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Dense and Expanding: Urban Development and Land Markets in Chennai, India

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Urban Development and Land Markets in Chennai, India

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Abstract

Urban development patterns in India have become increasingly important as cities become centers for foreign direct investment and the economic transformation of the country. The metropolitan area of Chennai, India, has a strange urban structure for an Indian city of its size; extremely high and increasing population density in the city center and rapid low-density expansion at the periphery. This paper documents Chennai's spatial development through detailed data on land use, population and land values. A hedonic regression on the price of land suggests that *de facto* policy differences between political jurisdictions have a significant effect on land prices.

Keywords

South Asia, India, Urban Spatial Structure, Population Density, Land Markets, Land Policy

INTRODUCTION

There is growing research literature on urban land and housing markets in India.[i] Over the past five years, detailed studies have been carried out on urban land market dynamics in Mumbai, Bangalore and Delhi. Taken together, these studies provide detailed assessments of urban land development in India, and explore the various effects of urban planning and development control regulation on the spatial development of India's leading urban regions. This paper adds to this discussion by providing an assessment of the land market from data on land values rather than a focus on policy. In addition, it provides four decades of detailed, spatially disaggregated information on land use, population and land values for the metropolitan area. The research presented in this paper uncovers evidence that Chennai exhibits a unique pattern of spatial development for an Indian city of its size; the population in its already dense city center continues to grow, while simultaneously, the metropolitan expands in a low density pattern on the periphery.

Research for this paper was conducted as a land market assessment in the Chennai Metropolitan Area (CMA) as a joint effort of the World Bank, the Chennai Metropolitan Development Authority (CMDA) and the Department of Geography, University of Madras. The study was initiated in June, 2003, and the underlying methodology and approach is provided by Dowall (1995).[ii] The CMDA was responsible for compiling detailed land use archival information for the metropolitan area and interpreting IKONOS satellite images for 2001. The CMDA also built the socio-economic and housing database, linking together information on population, households and dwelling units from Government of India Censuses. The University of Madras' Department of Geography was responsible for carrying out the extensive surveys of real estate brokers in the metropolitan area.

The paper is divided into four sections. The next section provides a brief background on the city of Chennai in the context of contemporary Indian urbanization. The second section explores population trends and spatial patterns of population density, comparing Chennai to other Indian cities. Following that, the trends and spatial patterns of land use are described and analyzed. Section four presents data on the price of residential and industrial land, including a hedonic regression on the price of land in residential plots. The paper concludes by summarizing key findings.

BACKGROUND

Chennai is the fourth largest metropolitan area in India, with a population of 7 million in 2001. Located in State of Tamil Nadu, Chennai is the major city of southern India. In its formative years, Chennai served as the capital of the Madras Presidency and was its main administrative and commercial center. In more recent times, Chennai has been designated as the capital of the State of Tamil Nadu. The city has a diversified economic base, with

well-developed industrial and tertiary sectors. Chennai is the main automobile production and assembly center in India, and it is gaining momentum as a back-office and IT center.

Chennai is located on the southeastern coast of India on the Bay of Bengal. The Metropolitan Area is comprised of the Chennai City Corporation (CCC), 16 municipalities, 20 Special Grade Village Panchayats and 214 villages. The total land area is 1,189 square kilometers. The urbanized area extends approximately 50 kilometers from north to south and 30 kilometers from east to west. The area of the Chennai City Corporation is much smaller, about 20 kilometers from north to south, and about 12 kilometers from east to west.

Like other large India cities, Chennai is growing fast economically and demographically (see Tables 1 and 2). The economy of Chennai grew by 13% per year on an annual compound average basis between 1990-1 and 2002-3. Population growth in Chennai and other large Indian cities has also increased rapidly. Between 1981 and 2006, the population of Chennai grew by 2.3% per annum. While this figure is robust, it is less than the overall growth rates for Indian cities (2.99%).

Table 1
State net GDP in current prices (millions of USD), selected Indian states

State	City	1990-1991	1995-1996	2000-2001	2002-2003	Annual % Change 1991-2003
Gujarat	Ahmedabad	5,388	13,755	20,025	26,406	13.0
Karnataka	Bangalore	4,579	11,147	20,796	22,371	12.9
Andhra Pradesh	Hyderabad	6,655	15,997	28,146	32,352	12.9
Tamil Nadu	Chennai	6,166	15,534	28,087	30,135	13.0
Delhi	Delhi	2,282	5,667	12,826	15,318	15.8
Maharashtra	Mumbai	12,954	31,356	46,834	57,717	12.2

Source: Reserve Bank of India, www.rbi.org.in

Note: The website of the Reserve Bank of India informs that due to differences in the method of compilation, these are not "strictly comparable" between states.

In many ways, Chennai, like Mumbai, Delhi and Bangalore, is a globalization "hotspot." It is a magnet for considerable foreign direct investment and economic transformation. However, in addition to global forces, the metropolitan restructuring of Chennai and other Indian cities also depends on local agency in managing growth (Shaw and Satish, 2006). In return, the manner in which Indian cities accommodate new businesses and migrants, while trying to improve environmental quality and housing affordability, will determine their future regional competitiveness. Those that fail to manage urban growth as well as foreign investment will see congestion, land and real estate inflation, and declining urban service quality, factors that will reduce urban productivity.

Table 2
Population and compound annual growth rates of selected cities in India, 1981 – 2006

City/Area	1981	1991	2001	2006	u CAGR
Ahmadabad	2,548,057	3,312,216	4,519,278	5,600,000	3.20%
Hyderabad	2,545,836	4,344,437	5,533,640	6,700,000	3.95%
Bangalore	2,921,751	4,130,288	5,686,844	7,100,000	3.62%
Chennai	4,289,347	5,421,985	6,424,624	7,600,000	2.31%
Delhi	7,456,474	11,679,596	17,829,980	19,700,000	3.96%
Mumbai	9,281,877	12,596,243	16,368,084	19,850,000	3.09%
All urban India*	158,851,000	217,254,000	288,283,000	331,729,000	2.99%

Source: City Population website, Brinkoff http://www.citypopulation.de/India.html and UN-Habitat Global Urban Observatory http://www.unchs.org/programmes/guo/guo_citibase.asp
*These figures are from 1980, 1990 2000, and 2005, respectively.

