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Chennai Urban Land Market Assessment

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I. Introduction

This paper reports on the results of a land market assessment conducted in the Chennai Metropolitan Area in India. It provides detailed spatially disaggregated information on land use, population, and housing and land values for the metropolitan area. The assessment was a joint effort of the World Bank, the Chennai Metropolitan Development Authority (CMDA) and the Department of Geography at the University of Madras. The study was initiated in June 2003, and the underlying methodology and approach is provided by Dowall (1995).[1] The CMDA was responsible for compiling detailed archival land-use information for the metropolitan area for 1971, 1981, and 1991. In addition, the CMDA interpreted 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 for 1971, 1981, 1991 and 2001. The University of Madras's Department of Geography was responsible for carrying out the extensive surveys of real estate brokers in the metropolitan area. A total of 688 observations were tallied on various types of residential and industrial land prices.

This paper adds to the growing research literature on urban land and housing markets in India.[2] 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 and explore the various effects of urban planning and development control regulation on the spatial development of India's leading urban regions. Most of these studies have been focused on policy rather than an assessment of the market from data on land values, so this paper presents something new.

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1 For the detailed study design and work program for the Chennai project, see David E. Dowall, *Chennai Urban Land Market Assessment Study Design and Scope of Work*. Prepared for the World Bank, June 2003.

2 See, for example, Bertaud and Brueckner (2003), and Bertaud, Buckley and Owen (2003).

The paper is divided into eight sections. The next section provides a brief background on Chennai. The third section explores population trends and spatial patterns. The fourth, fifth and sixth sections assess population density patterns, housing stock, and land use. Section seven analyzes residential and industrial land prices. The paper concludes by summarizing key findings and offers policy recommendations.

II. Brief Background on Chennai

Chennai is the fourth largest metropolitan area in India, with a 2001 population of seven million. Located in the 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 Chennai City Corporation, 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, north to south, and 30 kilometers east to west. The City Corporation area is much smaller, about 20 kilometers, north to south, and about 12 kilometers east to west (Map 1).

Like other large India cities; Chennai is growing fast economically and demographically. Tables 1 and 2 provide economic and population growth trend data for Chennai and comparable Indian cities. Chennai, like other large Indian cities, has seen its economy grow dramatically between 1990–91 and 2002–03. On an annual compound average basis, it has grown by 13 percent per year.

Population growth in Chennai and other large Indian cities has also increased rapidly. Between 1981 and 2006, Chennai's population has grown by 2.3 percent per annum. While this figure is robust, it is less than the overall growth rates for Indian cities (2.99 percent). Hyderabad has grown the fastest, at nearly 4 percent per year over the period.

MAP 1.
Location of Chennai Metropolitan Area in Tamil Nadu and India

TABLE 1.
State Net GDP in Current Prices (Millions of USD)

City	State	Year					Annual % Change 1991–2003
		1985–1986	1990–1991	1995–1996	2000–2001	2002–2003	
Ahmedabad	Gujarat	2,697	5,388	13,755	20,025	26,406	13.0
Bangalore	Karnataka	2,277	4,579	11,147	20,796	22,371	12.9
Hyderabad	Andhra Pradesh	2,975	6,655	15,997	28,146	32,352	12.9
Chennai	Tamil Nadu	3,048	6,166	15,534	28,087	30,135	13.0
Delhi	Delhi	1,100	2,282	5,667	12,826	15,318	15.8
Mumbai	Maharashtra	5,897	12,954	31,356	46,834	57,717	12.2

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

Note: The website says that, due to differences in the method of compilation, these are not “strictly comparable” between states.

TABLE 2.
Population and Compound Annual Growth Rates of Selected Cities in India, 1981–2006

City	1981	1991	2001	2006	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.

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. How well Chennai and other Indian cities respond to the challenges of globalization depends largely on how they grow and spatially restructure themselves. As this paper illustrates, demographic and economic growth have strong and direct impacts on land use and urban development (Energy and Infrastructure Unit, South Asia Regional Office, 2002).

