)
Log of State H.Q. road distance(km.)	-0.003** (0.002)	-0.028 (0.016)	-0.520*** (0.068)
Log of Subdivision H.Q. road distance	0.001 (0.001)	-0.020 (0.013)	-0.348*** (0.058)
Log of Nearest city with population of 1 lakh or more road distance(km.)	0.001 (0.001)	-0.006 (0.013)	-0.057 (0.058)
Log of Nearest city with population of 5 lakh or more road distance(km.)	0.001 (0.002)	-0.001 (0.016)	0.343*** (0.068)
Log of Number of school, colleges or universities	-0.002 (0.002)	-0.026 (0.020)	-0.458*** (0.086)
Log of Electricity connection	0.001 (0.001)	-0.040** (0.015)	0.711*** (0.065)
Log of Road length	-7.640 (0.001)	-0.014 (0.013)	-0.271*** (0.058)
No. of observations	1803	1803	1798
R^2	0.005	0.017	0.229
Adjusted R^2	0.016	0.012	0.225
F statistic	3.955**	2.737**	59.253***
VIF	1.4	1.4	1.4

Source: Estimated by using equations (1). Figures in the parentheses are standard errors. ***, **and* indicates statistical significance at 1%, 5% and 10% level

(at 1%) effect on population growth, or it states that with a 1 % increase in road distance to state H.Q will increase population growth by 0.06%, or a 1% increase in temperature increases population growth by 0.08%. In regression model 12, variables like road distance to state H.Q

and Subdivision H.Q. , temperature, number of schools, colleges or universities have negative and significant (at 1%) effect on city density. In a particular, a 1 unit increase in road distance to state H.Q decreases population growth by -0.3%, or with 1 % increase in road distance to subdivision H.Q decreases population growth by 0.5%.

Table 9 presents the results of class V towns. In regression model 13, road distance of state H.Q. has negative (as expected) and significant (at 5%) effect on total population. Regression model 14 shows that electricity connection has negative and significant (at 5%) effect or temperature has positive impact on population growth. In a particular, a 10% increase in electricity connection reduces population growth by 0.4%. Regression model 15 shows that variables like rainfall, road distance to nearest city with population of 1 lakh and electricity connection have a positive and significant (at 1%) effect on city density, while temperature, road distance to state H.Q, number of schools and road length have negative impact on city density.

Table 10: Determinants of urbanization in class VI cities of India in 2011

Log of Independent variables	Log of Total population(2011)	Log of Population growth(2001-11)	Log of City density
	(16)	(17)	(18)
Intercept	7.335***	-8.830**	9.690***
	(0.547)	(4.336)	(1.147)
Log of Rainfall(mm.)	0.052	0.027	0.147
	(0.040)	(0.300)	(0.078)
Log of Temperature	0.024	1.003	-0.184
	(0.074)	(0.534)	(0.153)
Log of State H.Q. road distance(km.)	0.00	-0.151	-0.035
	(0.036)	(0.217)	(0.076)
Log of Subdivision H.Q. road distance	0.039	-0.565**	-0.238**
	(0.037)	(0.219)	(0.081)
Log of Nearest city with population of 1 lakh or more road distance(km.)	-0.037	-0.362	-0.190**
	(0.033)	(0.231)	(0.071)
Log of Nearest city with population of 5 lakh or more road distance(km.)	0.019	-0.168	-0.033
	(0.034)	(0.182)	(0.078)
Log of Number of school, colleges or universities	0.061	-0.733***	-0.066
	(0.048)	(0.272)	(0.099)
Log of Electricity connection	0.030	1.232**	-0.136
	(0.045)	(0.371)	(0.108)
Log of Road length	-0.031	0.075	-0.243***
	(0.033)	(0.230)	(0.074)
No. of Observations	247	27	197
R^2	0.025	0.740	0.205
Adjusted R^2	0.012	0.603	0.167
F statistic	6.667**	5.383**	5.364**
VIF	1	1	1