Most large cities in India have had very restrictive land use policies and regulations, including the urban land ceiling act, rent control, uniform low floor space index (FSI), public sector dominance of the real estate market and inadequate provision of urban infrastructure (CMDA 2004). Chennai is somewhat different because it has partially liberalized its land policy and it recognizes the role of the private sector in housing and real estate development. At the same time it still has rent control and a very low FSI (1: 1.5). These regulations, combined with inadequate infrastructure service coverage, are especially problematic in the area outside the central 10 km of the CMA (Dahiya 2003), and might be a cause of the unusual density trends of the city.[iii]

TRENDS IN SPATIAL DISTRIBUTION OF POPULATION AND DENSITY

The population of the CMA doubled form 1971- 2001, from 3.5 to 7.0 million people, though over the thirty-year period, the rate of population growth fell. Due to suburban growth, Chennai's metropolitan population is less concentrated in the center city. In 1971 the CCC accounted for 75 percent of the region's population, but by 2001 that share had decreased to 62 percent.

Table 3
Population trends Chennai City, Suburbs and Metropolitan Area, 1971 - 2001

Area	1971	1981	1991	2001
Chennai City Corporation	2,642,000	3,285,000	3,843,000	4,343,000
Suburbs	860,000	1,313,000	1,964,000	2,690,000
Total Chennai Metropolitan Area	3,502,000	4,598,000	5,807,000	7,033,000

Source: CMDA, 2006.

The core of Chennai, the area within 5 kilometers of the central railway station, accounted for 50 percent of the region's population in 1971. By 2001, the core's share

had declined to 31 percent, but in absolute terms its population increased by over 400,000 (see Table 4). In contrast, the ring just beyond the core, extending out to a distance of 10 kilometers, increased in both absolute terms, by 1.44 million people, as well percentage terms, from 27 to 34 percent.

Table 4
Population by distance from city center and percent distribution, 1971 - 2001

Distance	1971	%	1981	%	1991	%	2001	%
0-5	1,757,206	50	1,998,165	43	2,053,829	35	2,189,532	31
6-10	943,368	27	1,427,785	31	1,978,301	34	2,383,203	34
11-15	273,622	8	418,661	9	701,407	12	1,026,238	15
16-20	279,008	8	406,985	9	603,205	10	804,368	12
21-25	178,565	5	265,031	6	355,195	6	463,233	7
26 +	79,210	2	85,529	2	145,865	3	173,643	3
Total	**3,510,979**	**100.0%**	**4,602,156**	**100.0%**	**5,837,802**	**100.0%**	**7,040,217**	**100.0%**

Thus, the already dense center of Chennai continues to absorb population. This may be due to the fact that there has been little redevelopment in the center city—which would have displaced population. It also suggests that housing conditions are deteriorating due to overcrowding and subdivision of existing apartments. The population in the 6 to 10 kilometer distance band seems to have stopped increasing in relative importance. This leveling-off of growth might indicate that that area has reached a density limit and further population growth in that area will slow down. It may also reflect the effect of more stringent FSI (1:1.50) regulations in this area.

Although Chennai is suburbanizing, the decentralization is not due to a loss of population in the center, as with the decentralization patterns typical of North American cities. Rather, the decentralization pattern observed in Chennai's population is due to the filling-in of available land to some limit of density.

Table 5
Population, urban land development and gross population density, 1971 – 2001

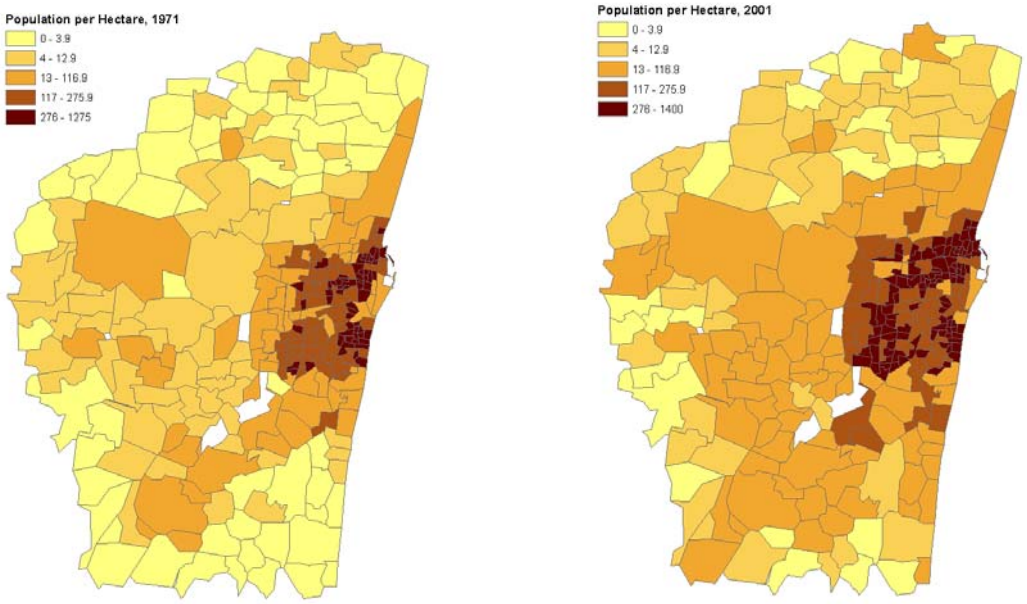
Year	Population	Urbanized land (ha)	Gross population density
1971/1973*	3,505,502	25,766	136
1980/1981*	4,601,566	35,097	131
1991	5,818,479	40,743	143
2001	7,040,696	46,389	152

*The population data are from 1971 and 1981, and the land use data are from 1973 and 1980.

The decentralization of a city's population is often associated with a decrease in overall population density, and a decrease in population density in the central areas of the city.

However, in the case of Chennai, the population has grown in the areas farther from the center, but the overall gross density has increased. The average gross density of the city, measured by the number of persons per urbanized hectare[iv] of land, increased from 136 in 1971 to 152 in 2001, indicating that the city is supporting a larger number of residents per hectare of land.