Looking forward, Indian cities will need to dramatically expand, reconfigure their spatial structure, and upgrade and improve urban service delivery. They need to accommodate new businesses and migrants and do so while trying to improve environmental quality and housing affordability. These are huge challenges. Cities that fail will see congestion, land and real estate inflation, and declining urban service quality.

A city's urban land management policy framework plays a big role in determining how well it can respond to globalization. The Indian cases are interesting because most of the large cities have had very restrictive land use policies and regulations. Five elements are key: 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).

The Chennai case is interesting in that it has partially liberalized—the urban land ceiling act has been repealed (1999) and it recognizes the role of the private sector in housing and real estate development. At the same time, it still has rent control, very low FSI (1:1.5) and inadequate infrastructure service coverage. These regulations are especially problematic in the area outside the central 10 km of the Chennai Metropolitan Area and might be a cause of the unusual density trends of the city and the relatively high land prices in the Chennai City Corporation.[3]

III. Population Trends and Spatial Patterns

Table 3 presents population trends for the City of Chennai and the Metropolitan Area for the period 1971–2001. Since 1971, the Chennai Metropolitan Area (CMA) has doubled its population from 3.5 to 7.0 million. Over the thirty-year period, the rate of population growth has fallen from an annual compound growth rate of 2.76 percent in the 1970s to 1.93 percent in the 1990s. In absolute terms, population growth in the CMA is significant—increasing by 3.5 million persons between 1971 and 2001, an annual increase of over 100,000 people per year. Due to suburban development, Chennai's metropolitan population is less concentrated in the city center. In 1971, the Chennai City Corporation (CCC) accounted for 75 percent of the region's total population. By 2001, the Corporation accounted for 62 percent of metropolitan population. In absolute terms, the population of the CCC increased by 1.7 million, over 50,000 people per year.

TABLE 3.
Population Trends in Chennai City, Suburbs and Total 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.

[3] Another factor, pointed out by architectural historian Norma Evenson (1989), is that the British subdivided Chennai (Madras) into large plots for colonial administrators.

Table 4 and Figure 1 both take closer looks at the spatial distribution of population in the region and examine the structure of population change by distance from the city center. 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. In contrast, the ring just beyond the core, extending out to a distance of 10 kilometers, increased in both absolute terms (1.44 million) as well as percentage terms (from 27 to 34 percent). The trends indicate that much of the deconcentrated population is shifting to the inner suburbs, located 6–10 kilometers from the CBD. Farther out, in the range of 11–15 kilometers from the city center, population increased by nearly four-fold between 1971 and 2001, and its share of regional population nearly doubled from 8 to 15 percent over the same period. The periphery of the region grew in step with overall growth rates.

TABLE 4.
Population by Distance from City Center and Percent Distribution, 1971, 1981, 1991 and 2001

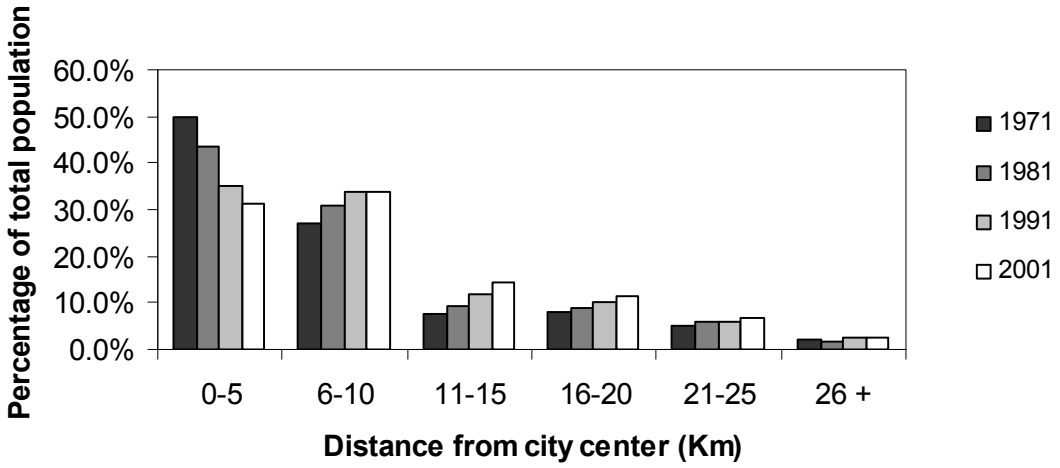
Distance (km)	1971	%	1981	%	1991	%	2001	%
0–5	1,757,206	50.0%	1,998,165	43.4%	2,053,829	35.2%	2,189,532	31.1%
6–10	943,368	26.9%	1,427,785	31.0%	1,978,301	33.9%	2,383,203	33.9%
11–15	273,622	7.8%	418,661	9.1%	701,407	12.0%	1,026,238	14.6%
16–20	279,008	7.9%	406,985	8.8%	603,205	10.3%	804,368	11.4%
21–25	178,565	5.1%	265,031	5.8%	355,195	6.1%	463,233	6.6%
26 +	79,210	2.3%	85,529	1.9%	145,865	2.5%	173,643	2.5%
Total	3,510,979	100.0%	4,602,156	100.0%	5,837,802	100.0%	7,040,217	100.0%

