Spatial Inequalities in Big Indian Cities

PRANAV SIDHWANI

Using ward-level data released by the census, the paper carries out a study of residential segregation in the 10 most populated Indian cities. It finds that there is significant residential segregation by caste and also by access to in-house drinking water, a basic public good, and access to in-house latrines, a basic private good. Further, in the case of some cities covered in the study, the proportion of Scheduled Castes/Scheduled Tribes in wards is highly correlated with access to public, private, and luxury goods.

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Pranav Sidhwani (*pranav@cprindia.org*) is with the Centre for Policy Research, New Delhi.

1 Introduction

Urban sociologists have argued for long that the heterogeneous nature of cities leads to a breakdown of rigid social structures (Wirth 1938). Given that the Indian economy has grown impressively in the last two decades, it is not absurd to assume that the old caste structure may have given way to a new class consciousness. A recent study found that while caste inequalities are higher in developed villages and smaller cities, they are lower in bigger cities (Desai and Dubey 2011). However, while caste membership or religion used to be the principal determinant of a person's social position, and class status could influence that only peripherally, there is no concrete evidence to show that a reversal of sorts has taken place in the last two to three decades.

On the other hand, spatial segregation,[1] which is the spatial concentration of population groups, has long been cited as a characteristic of metropolises and it reflects the social paradigm of a city (Greenstein et al 2000). In addition, spatial structures fortify and influence the progression of social structures. Thus, residential segregation has far-reaching consequences—it ensures the system of stratification continues in the next generation (Morgan 1984). This is why studying the spatial patterns of social structures assumes importance.

This paper attempts to identify the spatial dynamics that play out in urban India, using ward-level data for 10 of the country's biggest cities. It examines spatial segregation based on caste by building on the methodology used by Vithayathil and Singh (2012), using the index of segregation, which is a modified version of the index of dissimilarity. The paper goes a step further and compares this with segregation by access to in-house drinking water (a basic public good), on access to in-house latrines (a basic private good), and on ownership of two-wheelers (a luxury or "aspirational" good). It also attempts to understand the interplay between access to these assets and the proportion of Scheduled Castes (SC) and Scheduled Tribes (ST) in the wards. The paper finds that there is high residential segregation in cities by caste, and even higher segregation in terms of access to basic public and private goods. It also finds a medium to strong negative correlation between the proportion of SCs/STs in the population and access to in-house drinking water across wards in Chennai and Kolkata, a moderately high negative correlation between the proportion of SCs/STs in the population and access to in-house latrines in Pune, Bangalore, Chennai, Jaipur, Ahmedabad and Mumbai, and moderate to strong negative correlation between the proportion of SCs/STs in the population and ownership of two-wheelers in Pune, Chennai, Ahmedabad, Delhi and Mumbai.

The paper is organised as follows. Section 2 briefly discusses the existing literature on spatial segregation; Section 3 discusses the data and methodology used for the analysis; Section 4 discusses the results; and Section 5 draws conclusions.

2 Existing Literature on Segregation in India

Spatial segregation studies have been common in the West, particularly in the US, where studies on discrimination of African-American and Hispanic communities, dating back to Burgess (1925) and Park (1926), have played an intrinsic role in shaping the nature of such studies in general. While there are numerous studies discussing discrimination on the basis of caste in India, there are only a few quantitative studies on spatial segregation in Indian cities.

Mehta's studies on residential segregation in Pune (1968, 1969), inspired by the Duncans' study of residential patterns in Chicago (1955, 1957), found that residential segregation was highest in the case of groups on either end of the spectrum, both on the basis of caste and socio-economic status. He showed that the largest relative increases in degree of segregation between 1822 and 1937 had been among Brahmins and the depressed classes. He also found that while rich and upper-caste Hindus were largely centralised, people belonging to the lower socio-economic groups and lower castes were decentralised, and that this pattern held for the period under study.

Khairkar (2008) attempted to study the formation of a linguistic cluster in Pune city, using data from a survey conducted on migrants. While the analysis was not on how this cluster was different from the rest of the city in terms of access to various amenities, among other things, it tried to understand why migrants chose to cluster together. It found that the primary reasons were security, cultural affinity, and an attempt to preserve their identity.

A more recent study by Vithayathil and Singh (2012), which tried to build on Mehta's study of Pune using ward-level data for 2001, released by the Census of India, finds that there are high levels of residential segregation by caste in India's seven largest metro cities—Mumbai, Delhi, Kolkata, Chennai, Bangalore, Ahmedabad and Hyderabad. Using male literacy status (literate or illiterate) as a proxy for socio-economic status, they find that residential segregation by caste is more prominent than segregation by socio-economic status.

This paper tries to build on Vithayathil and Singh (2012) using ward-level data for 2011. It compares levels of spatial segregation in the 10 largest cities of India on the basis of caste, gender (used as a baseline), socio-economic status (male literacy used as a proxy), access to in-house drinking water, access to in-house latrines, and ownership of two-wheelers.

3 Data

The Census of India, conducted every 10 years, is the single largest source of data on a variety of characteristics of the Indian population, including demographics, economic activities, and housing and household amenities. It recently released, for the first time, a set of very informative tables on the amenities and assets of settlements. They give the percentage of households with access to amenities such as tap water and piped sewerage, and ownership of assets such as televisions, mobile phones, and two-wheelers at the ward and village levels (HH Amenities henceforth).