Figure 1
Diagram of population density (persons per urbanized hectare), 1971 and 2001



Moreover, as demonstrated in Figure 1, the overall density of the city has increased because the city is expanding; however, in terms of density, the increase has not been large in the in the areas further than 10 kilometers from the city center. Many zones have seen slight increases from very low densities of less than 13 persons per hectare to between 13 and 120 persons per hectare. However, the density of the Chennai City Corporation has increased dramatically, especially in the area from 6 to 10 kilometers from the center of the city, where it has almost doubled to very high levels of population density. Some areas of Chennai have more than 1,000 people per hectare, which is density as high as in centers of much larger Indian cities like Mumbai or Kolkata.

Density gradients

A more sophisticated measure of the distribution of gross density is the density gradient. The density gradient is based on the standard model of urban structure, the monocentric city model, and empirical evidence from cities around the world (for a review, see Mills and Tan 1980). The density gradient describes the density pattern of a city as falling at a negative exponential rate. It is written with the equation:

$$D(x) = d_0 e^{-gx}$$

D(x) is the density at any distance x from the city center, d_0 is the predicted density at the center of the city multiplied by the exponential term, and *g* is the density gradient. Thus, density falls from the predicted density of the center of the city at a rate equal to the distance times the gradient: the larger the gradient, the faster density drops from the city center. Gradients in developed countries tend to be flatter than those in developing countries, due to higher incomes and more efficient transportation systems. This results from an increased expenditure on lot size (because housing is a normal good) and the higher technology and quality of transportation systems decreasing commute costs.

Table 6 illustrates two important trends in the population density of Chennai. First, unlike most cities in developed countries, the estimated intercept (predicted population density in the center of the city) has increased over the last 30 years. In 1971 the density was estimated at 464 persons per hectare and by 2001 it had increased to 720 persons per hectare. The other, more typical trend, is that the metropolitan region's population density gradient has flattened out, declining from -.207 to -.183 in 2001.

Table 6
Population density gradients, 1971 – 2001

Year	Intercept (d_0)	Gradient (g)	R^2
1971	464	-.207	.741
	(57.675)	(28.766)	
1981	613	-.206	.763
	(64.238)	(-30.540)	
1991	648	-.190	.759
	(69.432)	(-30.123)	
2001	720	-.183	.717
	(65.794)	(-29.940)	

In Chennai, the flattening of the density gradient occurs together with an increasing density in the center of the city. This combination suggests that the flattening of the gradient is due to population growth and increased availability of transportation, rather than from growth in household income and the suburbanization documented in developed countries.

Comparison Density Gradients

The population density in the city of Chennai has changed in a very different way over the past forty years than that of comparable Indian cities. It has gone from having a much lower central city density and density gradient than Hyderabad or Ahmedabad, to having a much higher central city density and density gradient. This change is due to increasing

density in the central city; in fact, in some parts of central Chennai the gross density is even higher than that of Mumbai, a city almost three times its size.

According to Brush (1968), Chennai had a lower density gradient than other Indian cities of a comparable size in 1961 (see Table 7). During that time, it also had a lower gross density at the city center than the comparable cities of Hyderabad and Ahmedabad. In Brush's study of the spatial structure of Indian cities, he demonstrated that the larger cities in India tend to have lower density gradients, finding an average gradient of 0.376 for the larger 12 urban areas studied and an average gradient of 0.779 for the smaller 12 urban areas studied.

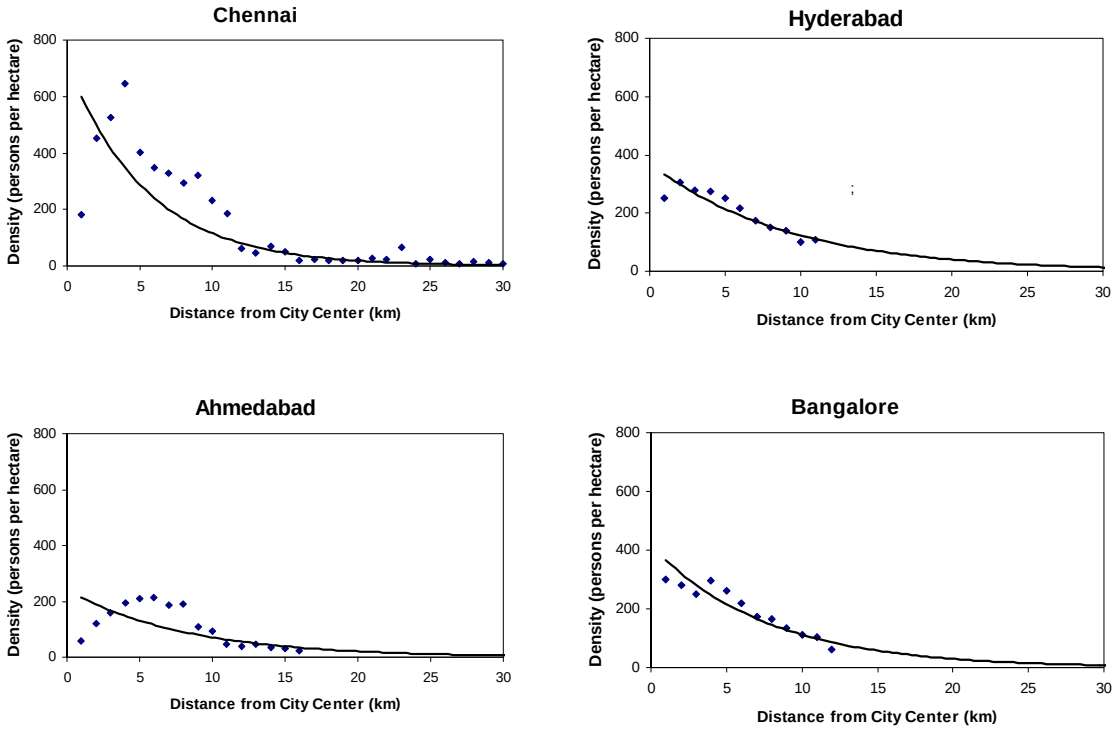
Table 7
Population and density data for selected Indian cities, 1961

City	Population	Persons per acre in city center	Density gradient
Bombay	4,152,056	390	.099
Madras	1,729,141	270	.164
Hyderabad	1,129,345	332	.243
Ahmedabad	1,155,344	437	.504
Bangalore	864,203	224	.273

Source: Brush, 1968.