These trends in Chennai are interesting, especially the fact that the city's already dense core has continued to absorb population. This may be due to the fact that there has been little redevelopment in the city center — 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 6–10 kilometer distance band seems to have stopped increasing in relative importance. This leveling off of growth might indicate that the area has reached a density limit and further population growth in that area will slow down. It may also reflect the effect of stringent FSI (1:1.50) regulations in this area. This indicates

that population growth in the coming years can be expected to occur in the areas farther from the center.

It is important to point out that the decentralization of Chennai is not due to a loss of population in the center as with the decentralization patterns typical of North American cities; in fact, the absolute population in the central five-kilometer area has increased since 1971 by over 400,000 people (Table 4). Rather, the decentralization pattern observed in Chennai's population is due to a filling in of available land to some limit of density.

FIGURE 1.
Spatial Distribution of Population, 1971–2001



IV. Population Density

The decentralization of a city's population is often associated with a decrease in density, although a closer look at the case of Chennai shows us that although the population has grown in the areas farther from the center, the overall gross density has increased. Thus, the average gross density of the city, measured by the number of persons per urbanized hectare[4] of land, increased from 136 in 1971 to 152 in 2001. This indicates that the city is supporting a larger number of residents per hectare of land. The gross population density in the Chennai City Corporation has increased from 152 in 1971 to 247 in 2001.

[4] Urbanized land is land devoted to residential, commercial, industrial and institutional use.

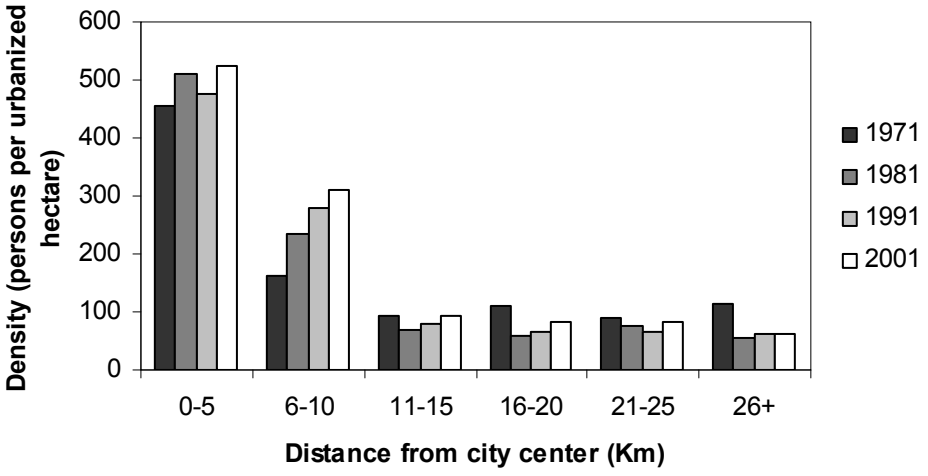
TABLE 5.
Population, Urban Land Development and Gross Population Density, 1971–2001

Year	Population	Urbanized Land (ha)	Gross Population Density: Persons/ Urbanized Hectare
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.