In conjunction with the HH Amenities data set, this paper uses ward-level data from the Primary Census Abstract (PCA) released by the Census of India for 2011.[2] In this paper, data for the 10 largest municipal corporations has been used. A municipal corporation is an urban local body governing a large city and is responsible for providing basic services within the boundaries of the city. The top 10 cities on the basis of their 2011 populations are Delhi (Municipal Corporation of Delhi); Greater Mumbai (Municipal Corporation of Greater Mumbai—MCGM); Bangalore (Bruhat Bengaluru Mahanagara Palike—BBMP); Hyderabad (Greater Hyderabad Municipal Corporation—GHMC); Ahmedabad (Ahmedabad Municipal Corporation); Chennai (Chennai Municipal Corporation—CMC); Kolkata (Kolkata Municipal Corporation—KMC); Surat (Surat Municipal Corporation—SMC); Pune (Pune Municipal Corporation—PMC), and Jaipur (Jaipur Municipal Corporation—JMC).

3.1 Issues With Data

While the HH Amenities database is a rich source to study settlement-wise patterns of asset ownership and access to amenities, there are some issues that limit the usability of the data set, which merit discussion.

The HH Amenities data set contains the percentage of households that have access to certain amenities and own certain assets in every settlement. However, it does not have the number of households in these settlements. The census was conducted in two phases—the houselisting and housing phase between April and June 2010, and the population enumeration phase in February 2011.[3] Also, institutional and houseless households are not reported in the tables prepared in the houselisting and housing phase.[4] So, the absolute number of households in the houselisting and housing census does not match the number of households in the population enumeration census. Table 1 compares the total number of households in the two phases for the 10 cities under consideration.

Table 1: Number of Households Listed by Phases of Census 2011

City	Population Enumeration Phase	Houselisting and Housing Phase
Delhi	32,73,174	31,97,133
Mumbai	27,79,943	26,65,481
Bangalore*	21,14,776	21,05,894
Hyderabad*	15,83,908	16,43,250
Ahmedabad	11,79,823	11,64,512
Chennai	11,54,982	11,06,567
Kolkata	10,24,928	9,64,183
Surat	9,75,797	9,49,116
Pune	7,42,602	7,33,990
Jaipur	5,99,507	5,75,268

* Includes municipal corporation and outgrowths. In the final analysis, outgrowths have been ignored. The houselisting and housing phase do not provide a break-up for municipal corporations and outgrowths in these cities, and this number has been used to facilitate comparison.
Source: Census of India 2011.

Since the absolute number of households is not available at the ward level in the HH Amenities database, we have to take it from the PCA, which presents data collected during the population enumeration phase. Apart from the issue of differing totals, as shown in Table 1, which percolates to the ward level, there are some other issues. First, the wards in the PCA sometimes do not

match the ones in the HH Amenities database. A case in point is census ward number 1,045 in the Municipal Corporation of Greater Mumbai, which is in the PCA but missing from the HH Amenities database. On the other hand, census ward number 3,837 of the same municipal corporation is present in the HH Amenities database, but not in the PCA. In the case of Surat, as per the PCA, census ward number 0107 is in the municipal corporation, but as per the HH Amenities database, it is an outgrowth.[5] Second, there are cases where the sub-districts of wards are listed differently in the PCA and HH Amenities database. For example, census ward number 0001 of the JMC is in Jaipur sub-district (code 00546) as per the HH Amenities database, and in Amber sub-district (code 00547) as per the PCA. Third, there are cases where a ward is present in both the databases, but is split between two sub-districts in the HH Amenities database, while as per the PCA, it is in one sub-district. For example, census wards 0036, 0071, 0076, and 0077 of the JMC are spread across two sub-districts as per the HH Amenities database, but the PCA indicates that they are in a single sub-district.

3.2 Data Used

While these issues need to be resolved, for the purpose of this paper, some flexibility has been exercised. To use the HH Amenities database, the number of households has been taken from the PCA. It needs to be emphasised that these are approximations and that the Registrar General of India should consider releasing the household numbers for the HH Amenities database. Second, differences in sub-districts have been ignored while matching the HH Amenities and the PCA data. Third, in cases where a ward spreads into more than one sub-district as per the HH Amenities data set but in only one as per the PCA, data for amenities have been taken only for the part of the ward in the sub-district that matches. Fourth, wards in the two databases that do not match have been ignored.

In this study, the actual data for cities pertains to the city municipal corporation. Outgrowths have been ignored in the analysis.[6] Table 2 presents the total population and number of households in the cities along with the numbers after dropping some wards.

For this study, we look at the distribution of SCs and STs across wards in different cities. This distribution is compared with the distribution of three goods across the same wards—in-house drinking water, in-house latrine, and ownership of two-wheelers (scooter, motorcycle, or moped)[7]—and also with the distribution by gender and socio-economic status, for which male literacy has been taken as a proxy, albeit imperfect. Data on the SC/ST population, gender, and male literacy are from the PCA, and the data on access to the three goods are from the HH Amenities database.