Source: Estimated by using equations (1). Figures in the parentheses are standard errors. ***, **and* indicates statistical significance at 1%, 5% and 10% level

Finally, table 10 presents the estimated results for class VI towns. Regression model 16 shows that electricity connection has positive (as expected) and significant (at 5%) effect on population growth. In particular, a 10% increase in electricity connection increases population growth by 12.32%. Road distance to subdivision H.Q. has a negative (as expected) and significant (at 5%) effect on population growth and in particular, a 10% increase in distance to subdivision H.Q reduces population growth by 5.65%. In Regression model 18, road length to subdivision H.Q., and road distance to nearest city with population of 1 lakh have negative and significant (at 5%) effect on city density. In particular, a 10% increase in subdivision H.Q. of road distance reduces city density by 2.38%. In the regression models, respectively, 0.025%, 0.740% and 0.205% total variation in total population, population growth and city density is determined.

The results show a very interesting disparity in the determinants of urbanization between different classes of cities/towns in major states of India. The amount of rainfall has negative and significant impact on size of city population in class II and class III cities/towns. However, for other class of cities/towns, impact of rainfall is not statistically significant. Road distance to state H.Q. has a negative impact on size of city/town population in class I, III, and V cities/towns. On the other hand, road distance to subdivision H.Q. has positive impact on size of class I cities but it has negative impact on the size of population in class IV cities/towns. Number of schools, electricity connection and road length has positive and significant impact on the size of city/town population of class I, II, III, and IV cities/towns.

Rainfall has negative and significant impact on population growth of class III towns. On the other hand, temperature has positive and significant impact on population growth of class I, II, III, IV, V cities/towns. Road distance to state H.Q. has negative and significant impact on population growth of class I, II, III cities/towns but it has positive and significant impact on population growth of class IV towns. Road distance to subdivision H.Q. has a positive impact on population growth of class I, II towns but a negative and significant impact on growth rate of city population of class VI towns. Number of schools has a negative impact on growth rate of city population of class VI towns. Electricity has a negative impact on growth rate of city/town population of class II, IV, V, cities/towns, but it has a positive impact on growth rate of city population of class VI towns. Road length has a negative impact on growth rate of t population of class IV towns.

Finally rainfall has a positive and significant impact on population density of class II, III, IV, and V cities/towns. Temperature, road distance to state H.Q., and road distance to subdivision H.Q. have a negative and significant impact on density of class I, II, III, IV, V, and VI cities/towns. Road distance to nearest city with population of 5 lakh has positive impact on density of class I, II, III, IV, and V cities/towns. Number of schools has negative impact on density of class I, II, IV, and V cities/towns. Electricity has positive impact on density of class I, II, III, IV, and V cities/towns while road length has a negative and significant impact on density of class II, III, IV, V and VI cities/towns.

IV. Conclusion and policy implication

This study examines the determinants of urbanization in different states of India by considering distribution of different class/size cities in India. The study has used Ordinary Least Square model for analyzing the impact of rainfall, temperature, road distance to nearest city, number of schools, electricity connections on urbanization by using data from Town directory - 2011 which is Census of India data source.

The study finds that the amount of rainfall has a negative and significant impact on size of city population in class II and class III cities/towns. Road distance to state H.Q. has a negative impact on size of city/town population in class I, III, and V cities/towns. The number of schools, electricity connection and road length has positive and significant impact on the size of city/town population of class I, II, III, and IV cities/towns. While difference in temperature has a positive and significant impact on population growth of class I, II, III, IV, V cities/towns, road distance to state H.Q. has negative and significant impact on population growth of class I, II, III cities/towns, but it has positive and significant impact on population growth of class IV towns. Finally, while rainfall has positive and significant impact on density of class II, III, IV, and V cities/towns, temperature differences, road distance to state H.Q., and road distance to subdivision H.Q. have a negative impact on density of class I, II, III, IV, V, and VI cities/towns. Also, road distance to nearest city with population of 5 lakh has positive impact on density of class I, II, III, IV, and V cities/towns.