Disaggregating the gross density measure over the distance from the city center gives a much more complete picture of exactly how the density of the Chennai Metropolitan Area has changed over the last thirty years (Figure 2). We observe that, in fact, the density has not increased (or only increased minimally, depending on whether we believe the 1971 data) in the area further than 10 kilometers from the city center. Meanwhile, the density of the Chennai City Corporation has increased dramatically, especially in the 6–10 kilometer band, where it has almost doubled.

FIGURE 2.
Gross Population Density (Persons per Urbanized Hectare) by Distance Bands



Density Gradient. 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 findings 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 density gradient, the faster density drops from the city center. Therefore, density gradient serves as a measure of decentralization or suburbanization.

The monocentric city model is based on simplified assumptions about cities (people are the same, they all work in the center of the city, their transportation costs are equal) yet it provides powerful insights into density and land prices. If all work occurs in the center of the city, residential areas radiate outwards, at declining densities as households trade-off house (or plot size) for commuting costs. Therefore, a flattening of density from the center of the city outward can come from better transportation systems. This is historically evident as cities have grown in size and densities have spread outward as railroads and then roads are installed.

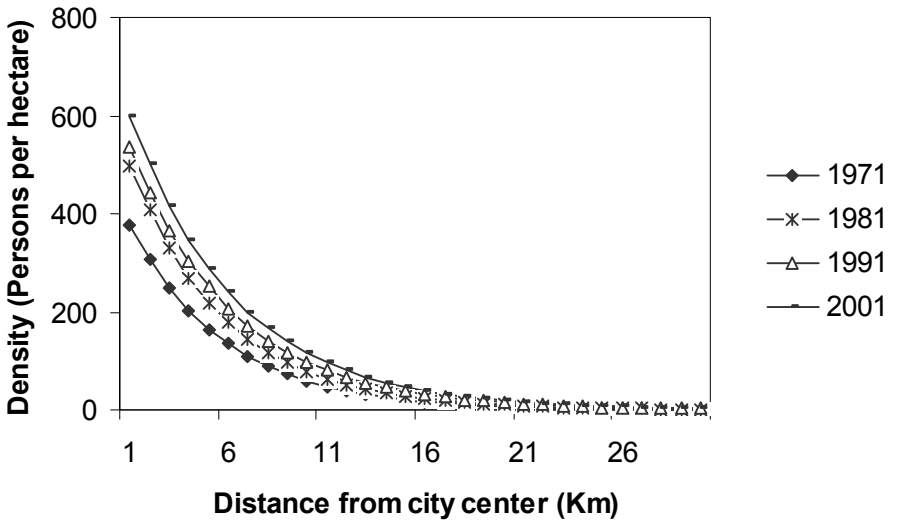
Gradients in developed countries tend to be flatter than those in developing countries, due to higher incomes and more efficient transportation systems. This effect operates through the increased expenditure on lot size (housing is a normal good) and the higher technology and quality of transportation systems. Table 6 provides estimates of population density gradients for the Chennai Metropolitan Area for census years from 1971 to 2001. The table illustrates two important trends for Chennai. First, unlike many other cities, estimated intercept population densities (predicted population density in the center of the city) have increased over time. In 1971, the density was estimated at 464 persons per hectare. By 2001, it had increased to 720 persons per hectare. The other trend is that the metropolitan region's population density gradient has flattened out, declining from -.207 to -.183 in 2001.

Thus, the flattening of the density gradient occurs together with an increasing density in the center of the city. This suggests the flattening of the gradient is due to population growth and increased availability of transportation, rather than from growth in household income. Figure 3 presents population density gradients for 1971 to 2001.