Table 2: Population, Households, and Wards in PCA and Numbers Used

City	Population		Number of Households		Number of Wards	
	PCA	PCA Matched	PCA	PCA Matched	PCA	PCA Matched
Delhi*	1,60,00,745	1,60,00,605	32,73,174	32,73,148	272	272
Mumbai	1,24,42,373	1,22,56,801	27,79,943	27,41,686	97	96
Bangalore	84,43,675	84,43,675	21,01,831	21,01,831	198	198
Hyderabad	67,31,790	67,31,790	15,24,392	15,24,392	150	150
Ahmedabad	55,77,940	55,77,940	11,79,823	11,79,823	57	57
Chennai	46,46,732	46,46,732	11,54,982	11,54,982	155	155
Kolkata	44,96,694	44,96,694	10,24,928	10,24,928	141	141
Surat	44,67,797	44,66,826	9,75,797	9,75,578	102	101
Pune	31,24,458	31,24,458	7,42,602	7,42,602	144	144
Jaipur	30,46,163	30,46,163	5,99,507	5,99,507	77	77

* Part of ward number 0144 does not match.
Source: Census of India 2011.

To ascertain the degree of error we are working with if we use the number of households in every ward from the PCA to get the number of households with access to these three goods, we compare the estimated number of households with access, aggregated at the city level, with the actual numbers for cities given in the HH Amenities data. Table 3 presents the findings.

Table 3: Comparison of Calculated Number of Households with Access to Three Goods and Actual Number

City	In-house Drinking Water		In-house Latrine		Two-wheelers	
	HH Amenities	Calculated from PCA	HH Amenities	Calculated from PCA	HH Amenities	Calculated from PCA
Delhi	25,16,452	25,77,096	28,77,391	29,48,242	12,44,741	12,74,680
Mumbai	21,06,359	21,64,424	15,35,831	15,83,861	4,16,771	4,31,297
Bangalore*	17,03,953	17,07,297	20,39,188	20,46,113	9,73,168	9,76,824
Hyderabad*	14,85,273	14,31,085	16,09,072	15,50,988	7,99,383	7,69,814
Ahmedabad	10,74,530	10,79,326	10,87,484	11,02,011	6,13,533	6,21,556
Chennai	8,44,285	8,80,532	10,57,802	11,02,977	5,15,581	5,37,400
Kolkata	6,98,088	7,45,698	9,15,319	9,72,506	1,17,173	1,23,685
Surat	8,25,534	8,48,225	8,98,824	9,24,400	4,20,756	4,33,540
Pune	6,68,639	6,76,406	5,81,206	5,89,908	4,32,893	4,38,436
Jaipur	4,74,037	4,93,185	5,39,717	5,62,181	3,42,747	3,57,420

* Includes municipal corporation and outgrowths. In the final analysis, outgrowths have been ignored. The houselisting and housing phase do not provide a break-up for municipal corporations and outgrowths in these cities, and this number has been used to facilitate comparison.
Source: Census of India 2011.

3.3 Methodology

There are several indices to calculate spatial segregation. Massey and Denton (1988) suggested grouping these segregation indices as measures of evenness, exposure, concentration, centralisation, and clustering. Many suggest that while there is no one index that summarises the spatial segregation pattern of an urban area, the data available does not permit the use of several measures to get a holistic view of the spatial structures of cities. The index of dissimilarity (D), which is a measure of evenness and is the most widely accepted and used measure in segregation analyses all over the world, is the most appropriate index to use. This index, despite all associated problems, as Cortese et al (1976) pointed out, gives a sense of how the population of one particular group is distributed across different wards vis-à-vis the distribution of the population of that group in that city. In addition, the simple interpretation of the index also adds to the attractiveness of using it—the value is simply the proportion of people of one group that would need to move to have a uniform distribution of population by group.

However, there is one problem that needs attention. Wards, as defined by the census, differ in number and size not only in different cities, but also within cities. The index of dissimilarity is largely considered to be organisationally equivalent (although there are some, such as Siegel 2001, who argue otherwise) in the sense that it is unaffected by changes in the number of

sub-areas under consideration. But it has been argued that the index is not composition invariant, implying that it is affected by the scaling of columns or rows. Thus, the one modification that is required for an inter-city comparison is adjusting the index to make it composition invariant. One such alternative discussed in the literature is the Segregation Index (S) suggested by Gorard (2000) and defined as,

$$S = 0.5 * \sum_{i=1}^{n} \left| \frac{X_i}{X} - \frac{T_i}{T} \right| V$$

where n is the total number of wards,
X_i is the population of group X in the ith ward,
X is the total population of group X,
T_i is the total population of the ith ward, and
T is the total population.

This paper uses the Gorard Index of Segregation (S) to measure segregation in the 10 cities under consideration, which has the same interpretation as the Index of Dissimilarity (D).

To calculate S, the data needs to be dichotomous. So, for literacy, literacy status is used; for gender, male or female; for caste, SC/ST or others; for drinking water, whether located in-house or otherwise; for latrines, whether located in-house or not; and for two-wheelers, ownership of one or not.[8] A word of caution here. Since census data is available only for SCs and STs, others would include the general category population as well as Other Backward Classes (OBC). More explicitly, for segregation by gender, the distribution of the total population is compared to the distribution of females; for segregation by male illiteracy, the distribution of total males and illiterate males; for segregation by caste, the distribution of the total population and SCs/STs; for segregation by a basic public good, the distribution of total households and households without in-house drinking water; for segregation by a basic private good, the distribution of total households and households without in-house latrines; and for segregation by luxury goods, the distribution of total households and households with two-wheelers. Table 4 summarises the variables used in the study.