Over the last forty years, the central city density of Chennai has increased at a faster rate than the population has suburbanized, while in comparable cities, populations have suburbanized significantly. Chennai's density gradient has a much higher intercept value (over 600 persons per hectare) than that of Hyderabad, Ahmedabad or Bangalore, and the curve of the gradient is much steeper (see Figure 2).

Figure 2
Density gradients for Chennai, Hyderabad, Ahmedabad, and Bangalore[v]



LAND USE

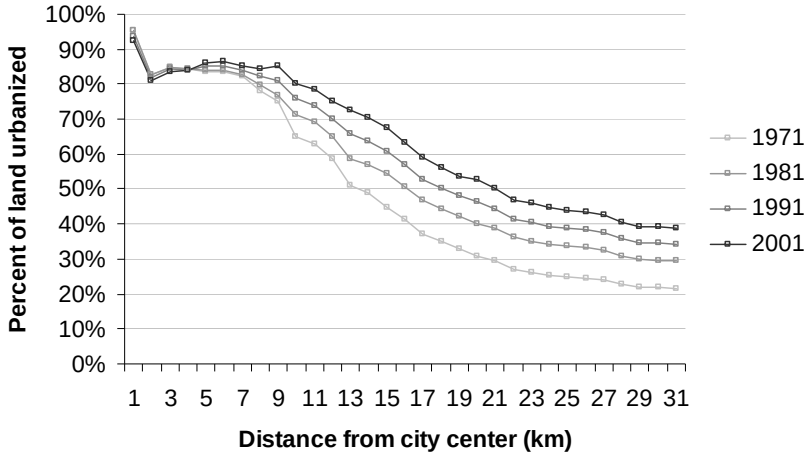
Together with population growth and density trends, land use is another key determinant of land market outcomes and performance. The overall land use patterns of the Chennai Metropolitan Area are comparable to those found in other large coastal plain areas—a dense center district with radial development along principal transportation corridors. As with trends in population growth, the Chennai Metropolitan Area has experienced a steady decrease in the rate at which it urbanizes land. Although these numbers should not be used as a comparison of the last twenty years,[vi] it is clear that the rate of growth in hectares of urban land has decreased.

Table 8
Total land area and urbanized land areas in Chennai, 1973 – 2001

	Total land (ha)	Urbanized land (ha)	Percent of total land urbanized (%)	Absolute increase in urbanized land (ha)	Average annual increase in urbanized land (ha)	Compound annual growth rate of urbanized land (%)
1973	115,333	25,766	22			
1980	115,333	35,097	30	9,331	1,333	4.5
1991	115,333	40,743	35	5,646	513	1.4
2001	115,333	46,389	40	5,646	565	1.3

Currently, about 40% of total land area within the Chennai Metropolitan Area is urbanized. Within the Chennai City Corporation, however, between 80 and 100% of the land is urbanized (Figure 3), and probably has reached the upper limit of urbanization due to zoning, land use regulations and government ownership. There is a sharp drop in the percentage of urbanization beyond the area of the old city, which is due to the dominance of the fort area (which is mostly open space), the river corridor and the coastal strand. The percentage of urbanized land flattens out beyond 5-10 kilometers from the city center and then declines; indicating that peripheral land is mostly undeveloped.

Figure 3
Percentage of zone urbanized by distance from city center, 1971 - 2001



The vast majority of urban land conversion over the last four decades occurred outside of the CCC. Between 1973 and 1980, the areas between 11 to 15 and 21 to 25 km from the city center underwent the most drastic changes, and together made up about 60% of the land converted to urban use. In this period, land in the 16 to 20 km zone is converted to

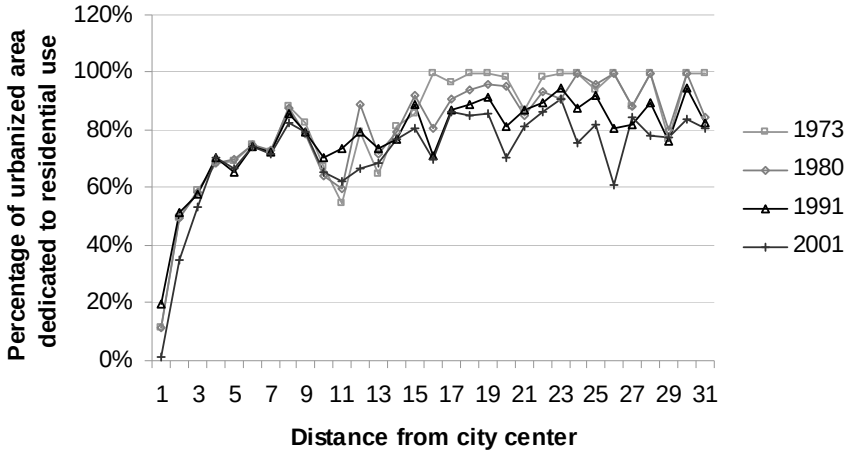
urban use at a disproportionately small rate. However, between 1981 and 2001, the pattern of land conversion is more in line with the expected. Almost a third of the land urbanized in the CMA was between 11 and 15 km of the city center, directly outside of the CCC. Beyond this distance band the rate of conversion decreases proportionately. It seems that the area furthest from the city center is still not yet being urbanized at an appreciable rate.

The result of these trends in population and conversion of land to urban use is that the number of people per hectare urbanized has increased. If the present trends continue and the amount of land urbanized per person continues to decrease, the current decade should see less land converted to urban use per person. In the current decade, only about 2,500 hectares of land will be converted to urban use in Chennai, about half as much as the previous decade.

Residential land

The largest component of urbanized land is residential land, about 72% on average. The amount of urbanized land dedicated to residential use increases significantly by distance from city center (see Figure 4). In the central areas of the city, institutional and commercial uses occupy a significant portion of the urbanized land, although residential use is the majority in all but the central 2 km of the city center. The drop in residential use at 12 km distance from the city center, as will be clear in the next section, is due to a preponderance of industrial use.