As urbanization is the major source of higher GDP, it is necessary to manage and promote urbanization in India. For the proper management urbanization in India, the study suggests the following policy options: first, government should provide quality public services such as roads,

transport facilities, electricity, etc to urban dwellers living in different class/size of cities/towns. Second, investment (domestic and foreign) in small, medium and bigger industries located in different class/size of cities/towns in India can play an important role in the development of urban sectors and reduction of unemployment. Fourth, schemes for urban poor such as waste management, street lighting, child care centers, health centers, social security, and education have to be provided by government by considering the needs of different class/size of cities/towns. India is steadily marching on the path of urbanization, and these policies will be helpful for the development of urban sectors. Further, given the paramount need to promote balanced urbanization in India, the study suggests promote urban policies should be formulated by taking into consideration the difference in class/size of populations, as different factors are found to have impacted urbanization in these cities/towns differently, particularly in the recent decades.

References:

Ades, A. F., and E. L. Glaeser. 1995. "Trade and Circuses: Explaining Urban Giants." The Quarterly Journal of Economics 110 (1): 195–227. doi:10.2307/2118515.

Bhagat, R. B. 2011. "Emerging Pattern of Urbanisation in India." Economic and Political Weekly 46 (34): 10–12.

Bose, A. 1973. Studies in India's Urbanization. 1901-1971. Bombay and New Delhi: Tata McGraw Hill.

Bose, A. 1978. India's Urbanization. 1901-2001. New Delhi: Tata McGraw-Hill Publishing Company Limited.

Calì, M. 2009. Urbanization, inequality and economic growth: Evidence from Indian states. World Bank. https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/3387.pdf

Das (2013), "The growing number and size of towns/cities in India: Emerging issues from 2011 census data", International Union for the Scientific Study of Population_Website: htp://iussp.org/sites/default/files/event_call_for_papers/Urban%20transition% 20India_IUSSP%202013.pdf

Kalamkar, S. S. 2009. "Urbanisation and Agricultural Growth in India." Indian Journal of Agricultural Economics 35 (3): 442.

Kundu, A. and Gupta, S. (1996). Migration, Urbanization and Regional Disparities. Economic and political weekly, 31 (52), 3391-3398.

Kadi, G., and Nelavigi, K. P. (2015), Growth of urbanization in India. The International Journal of Science & Technoledge 3(7): 30-38.

Krishan, G. (1993). The slowing down of Indian urbanization. Geography, 78 (1), 80-84.

Mahey, K., & Tripathi, S. (2016). Urbanization and Economic Growth in Punjab (India): An Empirical Analysis, doi. http://dx.doi.org/10.1080/17535069.2016.1227875

Mills, E. S., and C. M. Becker. 1986. Studies in Indian Urban Development. Oxford University Press, World Bank Research Publication. Accessed April 10, 2012. http://documents.worldbank.org/curated/en/390861468257964833/Studies-in-Indian-urban-development.

Mathur, O. P. 2005. "Impact of Globalization on Cities and City - Related Policies in India." In Globalization and Urban Development, edited by H. W. Richardson and C.-H. C. Bae, 43–58. Berlin: Springer.

Mundhe, N. N., and R. G. Jaybhaye. 2014. "Monitoring Level, Trends and Patterns of Urbanisation in Maharashtra (1991-2011)." Indian Streams Research Journal 4 (6): 1–12.

Rhoda, R. 1983. "Rural Development and Urban Migration: Can We Keep them Down on the Farm?." International Migration Review 17 (1): 34–64. doi:10.2307/2545923.

Sridhar, K. S. 2010. "Determinants of City Growth and Output in India." Review of Urban & Regional Development Studies 22 (1): 22–38. doi:10.1111/rurd.2010.22.issue-1.