Table 4: Basic Facts about the 10 Cities under Study

City	Sex Ratio	Male Illiterate (%)	Female Illiterate (%)	Proportion of SCs/STs (%)	HHs without In-house Water (%)	HHs without In-house Latrine (%)	HHs with Two-wheelers (%)
Delhi	870	20.0	28.9	16.6	21.3	9.9%	38.9
Mumbai	853	16.1	22.2	7.4	21.1	42.2	15.7
Bangalore	923	18.1	23.9	13.2	19.1	3.2	46.3
Hyderabad	955	23.2	30.2	8.4	8.6	1.9	48.9
Ahmadabad	898	18.3	25.2	11.9	8.5	6.6	52.7
Chennai	989	15.7	21.8	17.0	23.8	4.5	46.5
Kolkata	908	18.2	22.4	5.6	27.2	5.1	12.1
Surat	756	19.7	27.2	5.3	13.1	5.2	44.4
Pune	948	17.9	22.5	14.5	8.9	20.6	59.0
Jaipur	900	22.3	32.8	16.7	17.7	6.2	59.6

(1) Calculated by aggregating the ward level numbers. (2) Sex ratio is females per 1,000 males. (3) Male illiterate and female illiterate are as proportions out of total male and female populations, respectively. (4) SCs/STs taken as a proportion of total population. (5) Households with access to the three goods taken as a percentage of total households.
Source: Census of India 2011.

To get a better sense of how these variables are distributed across wards within the 10 cities under study, box plots for them are presented for each city and each variable in Figures 1 and 2 (pp 59, 60). To see where the "richest" wards stand in this distribution, car ownership was taken as a proxy of wealth and an average number calculated for every variable in the top 10% wards in terms of the proportion of households with a car. These numbers are represented by the grey triangles in the box plots. Interestingly, in terms of access to in-house tap-water, only the top 10% wards in four cities—Delhi, Jaipur, Mumbai, and Surat—do better than the median ward. In terms of in-house latrines, only top 10% wards in Mumbai, Surat and Pune do better than the median ward, and in terms of ownership of two-wheelers, the top 10% wards do better than the median in all 10 cities. In terms of the proportion of SCs/STs, only the top 10% wards of Hyderabad and Surat have a greater proportion of SCs/STs than the median ward. From the box plots, it can be seen that there are several outliers in the distribution of SCs/STs, and in the lack of access to in-house drinking water and latrines. This is one of the possible causes of the index of segregation having a high value.

Further, the correlation coefficients are computed between the proportion of SCs/STs in the population and access to the three goods individually. This has been done to ascertain if there is a strong linear relationship between the proportion of SCs/STs and the proportion of households with access to these three goods across wards in the 10 cities.