Figure 4
Percent of urbanized area dedicated to residential use by distance from city center, 1971 - 2001

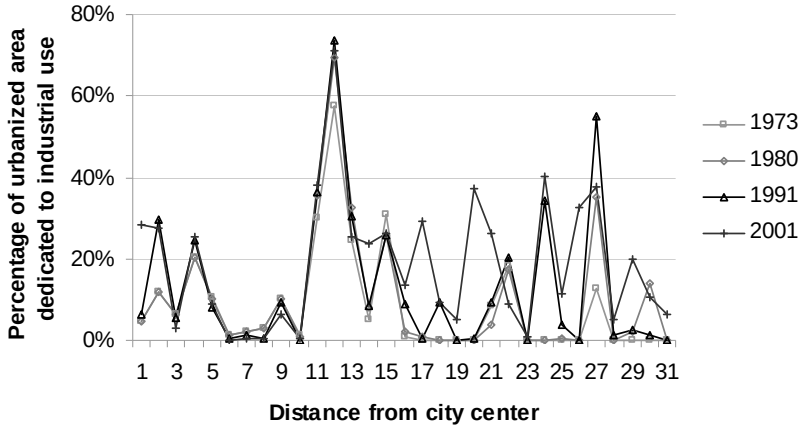


Industrial land

The spatial pattern of industrial land use in the CMA seems very erratic (Figure 5). Until recently, there were appreciable concentrations of industrial at 4, 12 and 15 km from the

city center, the largest by far being at 12 km, where more than half the urbanized area was dedicated to industrial use. In recent years, industrial centers have sprung up at much further distances from the city center, reflecting the suburbanizing trend of industrial activity in India. In 2001, industrial use took over a significant percent of urban areas at 17, 21, 24 and 27 km distance from the city center. Industrial activity in the center of the city has also increased in recent decades.

Figure 5
Percent of urbanized area dedicated to industrial use by distance from city center, 1971 - 2001

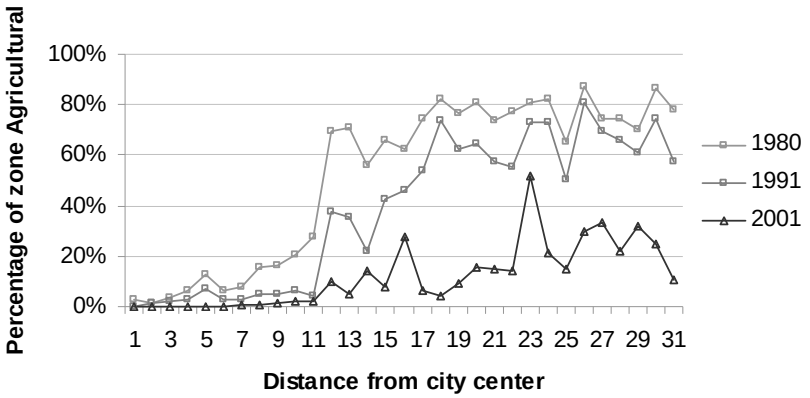


Agricultural Land

The observed amount of agricultural land per zone by distance from the center of Chennai is consistent with the theoretical intuition that land is converted from agricultural to urban use when potential rents from urbanization exceed current agricultural rents (Figure 6). Thus, as Chennai increases in population, more land is demanded for housing and other urban uses and is subsequently converted away from agricultural uses. Although land is not converted in a direct linear relationship by distance from the city center, there is an observable trend.

The conversion of land to urban use is often influenced by government regulation. The doubling of the percent of land used in agriculture at the border of the CCC in 1981 and 1991 suggests that there was a non-market force preventing the conversion of land away from agricultural use beyond the CCC. This is no longer the case in 2001. The pattern of land use in 2001 is more similar to that predicted by economic models of urban areas, i.e., a gradual increase by distance from the center city, rather than a jump between two levels at the border of the CCC.

Figure 6
Percent of zone dedicated to agriculture by distance from city center, 1971 - 2001



Much more land was converted away from agricultural use between 1991 and 2001 than in the previous decade. Additionally, more land has been taken out of agricultural use than has been incorporated into urban use, roughly 41,000 hectares versus about 6,000 hectares. While some part of this large discrepancy might be due to problems with the data (see footnote 7), this is a potentially significant problem. One possible cause is land speculation—the purchase of land for later development—which can be problematic for even urban growth. More detailed research in this area is needed to clarify matters.

Discussion

The urbanization patterns of the most recent decade, 1991 – 2001, follow the theoretical predictions of land use driven by market forces more closely more than those of previous years. Chennai went through a period of significant sprawl between 1971 and 1991, when less land was urbanized between 11 – 15 km from the city center than beyond, possibly reflecting the influential role of the state. However, in the more recent twenty years, this is the area that has experienced the most rapid rate of conversion of land to urbanized use. This makes sense as it is the area directly outside the CCC, which should absorb urban growth as the central city reaches capacity. Also, industry has finally started suburbanizing further from the center of the city than the 12 km zone. There is no longer a huge increase in the amount of land dedicated to agricultural in the area directly outside the CCC, rather a slow increase outward. However, the fact that almost seven times more land was taken out of agricultural use than was converted to urban use between 1991 and 2001 might be a cause for concern. In addition to less government interventions, investments in infrastructure may have had an impact on the spatial pattern of urban land development.

THE PRICE OF LAND

The price of land in Chennai varies considerably by location, level of infrastructure and surrounding land use. The most expensive land is that purchased in serviced residential plots in the city center, while the cheapest is in unserviced residential parcels in the outskirts of the city. Industrial land falls somewhere in between. In the following sections we compare the effect of different attributes on the price of land. The significant factors that influence land price are distance, access to infrastructure, development approval and some elements of the zone in which land is located – its jurisdiction, the level of urbanization and recent growth.