TABLE 6.
Population Density Gradients, 1971–2001

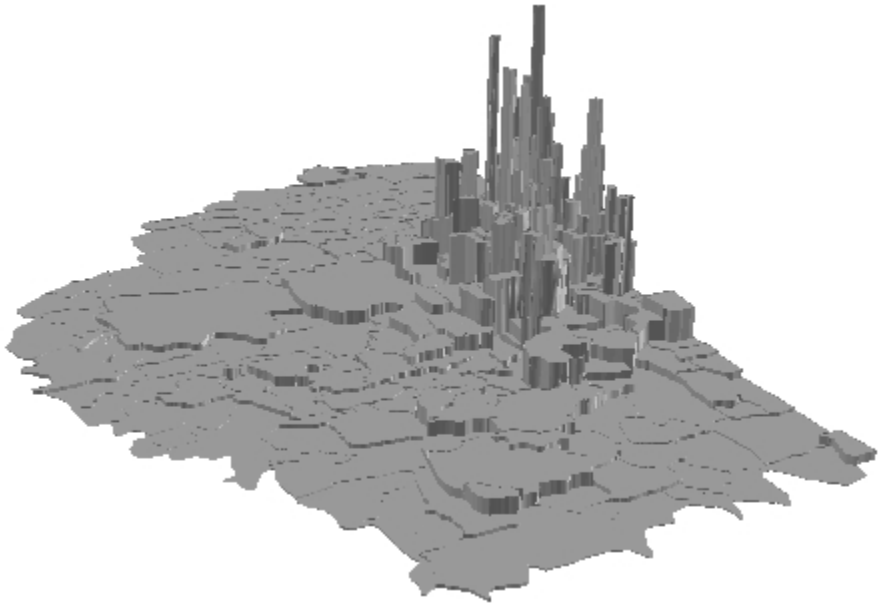
Year	Intercept (d_0)	Gradient (g)	R^2
1971	464 (57.675)	-.207 (28.766)	.741
1981	613 (64.238)	-.206 (-30.540)	.763
1991	648 (69.432)	-.190 (-30.123)	.759
2001	720 (65.794)	-.183 (-29.940)	.717

FIGURE 3.
Density Gradients for Chennai, 1971–2001



Map 2 illustrates 2001 population density surface for the Chennai Metropolitan Area. It clearly shows the very high densities in central areas of the city, spines of higher density to the west of city center and south along the coast.

MAP 2.
3-D Population Density, 2001



Comparison Density Gradients. The population density in the city of Chennai has changed very differently over the past forty years than in comparable Indian cities. It has gone from having a much lower central city density and density gradient than Hyderabad and 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 (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 demonstrates 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 in 1961