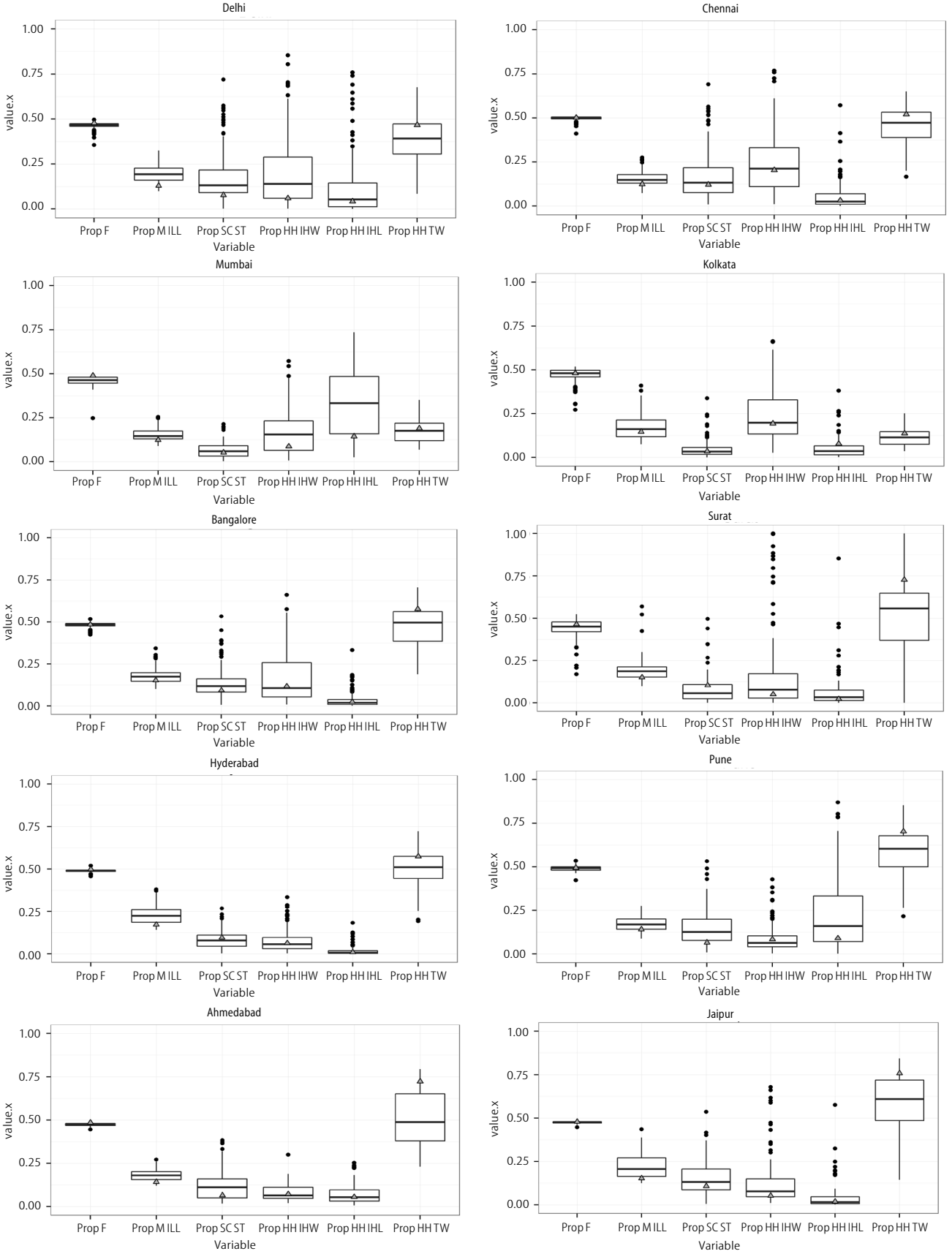
4 Results

From the box plots, we can see there are several wards in cities that are outliers in terms of the proportion of SCs/STs, which means that they are "faraway" from the main group of data.[9] Comparing the average levels of access to public, private, and luxury goods across these outlier wards for every city, calculated as averages of the proportions weighted by the number of households, with the overall numbers for the cities presents an interesting picture of segregation. Table 5 has the numbers.

Table 5: Comparison of Outlier Wards with Total Wards

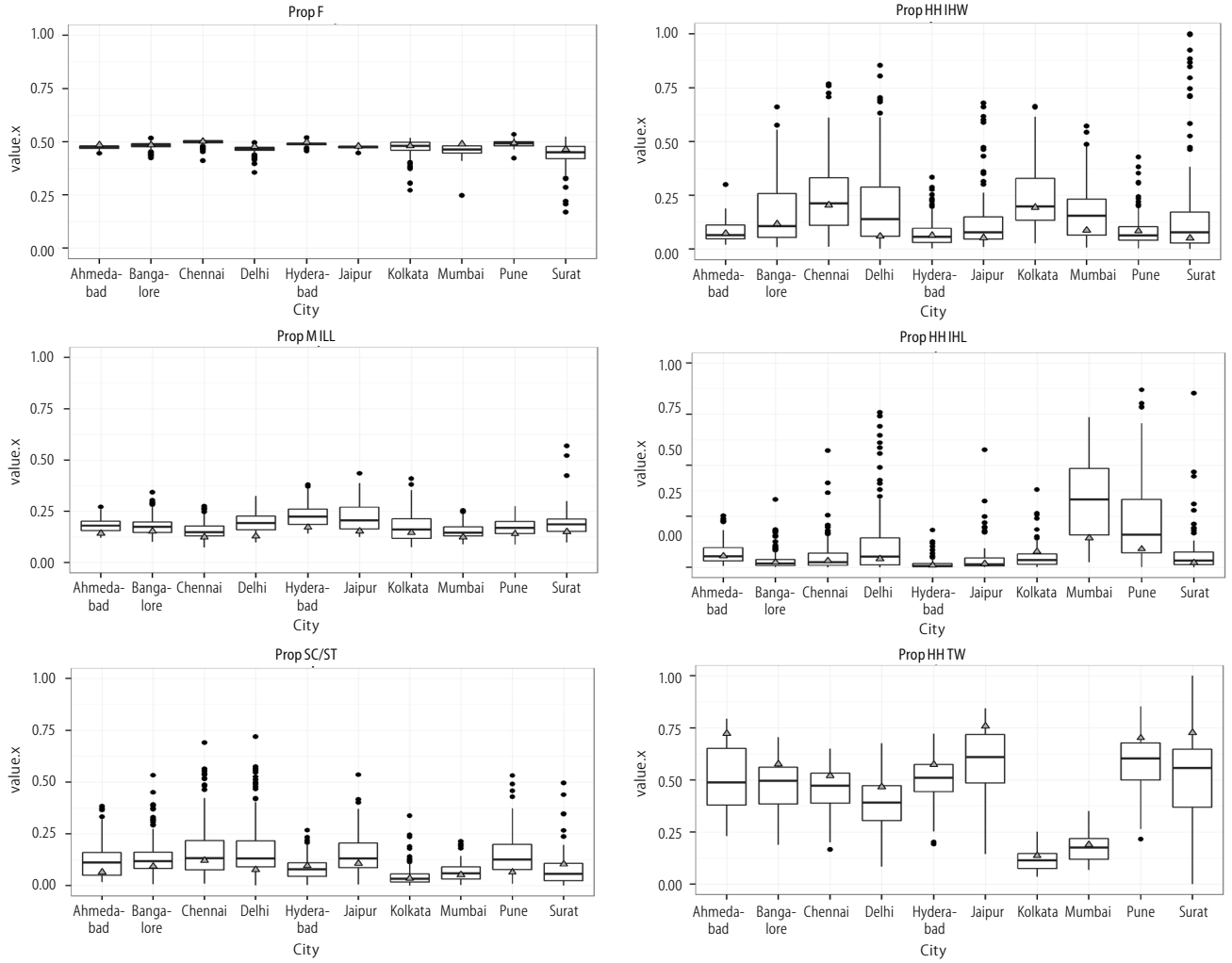
City	Number of Outlier Wards	Proportion of SCs/STs Out of Total in These Wards (%)	SC/ST Proportion		HH without IHW		HH without IHL		HH with Two-wheelers	
			Outlier Wards (%)	Total (%)	Outlier Wards (%)	Total (%)	Outlier Wards (%)	Total (%)	Outlier Wards (%)	Total (%)
Delhi	13	13.8	52.1	16.6	9.3	21.3	7.2	9.9	30.1	38.9
Mumbai	4	9.8	19.9	7.4	22.4	21.1	54.2	42.2	11.3	15.7
Bangalore	13	14.2	35.6	13.2	23.5	19.1	10.7	3.2	37.5	46.3
Hyderabad	4	5.6	23.1	8.4	12.8	8.6	2.6	1.9	46.7	48.9
Ahmadabad	4	16.1	36.5	11.9	10.7	8.5	18.8	6.6	33.4	52.7
Chennai	10	20.2	53.7	17.0	53.0	23.8	12.8	4.5	25.4	46.5
Kolkata	12	40.6	19.5	5.6	43.2	27.2	9.0	5.1	12.5	12.1
Surat	6	3.8	27.5	5.3	40.0	13.1	14.2	5.2	39.4	44.4
Pune	4	7.6	47.4	14.5	14.8	8.9	65.2	20.6	34.3	59.0
Jaipur	3	11.1	46.9	16.7	33.6	17.7	29.5	6.2	39.9	59.6