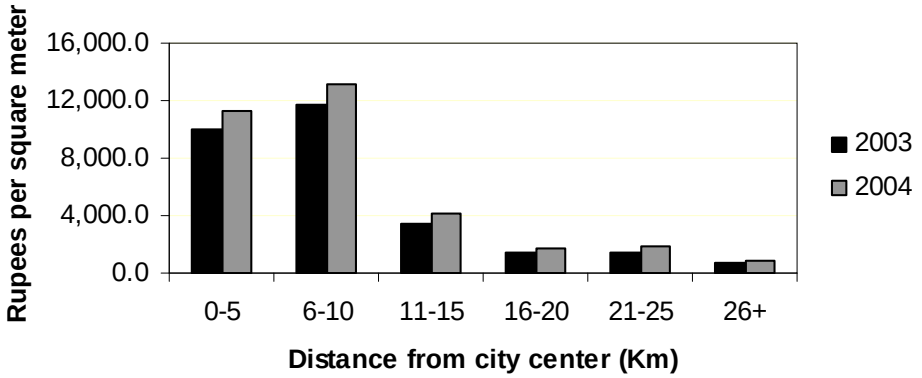
The University of Madras' Department of Geography was responsible for carrying out the extensive surveys of real estate brokers in the metropolitan area. The survey methods followed procedures and guidelines outlined in Dowall (1995). At least three brokers were interviewed in each analysis zone, and the median value of the three responses was utilized in the statistical analysis.

Residential land

The mean price of land in a residential plot in the Chennai Metropolitan Area in 2003 was about 8,200 rupees per square meter, and in 2004 it increased to 9,250 rupees per square meter. Unfortunately, we do not have a more complete historical dataset and a comparison of land prices over two years does not lead to a conclusive discussion of trends because land prices often fluctuate significantly. However, we can draw several conclusions from the land price data set that we have generated. One relates to the effects of distance from the city center on land prices. The other set considers the effects of infrastructure and development regulations on land values. We start with distance.

Decreasing land value over distance from the city center is the most widely accepted and demonstrated insight of the monocentric city model. In the Chennai Metropolitan Area in 2003, the price of land drops dramatically the further that land is located from the city center (Figure 7), although residential land prices in the city center (0 to 5 km) are lower than in the next ring. This runs contrary to the general notion that land is most valuable in the center of a city, and is probably due to the poor environmental quality and the poor conditions of the housing stock in the old city. The rapid decline of land price beyond 10 kilometers may reflect that being located in the CCC is a positive factor associated with higher quality urban services. Additionally, it could reflect the higher market potential for plots inside the central 10 km of the region.

Figure 7
Mean price of land in residential plots by distance from city center, 2003 and 2004



The available data show that average cost of land in residential parcels for the area outside of the CCC in 2003 was about 1,000 rupees per square meter and 1,250 in 2004, a marginal increase of 25%. Data were not available on the price of residential parcels within the CCC. This most likely results from a lack of parcel sized tracts of land in the central 10 km of the CMA. Complete data was not available on all zones outside of the CCC, probably for the same reason.

Figure 8
Mean price of land in residential parcels by distance from city center, 2003 and 2004

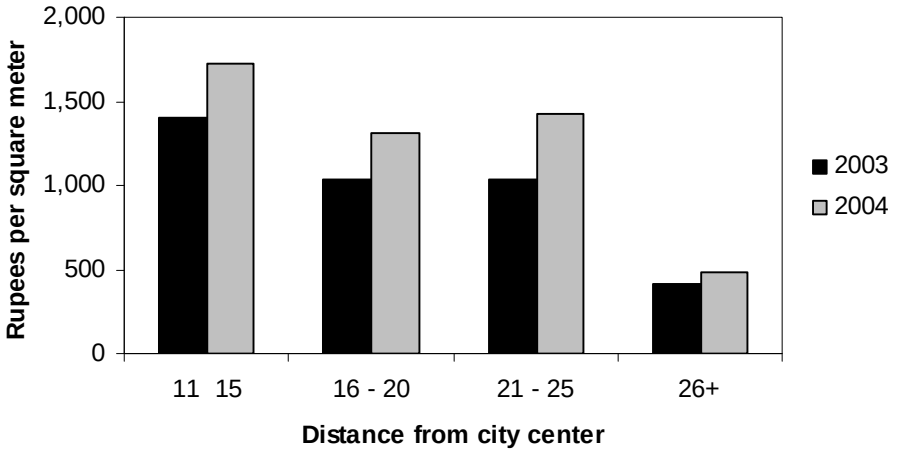
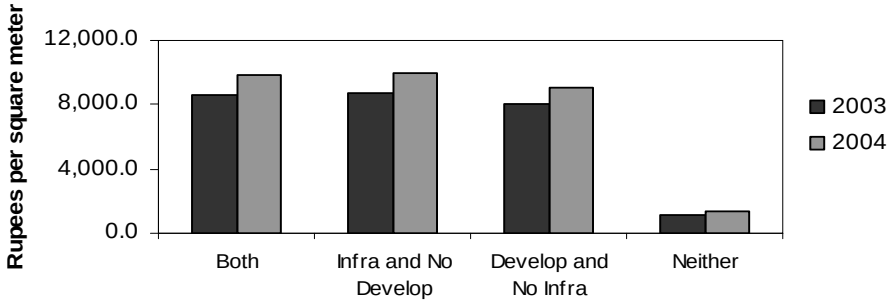


Figure 8 shows that parcel prices decrease with distance. Although the pattern seems quite different from the price of land in residential plots, it should be noted that Figure 8 only shows data for land outside of the central 10 km. Both residential plots and parcels fit into three price ranges by distance; the first is land directly outside the CCC, between

11 and 15 km from the center, the second between 16 and 20 km, and the last the area beyond 20 km.

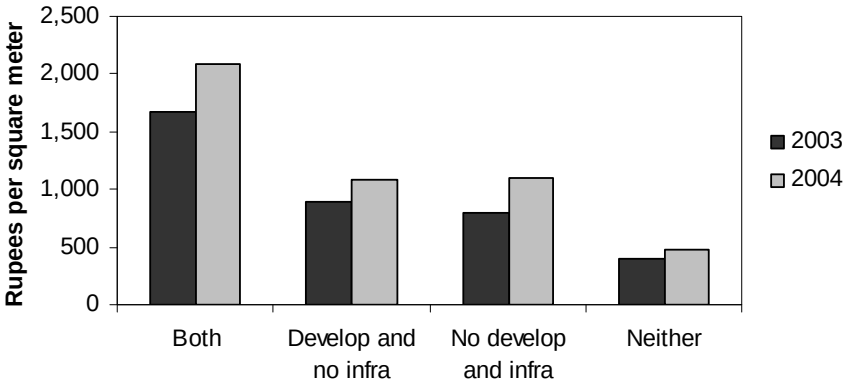
In addition to the distance of land from the center of the city, the potential to develop land is an important factor in determining its price. Generally, in the developing world, the potential for development of a piece of land is indicated by its having a clear property title and whether it is connected to infrastructure. In the case of Chennai, approval for development and connection to infrastructure seem to be almost inseparable, indicated by the minimal variation in price between lots that have received development approval, infrastructure or both (Figure 9).