Thongkhanthang, P. (2015), "Growth of cities in North-East India ", International Journal of Development Research Vol. 5, Issue, 10, pp. 5881-5887, October, 2015

Tripathi, S. 2013. "Do Large Agglomerations Lead to Economic Growth? Evidence from Urban India." Review of Urban & Regional Development Studies 25 (3): 176–200. doi:10.1111/rurd.v25.3.

Tripathi, S. 2015. "An Overview of India's Urbanization, Urban Economic Growth and Urban Equity." International Journal of Economics and Empirical Research 3 (3): 115–127.

Tripathi, S., Mahey, K. (2016): Urbanization and economic growth in Punjab (India): an empirical analysis, Urban Research & Practice, (fourthcoming), doi, http://dx.doi.org/10.1080/17535069.2016.1227875

Appendix: Table (1) Descriptive statistics

Descriptive statistics of class I cities used in regression equation					
Variables	Mean	Standard deviation	Minimum	Maximum	CoV
Log of Total population(Thousands)(LNTP)	12.4	0.8	11.5	16.1	6.5
Log of City density(Lakhs)(LNCD)	7.3	3.3	0.0	10.6	45.2
Log of Population growth(LNPG)	0.4	0.7	-4.2	3.1	175.0
Log of Rainfall(mm.)(LNRF)	6.4	1.5	0.0	8.2	23.4
Log of Temperature(LNTE)	3.2	0.6	0.0	3.9	18.8
Log of State H.Q. road distance(km.)(LNSR)	5.03	1.3	0.0	6.9	25.8
Log of Subdivision H.Q. road distance (LNSD)	0.3	0.8	-1.6	3.8	266.7
Log of Nearest city with population of 1 lakh or more road distance(km.)(LNNO)	2.08	1.9	0.0	5.1	91.3
Log of Nearest city with population of 5 lakh or more road distance(km.)(LNNF)	3.9	1.5	0.0	6.2	38.5
Log of Number of school, college, university(LNSC)	5.3	0.9	2.3	9.1	17.0
Log of Electricity connection(LNEC)	10.9	1.04	7.1	14.8	9.5
Log of Road length(LNRL)	5.1	1.5	-1.8	9.4	29.4
Description statistics class II cities used in regression equation					
Log of Total population(Thousands)(LNTP)	11.1	0.2	10.8	11.5	1.8
Log of City density(Lakhs)(LNCD)	7.1	3.01	0.0	10.3	42.4
Log of Population growth(LNPG)	0.2	0.8	-4.9	2.9	400.0
Log of Rainfall(mm.)(LNRF)	6.6	1.02	0.0	8.2	15.5
Log of Temperature(LNTE)	3.1	0.6	0.0	3.9	19.4
Log of State H.Q. road distance(km.)(LNSR)	0.0	6.9	5.3	0.9	0
Log of Subdivision H.Q. road distance (LNSD)	0.5	1.04	-0.6	4.09	208.0
Log of Nearest city with population of 1 lakh or more road distance(km.)(LNNO)	3.6	0.9	0.0	5.8	25.0
Log of Nearest city with population of 5 lakh or more road distance(km.)(LNNF)	4.3	0.9	0.7	6.3	20.9
Log of Number of school, college, university(LNSC)	2.2	5.8	4.1	0.5	263.6
Log of Electricity connection(LNEC)	9.5	0.7	0.0	10.6	7.4
Log of Road length(LNRL)	4.2	0.9	0.0	6.2	21.4
Descriptive statistics of class III cities used in regression equation					
Log of Total population(Thousands)(LNTP)	10.2	0.2	9.9	10.8	2.0
Log of City density(Lakhs)(LNCD)	6.6	2.9	0.0	10.9	43.9
Log of Population growth(LNPG)	0.2	0.7	-5.1	3.6	350.0
Log of Rainfall(mm.)(LNRF)	6.7	1.1	0.0	10.6	16.4
Log of Temperature(LNTE)	3.08	0.7	0.0	3.9	22.7
Log of State H.Q. road distance(km.)(LNSR)	5.4	0.9	1.1	7.0	16.7
Log of Subdivision H.Q. road distance (LNSD)	1.2	1.2	-1.3	4.3	100.0