Figure 1: Box Plots for Variables under Study by City



Prop F – Proportion of females in population; Prop M ILL – Proportion of male illiterates in males; Prop SC ST – Proportion of SCs/STs in population; Prop HH IHW – Proportion of households without access to in-house drinking water; Prop HH IHL – Proportion of households without access to in-house latrines; Prop HH TW – Proportion of households with two-wheelers.

Figure 2: Box Plots of Cities under Study by Variable



Prop F – Proportion of females in population; Prop M ILL – Proportion of male illiterates in males; Prop SC ST – Proportion of SCs/STs in population; Prop.HH.IHW – Proportion of households without access to in-house drinking water; Prop HH IHL – Proportion of households without access to in-house latrines; Prop HH TW – Proportion of households with two-wheelers.

Outlier wards in these cities account for a varying level of total SCs/STs. Kolkata presents an interesting picture—40.6% of the total SCs/STs stay in 12 outlier wards of the 141 wards in the city. In terms of access to in-house water, 43.2% of the households in these wards do not have any access, compared to 27.2% of all households in the city. In terms of access to in-house latrines, 9.0% of these households do not have any access, which is almost double the number for all households in the city. The 10 outlier wards in Chennai also account for a high proportion of SCs/STs—20.2% of the SCs/STs of the city live in them. On an average, the population of these wards are majorly SCs/STs. In terms of access to in-house water in these outlier wards, 53.0% of households do not have any access compared to 19.1% of the total. Access to in-house latrines and ownership of a two-wheeler also present stark contrasts. Outlier wards in other cities account for a lower level of the overall SC/ST population, but have a high average proportion of SCs/STs in the total population, especially in Delhi, Pune, and Jaipur. In most cities, a lesser proportion of households have access to in-house water and in-house latrines in outlier wards as compared to overall.

Coming to the index of segregation, Table 6 gives the value of *S* by gender, male literacy, caste, and access to the three goods for the 10 largest cities. The baseline measure of

Table 6: Index of Segregation and Rank of Cities by Value of Index

City	S - Gender		S - Male Literacy		S - SC/ST		S - In-house Drinking Water		S - In-house Latrines		S – Two-wheelers	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
Delhi	0.010	6	0.097	3	0.253	5	0.359	3	0.478	2	0.120	5
Mumbai	0.016	3	0.076	9	0.196	10	0.214	10	0.177	10	0.160	2
Bangalore	0.011	5	0.083	7	0.202	9	0.345	4	0.359	8	0.110	6
Hyderabad	0.006	9	0.087	5	0.228	8	0.321	5	0.431	4	0.085	9
Ahmedabad	0.008	7	0.077	8	0.282	3	0.242	9	0.354	9	0.133	4
Chennai	0.007	8	0.086	6	0.277	4	0.279	7	0.437	3	0.099	8
Kolkata	0.023	2	0.166	1	0.350	1	0.243	8	0.373	6	0.155	3
Surat	0.034	1	0.066	10	0.288	2	0.390	2	0.379	5	0.192	1
Pune	0.012	4	0.094	4	0.250	7	0.292	6	0.365	7	0.083	10
Jaipur	0.006	10	0.127	2	0.250	6	0.413	1	0.531	1	0.100	7

segregation, calculated on the basis of gender, is low for the cities. This number would be interpreted as the proportion of the female population that would have to move across wards to get a uniform distribution. It ranges from 0.006 in Hyderabad and Jaipur to 0.034 in Surat.