Figure 9
Mean price of land in residential plots by infrastructure and development approval, 2003 and 2004



There is also a very large premium on having development approval, infrastructure or both versus not having any formal recognition of development potential. This is likely due to tendencies in the consolidation of irregular housing. Once a neighborhood is able to obtain either approval for development, it becomes much easier to get infrastructure installed, and vice versa. The premium on land with development approval and infrastructure is different for land sold in parcels (see next section).

Figure 10
Mean price of land in residential parcels by infrastructure and development approval, 2003 and 2004



Additionally, the relatively smaller premium on infrastructure and development approval for parcels as compared to plots makes sense, because they are both cheaper to obtain for parcels than plots due to the economies of scale and scope. While the data on land prices in residential parcels is consistent with expectations, we will not include it in the following section that explores a more nuanced understanding of land prices because the dataset is not complete enough.

Regression analysis of land value of residential plots

Land price data was collected by zones from surveys of real estate brokers. Brokers listed a price of different types of land according to whether it had infrastructure, development approval, both or neither. Table 9 displays the summary statistics of the data used in the regression analysis.

Table 9
Description of Land Price Data

Variable	Mean	Standard Deviation	Minimum	Maximum
Price per square foot in 2004	10,258	10,994	76.24	112,124
Infrastructure	.42	.493	0	1
Development approval	.38	.487	0	1
Distance from City Center	12.4	8.68	.491	31.79
Chennai corporation	.46	.499	0	1
Municipality	.02	.137	0	1
Town	.12	.327	0	1
Percent Urban Land	.65	.348	.007	1
Urban Change 1991 – 2001	.12	.235	-.47	.926
Percent Commercial Land	.06	.109	0	.865
Percent Industrial Land	.05	.106	0	.965

Three hedonic regression models were generated using the natural log of the price of land in residential plots as the dependent variable. The first model includes only characteristics of the plot, the second adds the jurisdiction in which the plot is located to these characteristics and the third includes characteristics of the zone in which the plot is located. Regression coefficients for the three models run on 2004 land price data are reported in Table 10. The models are of a log-linear form, thus the coefficients can be interpreted as percents. For example, a plot with infrastructure or development approval raise has a roughly 50 percent higher price, all things equal. The models are parsimonious and robust, explaining between 56 and 69 percent of the variation in the natural log of land prices for the city of Chennai. Overall, the independent variables have the expected signs, and are consistent with urban land economic theory. The price of land in Chennai decreases with distance from city center and when it is located near industrial areas, and

increases with access to infrastructure, development approval and when it is located in highly urbanized zones.

The notable feature of the land price models is the large and significant coefficient on the two jurisdictional dummy variables for the CCC and Towns. The first model shows land prices decrease by about 11 percent each kilometer further from the center of the city. However, the second model shows some of that effect is due to being within the CCC, which is roughly the central 10 kilometers of the CMA. The coefficient on the dummy variable for the CCC shows that being under the jurisdiction of the corporation is associated with an increase of 120 percent in the price of land, though it drops to 75 percent when controlling for level of urbanization, growth and land use. In the second model, the coefficient on distance decreases significantly. Though there is some correlation between the distance from center and being within the CCC, the large and significant coefficient on the latter demonstrates its effects separately from distance alone.

Additionally, being located in a Town also affects the price of land significantly, raising it by about 75 percent without controls and about 60 percent when controlling for land use and growth. These coefficients suggest that in addition to their location relative to the center of the city, land in these two jurisdictions has other benefits unmeasured in this regression. For example, despite the fact that the *de jure* FSI is constant at 1:1.5 across the CMDA region, actual observed land prices combined with previous evidence of population density, seem to indicate *de facto* land use controls might be different. Moreover, higher levels of infrastructure investment or more responsive public services might be responsible for a share of the price premium.

Table 10
Hedonic price regression results: Land in residential plots, 2004
Natural log of the price of land per square foot (rupees)

Variables	Model 1	Model 2	Model 3
Intercept	.935 (77.9)	.808 (39.40)	7.17 (33.18)
Distance from City Center	-.107 (-22.86)	-.057 (-6.59)	-.039 (-4.52)
Infrastructure	.650 (5.89)	.523 (4.93)	.462 (4.89)
Development Approval	.627 (5.62)	.495 (4.64)	.439 (4.63)
Chennai City Corporation		1.22 (7.55)	.75 (4.51)
Municipality		.469 (.281)	
Town		.759 (6.15)	.58 (4.48)
Percent Urban Land			1.43 (7.34)
Urban Change 1991 - 2001			1.06 (6.37)
Percent Commercial Land			.579* (1.66)
Percent Industrial Land			-1.99 (-5.93)
N	**577**	**577**	**577**
Adjusted R^2	**.56**	**.61**	**.69**

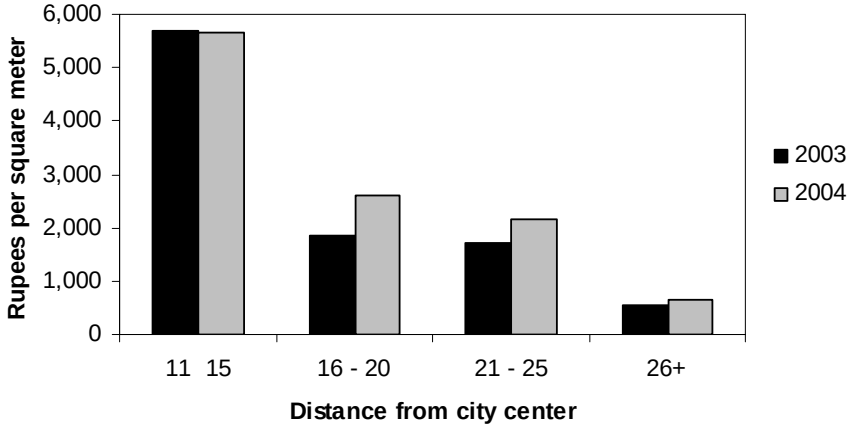
*Significant to the .1 level
T-statistics in parenthesis