Log of Nearest city with population of 1 lakh or more road distance(km.)(LNNO)	3.4	0.9	0.0	5.7	26.5
Log of Nearest city with population of 5 lakh or more road distance(km.)(LNNF)	4.2	0.9	0.0	6.4	21.4
Log of Number of school, college, university(LNSC)	3.4	0.6	0.7	7.5	17.6
Log of Electricity connection(LNEC)	8.6	0.8	0.0	11.1	9.3
Log of Road length(LNRL)	3.5	0.9	0.0	6.6	25.7
Descriptive statistics of class IV cities used in regression equation					
Log of Total population(Thousands)(LNTP)	9.5	0.4	9.0	10.0	4.2
Log of City density(Lakhs)(LNCD)	6.2	3.05	0.0	11.1	49.2
Log of Population growth(LNPG)					0
Log of Rainfall(mm.)(LNRF)	6.5	1.4	-0.4	8.9	21.5
Log of Temperature(LNTE)	3.06	0.7	0.0	6.06	22.9
Log of State H.Q. road distance(km.)(LNSR)	5.4	0.9	1.6	6.9	16.7
Log of Subdivision H.Q. road distance (LNSD)	1.7	1.2	-2.3	4.3	70.6
Log of Nearest city with population of 1 lakh or more road distance(km.)(LNNO)	3.3	1.06	0.0	6.1	32.1
Log of Nearest city with population of 5 lakh or more road distance(km.)(LNNF)	4.1	0.9	0.0	6.4	22.0
Log of Number of school, college, university(LNSC)	2.7	0.7	0.0	5.2	25.9
Log of Electricity connection(LNEC)	7.8	0.8	0.0	10.5	10.3
Log of Road length(LNRL)	2.8	1.06	-2.3	5.9	37.9
Descriptive statistics of class V cities used in regression equation					
Log of Total population(Thousands)(LNTP)	9	0.05	9	11	0.6
Log of City density(Lakhs)(LNCD)	6.2	2.9	0.0	10.3	46.8
Log of Population growth(LNPG)	0.02	0.5	-6.1	3.5	2500
Log of Rainfall(mm.)(LNRF)	6.03	2.2	0.0	9.7	36.5
Log of Temperature(LNTE)	2.9	1.01	0.0	3.8	34.8
Log of State H.Q. road distance(km.)(LNSR)	1.3	7.04	5.2	1.01	541.5
Log of Subdivision H.Q. road distance (LNSD)	1.8	1.06	-1.6	4.9	58.9
Log of Nearest city with population of 1 lakh or more road distance(km.)(LNNO)	3.1	1.1	-0.69	6.02	35.5
Log of Nearest city with population of 5 lakh or more road distance(km.)(LNNF)	4.1	1.02	0.0	6.5	24.9
Log of Number of school, college, university(LNSC)	2.02	0.7	0.0	4.8	34.7
Log of Electricity connection(LNEC)	7.03	0.9	0.0	10.4	12.8
Log of Road length(LNRL)	2.05	1.1	-0.7	5.1	53.7
Descriptive statistics of class VI cities used in regression equation					
Log of Total population(Thousands)(LNTP)	7.9	0.7	0	9	8.9
Log of City density(Lakhs)(LNCD)	7.2	1.1	1	12	15.3
Log of Population growth(LNPG)	10.8	66.7	-4	400	617.6
Log of Rainfall(mm.)(LNRF)	12.7	103.9	2	1822	818.1
Log of Temperature(LNTE)	3.3	0.8	1	17	24.2
Log of State H.Q. road distance(km.)(LNSR)	5.7	10.7	2	204	187.7
Log of Subdivision H.Q. road distance (LNSD)	2.7	11.3	-1	204	418.5
Log of Nearest city with population of 1 lakh or more road distance(km.)(LNNO)	3.2	1.2	0	13	37.5
Log of Nearest city with population of 5 lakh or more	7.6	66.1	0	1229	869.7

road distance(km.)(LNNF)					
Log of Number of school, college, university(LNSC)	15.4	252.6	0	4632	1640
Log of Electricity connection(LNEC)	6.6	0.9	0	9	13.6
Log of Road length(LNRL)	2.2	1.1	-1	5	50