Segregation by caste, compared to segregation on the basis of gender, turns out to be very high. As mentioned before, caste here includes only SCs and STs. This ranges from 0.196 in Greater Mumbai to 0.350 in Kolkata. This implies, for example, in Greater Mumbai's case, that 19.6% of the SC/ST population would have to move to produce an even distribution by caste, compared to 1.6% of the female population that would have to move to produce an even distribution by gender. Also, for seven of the 10 cities—Delhi, Ahmedabad, Chennai, Kolkata, Surat, Pune and Jaipur—segregation by caste is more than 0.250. This means that more than 25% of the SC/ST population of these cities would have to move across wards to get a more uniform distribution.

Next, to compare segregation by caste and socio-economic status, male literacy has been taken as a proxy of the latter. While this is an imperfect proxy, it does give a sense of the extent and magnitude of segregation that exists in these cities. Looking at segregation by socio-economic status on the basis of male literacy, the value of the index varies from 0.066 for Surat to 0.166 for Kolkata. Segregation by caste is higher than segregation by socio-economic status in every city.

Looking at segregation by access to a basic public good, in-house drinking water, and by access to a basic private good, in-house latrines, it is found that this is significantly high. In the case of in-house tap-water, *S* ranges from 0.214 in Mumbai to 0.413 in Jaipur. For all cities, barring Ahmedabad and Kolkata, segregation by access to in-house drinking water is higher than segregation by caste. Segregation by access to in-house latrines, on the other hand, ranges from 0.177 in Mumbai to 0.531 in Jaipur. This is higher than segregation by caste in all the cities except Mumbai, and higher than segregation by access to in-house drinking water in all cities except Mumbai and Surat.

Coming to the luxury/aspirational good, segregation by ownership of two-wheelers is comparable to segregation by socio-economic status. It ranges from 0.083 in Hyderabad to 0.192 in Surat. This is lower than segregation by caste, and access to in-house drinking water and in-house latrines in all cities.

Table 7: Correlation Coefficients of Proportion of SC/ST Population with Proportion of Households with Access to In-house Drinking Water, In-house Latrines, and Two-wheelers

City	r (SC/ST–IHW)	r (SC/ST–IHL)	r (SC/ST–TW)
Delhi	(0.07)	**(0.21)**	**(0.45)**
Mumbai	**(0.32)**	**(0.40)**	**(0.40)**
Bangalore	**(0.35)**	**(0.63)**	**(0.37)**
Hyderabad	**(0.35)**	**(0.32)**	(0.13)
Ahmedabad	(0.10)	**(0.44)**	**(0.52)**
Chennai	**(0.65)**	**(0.52)**	**(0.58)**
Kolkata	**(0.45)**	**(0.20)**	0.08
Surat	0.02	(0.07)	**0.26**
Pune	**(0.32)**	**(0.70)**	**(0.65)**
Jaipur	**(0.38)**	**(0.45)**	(0.17)

Figures in parenthesis are negative; figures in bold are significant at the 5% level.

To understand how access to and ownership of these goods relates to the proportion of SCs/STs in the population across wards in the 10 cities, the correlation coefficient of the proportion of SCs/STs in the population has been calculated against the proportion of households with access to the three goods at the ward level. Table 7 presents the findings.

The correlation between the proportion of SCs/STs in the population and access to the basic public good seems moderately high in Chennai (–0.65) and Kolkata (–0.45).[10] These two cities have a high degree of segregation by caste compared to the other cities in the study. As for the basic private good, the correlation between the proportion of SCs/STs in the population and access to in-house latrines is strong in Pune (–0.70) and moderate in Bangalore (–0.63), Chennai (–0.52), Jaipur (–0.45), Ahmedabad (–0.44), and Mumbai (–0.40). With regard to the luxury/aspirational good, Pune (–0.65) has a strong correlation between ownership of a two-wheeler and the proportion of SCs/STs in the population, while Chennai (–0.58), Ahmedabad (–0.52), Delhi (–0.45), and Mumbai (–0.40) have a moderate correlation. In Bangalore (0.00) and Pune (0.01), this seems negligible. It needs to be pointed out that while the results of this analysis are indicative at best, correlation does not imply causality. A high correlation coefficient merits a more detailed study of the spatial dynamics at play in some cases.

To surmise, the paper finds that there is high spatial segregation by caste in the 10 big cities of India and that this is higher than the baseline segregation measured by gender and socio-economic status (male literacy). It also finds that there is a high degree of segregation by access to a basic public good, in-house drinking water, and by access to a basic private good, in-house latrines. In most cases, this is higher than segregation by caste. As is seen in the box plots in Figures 1 and 2, the variables on which segregation is high are also the variables for which there are a lot of outliers, which means that there are some wards with an unusually high proportion of SCs/STs, households without in-house drinking water, and households without in-house latrines. On the other hand, segregation by ownership of a luxury good, two-wheelers, is lower than segregation by caste or access to in-house drinking water or latrines in most cases, but is higher than segregation by socio-economic status. Coming to the correlation between the proportion of SCs/STs and access to the three goods, it seems caste is strongly to moderately correlated to access in some cities. This particular finding requires further study.