Finally, neighborhood characteristics affect the price of land significantly. Land in areas that are highly urbanized and growing tend to be more expensive than other areas, while plots in areas with industrial activity have a lower price. The coefficients on these final three variables seem large because the independent variable is a percent. Thus, for example, for each percent of land area that is urbanized in a given zone, the price of land increases about one and a half percent. Similarly, for each percent of growth in urbanization of a given zone during the 1990s, the price of land increases about one percent. The negative coefficient on industrial use of land shows that for each percent of land area dedicated to industrial use in a given zone, the price of land decreases about two percent

Industrial land

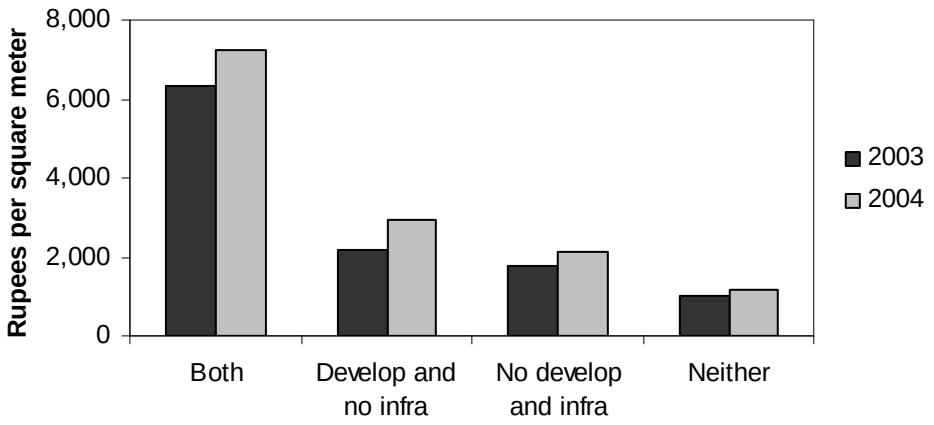
Data on the price of land in industrial plots were only available from about 40 zones of the 291 zones of the CMA, so we cannot make generalized statements about the price of industrial land with certainty. Like the data for residential parcels, price data for industrial land inside the CCC was much less available than outside the CCC. This is logical, as we have seen previously that there is not much land dedicated to industrial use in the central 10 km. Additionally, there is little or no price data available for industrial plots in the central 10 km without development approval or infrastructure, which is also logical since most of the land is already urbanized in this central 10 km, and so previously undeveloped land is not likely to be as available.

Figure 11
Mean price of land in industrial plots by distance from city center, 2003 and 2004



The overall price for industrial land is significantly lower than that of residential land, but higher than that of residential parcels at 2,820 rupees per square meter in 2003 and 3,380 rupees per square meter in 2004. The price gradient for this land is quite steep, perhaps steeper than that of residential plots; however, we were not able to regress it due to insufficient data. Inside the CCC, land in industrial plots cost an average of 3,623 rupees per square meter in 2003 and 4,344 rupees per square meter in 2004.

Figure 12
Mean price of land in industrial plots by infrastructure and development approval, 2003 and 2004



We expect infrastructure and development approval to be more important for industrial land because industrial activity needs infrastructure more than residential land, and the government is more likely to overlook informal housing than informal industrial use. The pattern of premium on infrastructure and development approval seen in Figure 12 corroborates this theory, though with a caveat. Having only infrastructure or development approval does not add much value to the land; however, having both increases the price of land by about six times.

CONCLUSION

This study has explored evidence that the Chennai Metropolitan Area has a distinct urban form compared to similar Indian cities. For a city of its size, it has a very dense center that continues to add population. Meanwhile, changes in land use indicate that the region is simultaneously growing in a sprawling pattern. The population growth in the periphery of the city is evident along transit corridors to the north, south and west. In addition to the analysis of trends in the spatial form of Chennai, this paper demonstrates that it is feasible and practical to conduct detailed urban land market assessments in Indian cities, and that the method can be extended to nonresidential uses.

The analysis presented in this paper has two central policy implications. First, the extremely high population density in the central area of Chennai is not the high-rise density of Asian cities like Tokyo or Hong Kong; rather, it is overcrowding. Chennai's increasing central city population density is more a reflection of limited redevelopment and modernization. Existing residential flats now contain more households consuming less space.

Secondly, it seems that very restrictive FSI regulations across the metropolitan area seem not to profoundly affect residential land price patterns, raising the question of *de jure* versus de facto FSI regulatory control. Factors such as development approval and infrastructure provision have a highly significant positive effect on land prices, especially for industrial uses, and the combination of these characteristics increases the value even more. The level of urbanization and recent growth near the plot in question has the expected effect on land price, and nearby industrial use decreases the price of land for residential use. Although land in the core 5 km of Chennai is less expensive than the land in the adjacent distance band, the general price gradient is similar to empirical findings in other Indian cities. Finally, there are price effects of being located within the jurisdiction of the Chennai City Corporation or a Town, which suggests that *de facto* land policies in these areas might be different from *de jure*. This is an area that should be explored further.

However, the data presented in this paper suggest that some trends are changing in recent years. Land policy reform in Chennai seems to have been successful in changing some patterns of urban development during the 1990s. Nevertheless, policymakers in Chennai continue to face a double challenge; an extremely dense urban core and sprawling pattern of development.

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[i] See for example, Bertaud and Bruekner (2003), and Bertaud, Buckley and Owen (2003).
[ii] For the detailed study design and work program for the Chennai project see Dowall (2003).
[iii] Another factor, pointed out by architectural historian Norma Evenson, is that the British subdivided Chennai (Madras) into large-plots for colonial administrators (1989)
[iv] Urbanized land is land devoted to residential, commercial, industrial and institutional use.
[v] Taken from research conducted by Alain Bertaud and Steven Malpezzi (1999).
[vi] An important caveat about this table is that the data recorded by the CMDA for 1991 were not consistent with methods used in 1981 and 2001. So the data we present here for 1991 are actually a calculated average between 2001 and 1981. This means that we cannot comment with certainty about recent trends in land use.

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