Sources: Census of India, Census Town Directories 2011, Author's computation and analysis

Table (2) Correlation coefficient used in the regression equation

Correlation coefficient of class I cities

	LNCD	LNPG	LNTP	LNRF	LNTE	LNEC	LNSC	LNSR	LNSD	LNNO	LNNF	LNRL
LNCD	1											
LNPG	-0.09	1										
LNTP	0.002	0.16	1									
LNRF	-0.96	0.07	0.06	1								
LNTE	-0.26	0.21	0.04	0.46	1							
LNEC	0.09	0.10	0.88	0.15	0.03	1						
LNSC	-0.06	0.10	0.81	0.11	0.16	0.74	1					
LNSR	-0.14	-0.006	-0.29	0.18	0.16	-0.20	-0.14	1				
LNSD	-0.12	0.09	-0.15	-0.21	-0.09	-0.12	-0.15	-0.12	1			
LNNO	-0.24	0.23	0.06	0.11	0.42	0.007	0.15	0.16	-0.10	1		
LNNF	-0.03	-0.01	-0.38	0.07	0.15	-0.33	-0.20	0.36	-0.16	0.29	1	
LNRL	0.03	0.08	0.54	0.20	0.09	0.54	0.52	-0.02	-0.16	0.09	-0.13	1

Correlation coefficient of class II cities

	LNCD	LNPG	LNTP	LNRF	LNTE	LNSC	LNSR	LNSD	LNNO	LNNF	LNEC	LNRL
LNCD	1											
LNPG	-0.08	1										
LNTP	-0.001	-0.04	1									
LNRF	-0.02	-0.03	-0.04	1								
LNTE	-0.27	0.15	0.03	0.29	1							
LNSC	-0.11	-0.08	0.28	-0.01	0.19	1						
LNSR	-0.08	-0.20	0.01	0.13	0.04	0.13	1					
LNSD	-0.21	0.12	-0.04	-0.03	-0.06	-0.22	-0.14	1				
LNCO	-0.01	-0.12	-0.007	0.12	0.15	0.31	0.27	-0.30	1			
LNCF	0.06	-0.09	-0.012	0.009	0.11	0.29	0.32	-0.36	0.54	1		
LNEC	0.19	-0.15	0.26	0.07	-0.13	0.18	0.03	-0.09	0.05	-0.02	1	
LNRL	-0.04	-0.08	0.15	0.29	0.004	0.19	0.12	-0.08	0.21	0.16	0.28	1

Correlation coefficient of class III cities

	LNCD	LNPG	LNTP	LNRF	LNTE	LNSC	LNSR	LNSD	LNNO	LNNF	LNEC	LNRL
LNCD	1											
LNPG	-0.04	1										
LNTP	0.06	0.08	1									
LNRF	-0.007	-0.09	0.02	1								
LNTE	-0.33	0.17	0.00	0.19	1							
LNSC	-0.03	-0.03	0.36	-0.04	0.31	1						
LNSR	-0.10	-0.12	-0.04	0.11	0.08	0.09	1					
LNSD	-0.14	-0.02	-0.11	0.08	-0.19	-0.34	-0.02	1				
LNNO	-0.04	-0.19	0.01	0.23	0.12	0.31	0.24	-0.19	1			
LNNF	0.01	-0.11	0.01	-0.07	0.15	0.25	0.31	-0.26	0.51	1		

LNEC	0.28	-0.07	0.3	0.13	-0.21	0.22	0.007	-0.08	-0.005	-0.06	1	
LNRL	0.02	-0.13	0.3	0.32	-0.15	0.21	0.08	-0.005	0.17	0.05	0.31	1