A question that arises is—do we not expect high segregation by caste? Many scholars studying caste dynamics in urban India (Béteille 2012; Chhibber and Varshney 2013) argue that these are changing, and slowly but steadily people in urban areas are leaving behind their caste identities. But there are others who think that caste identity still plays a significant role in shaping social and economic dynamics in Indian cities (Madheswaran and Attewell 2007; Vithayathil and Singh 2012). On the study of segregation by access to

public, private, and aspirational goods, the HH Amenities database opens up various possibilities that did not exist earlier.

5 Concluding Remarks and Scope for Further Studies

Studies on residential patterns and segregation, including this one, are driven by Park's insight (1926) that "social relations are so frequently and so inevitably correlated with spatial relations." While many have been arguing that caste identities in urban India are blurring, the evidence is anecdotal. This paper hopes to encourage researchers to look into residential patterns to ascertain the overall pattern of segregation in Indian cities. There are several problems associated with the data at hand and also with the measure of segregation used; for example, differing and changing ward sizes. This paper tries to provide a preliminary account of the patterns of spatial segregation in India's big cities.

Using ward-level data released by the Census, the paper carries out an inter-city comparison of the levels of spatial segregation in 10 big Indian cities. It finds that there is significant residential segregation by caste and also by access to in-house drinking water, a basic public good, and access to in-house latrines, a basic private good. Segregation by these measures are more prominent than residential segregation by male literacy, which has been used as a proxy for socio-economic status. Further, in the case of some cities covered in the study, the proportion of SCs/STs in wards is highly correlated with access to public, private, and luxury goods.

As Vithayathil and Singh (2012) point out, data limitations prevent us from studying how religion shapes patterns of residence. If, as is being argued, the caste divide is fading in urban India, it would be useful to study whether this is true of religion as well. It would also be useful to study the residential patterns of migrants. With continuing urbanisation, migration will continue, and it will be useful to study whether migrants coming to cities are being integrated with other residents there. Comparing residential patterns based on caste, religion, and migration would provide useful insights into how social dynamics work in the big Indian city.

NOTES

1 Residential segregation and spatial segregation have been used interchangeably in this paper.

2 The Primary Census Abstract contains basic demographic data, including number of households, population, SCs/STs, and distribution of workforce for all settlements.

3 A detailed discussion about the two phases is available here: http://censusindia.gov.in/Ad_Campaign/drop_in_articles/05-History_of_Census_in_India.pdf

4 A group of unrelated persons who live in an institution and take their meals from a common kitchen is called an institutional household. Households who do not live in buildings or census houses but live in the open on roadsides, pavements, in concrete pipes, under flyovers and staircases, or in the open in places of worship, mandaps, railway platforms, and so on are treated as houseless households.

5 Outgrowths are viable units that emerge adjacent to but are outside the administrative limits of statutory towns.

6 Except for basic summaries of data, where outgrowths have been included in the case of Bangalore and Hyderabad. This is because the HH Amenities data does not contain information in the municipal corporations in this region separately.

7 While a better indicator would have been access to in-house drinking tap water, data for it is only available at the city level and not the ward level. That said, in these cities, there is a high degree of overlap between the number of households having in-house drinking water and the number of households having in-house drinking tap water. In Delhi, the overlap is 88.4%, Mumbai 99.6%, Bangalore 86.3%, Hyderabad 98.7%, Ahmedabad 88.0%, Chennai 86.3%, Kolkata 95.4%, Surat 91%, Pune 99.7%, and Jaipur 94.1%.

8 It needs to be mentioned that while creating a binary variable for ownership of two-wheelers, there is a certain degree of error attached to it because the census does not provide numbers for ownership of different vehicles within a household. To understand the magnitude of the error, the proportion of households with both a car and a two-wheeler were calculated using data from the Consumer Expenditure Survey of the National Sample Survey Organisation for 2009–10. The numbers are 8.5% for Delhi, 5.4% for Greater Mumbai, 11.1% for Bangalore, 4.6% for Hyderabad, 15% for Ahmedabad, 8.6% for Chennai, 1.3% for Kolkata, 5.4% for Surat, 7.5% for Pune, and 20.3% for Jaipur.

9 In these box plots, outliers are calculated as observations, which have values greater than the third quartile +1.5 times the interquartile range, or less than the first quartile –1.5 times the interquartile range. For the proportion of SCs/STs in the ward population, outliers lie on the farther end of the distribution, that is, have values greater than the third quartile +1.5 times the interquartile range, which implies that there are wards in every city where the proportion of SCs/STs is very high.

10 Categorisation of the coefficient of correlation based on Evans (1996): 0.00 <= |r| <= 0.19 implies very weak correlation, 0.20 <= |r| <= 0.39 implies weak correlation, 0.40 <= |r| <= 0.59 implies moderate correlation, 0.60 <= |r| <= 0.79 implies strong correlation, and 0.80 <= |r| <= 1 implies very strong correlation.

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