Correlation coefficient of class IV cities

	LNCD	LNPG	LNTP	LNRF	LNTE	LNSC	LNSR	LNSD	LNNO	LNNF	LNEC	LNRL
LNCD	1											
LNPG	-0.003	1										
LNTP	0.01	0.04	1									
LNRF	-0.08	0.01	0.08	1								
LNTE	-0.36	0.11	0.01	0.42	1							
LNSC	-0.14	-0.04	0.26	0.23	0.29	1						
LNSR	-0.07	-0.10	0.07	0.25	0.03	0.13	1					
LNSD	-0.18	-0.03	-0.08	0.05	-0.06	-0.13	0.03	1				
LNNO	-0.03	-0.07	0.07	0.11	0.03	0.33	0.19	0.01	1			
LNNF	0.06	-0.05	0.04	0.08	0.03	0.22	0.27	-0.12	0.44	1		
LNEC	0.23	-0.11	0.21	0.16	-0.11	0.19	0.09	-0.02	0.06	0.05	1	
LNRL	-0.08	-0.09	0.12	0.36	0.006	0.25	0.21	0.06	0.16	0.13	0.24	1

Correlation coefficient of class V cities

	LNCD	LNPG	LNTP	LNRF	LNTE	LNSC	LNSH	LNSD	LNNO	LNNF	LNEC	LNRL
LNCD	1											
LNPG	0.009	1										
LNTP	0.01	0.000	1									
LNRF	-0.19	0.01	0.008	1								
LNTE	-0.33	0.05	0.02	0.69	1							
LNSC	-0.17	-0.05	-0.01	0.26	0.26	1						
LNSH	-0.18	-0.06	-0.04	0.30	0.15	0.23	1					
LNSD	-0.18	-0.03	0.02	0.11	0.07	0.05	0.09	1				
LNNO	-0.51	-0.03	0.01	0.09	0.04	0.21	0.18	0.06	1			
LNNF	0.03	-0.03	-0.008	0.08	0.04	0.19	0.36	-0.08	0.37	1		
LNEC	0.20	-0.08	0.006	0.12	-0.02	0.22	0.12	-.012	0.02	0.09	1	
LNRL	-0.13	-0.04	-0.001	0.37	0.23	0.23	0.20	0.06	0.10	0.15	0.22	1

Correlation coefficient of class VI cities

	LNCD	LNPG	LNTP	LNRF	LNTE	LNEC	LNSC	LNSR	LNSD	LNNO	LNNF	LNRL
LNCD	1											
LNPG	-0.18	1										
LNTP	0.43	-0.25	1									
LNRF	0.04	-0.21	0.07	1								
LNTE	0.003	0.20	0.03	-0.19	1							
LNEC	-0.18	0.55	0.04	0.07	-0.22	1						
LNSC	-0.15	-0.20	0.09	-0.009	0.19	0.12	1					
LNSR	-0.13	-0.22	0.01	0.06	-0.15	0.03	0.05	1				
LNSD	-0.29	-0.26	0.06	0.07	-0.01	0.08	0.09	0.12	1			
LNNO	-0.23	-0.41	-0.02	0.24	-0.14	0.004	0.21	0.12	0.26	1		
LNNF	-0.82	-0.16	0.02	0.15	-0.08	-0.11	0.04	0.33	0.08	0.40	1	
LNRL	-0.25	0.43	-0.03	0.17	-0.16	0.33	0.06	0.11	0.10	0.03	0.01	1

Notes: LNTP(log of total population), LNRF(log of rainfall), LNTE(log of temperature), LNEC(log of electricity), LNSC(log of school, college, university), LNSR(log of state H.Q. of road distance), LNSD(log of subdivision road distance), LNNO(log of nearest city with population of 1 lakh), LNNF(log of nearest city with population of 5 lakh), LNRL(log of road length). Sources: Census of India, Census Town Directories 2011, Author's computation and Analysis.