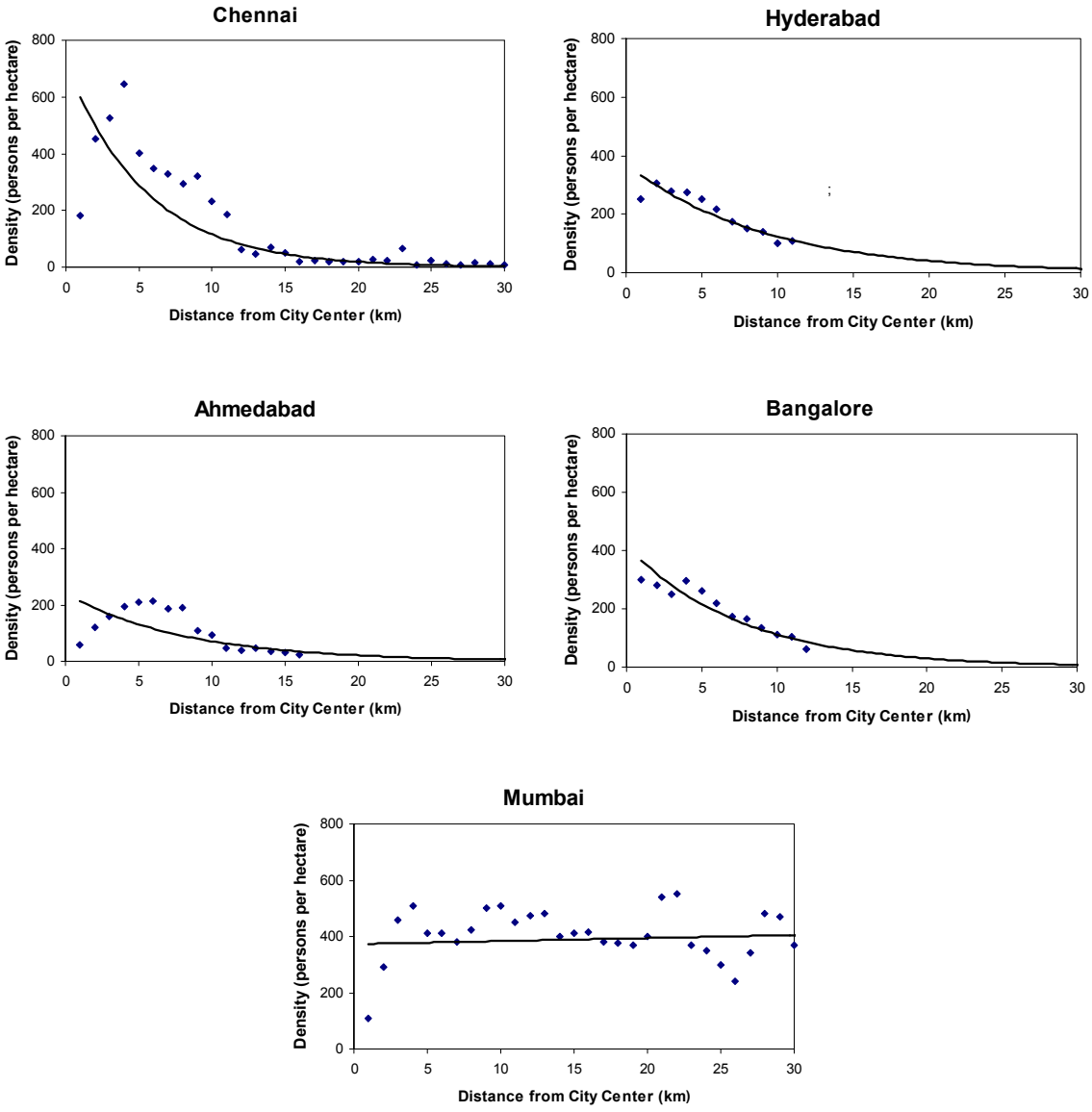
City	Population	Persons per Acre in City Center	Density Gradient
Bombay	4,152,056	390	.099
Madras	1,729,141	270	.164
Hyderabad	1,129,345	332	.243
Ahmedabad	1,155,344	437	.504
Bangalore	864,203	224	.273

Source: Brush, 1968.

Over the last forty years, the central city density has increased at a faster rate than the population has suburbanized, while in comparable cities, populations have suburbanized significantly. Figure 4 provides a comparison of recently estimated population density gradients for comparable Indian cities, taken from research by Alain Bertaud and Steve Malpezzi (1999). As the charts demonstrate, 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. This raises an interesting policy question about the impacts of stringent FSI regulations. De jure FSI rules are stringent by western standards, but on a de facto basis they seem less an impediment.

Thus, it is important to recognize that although the density gradient has flattened somewhat in Chennai over the last forty years, it is not through the same suburbanization phenomenon that other Indian cities are experiencing. While Chennai has undergone a suburbanization process, with industrial activity locating further from the central city area, it has also experienced rapidly increasing densities in the central city, and now the central city has densities as high as large cities like Mumbai.

FIGURE 4.
Comparison Density Gradients:
Chennai, Hyderabad, Ahmedabad, Bangalore and Mumbai



V. Housing Stock

The growth trends of housing stock are consistent with the above discussion of population and density. The rate of housing stock growth has decreased over the last forty years, although it has continually grown at a higher rate than the population. This means that the gross measure of persons per unit of housing has decreased from 5.3 in 1971 to 4.4 in 2001 (Table 8). This is not necessarily contradictory to the increase in gross

population density discussed above, but indicates that overall residential floor space densities have increased over time as units become slightly larger per household. It should be noted that these figures on housing stock include/do not include informal housing so they are underreported for all years.

TABLE 8.
Housing Growth Trends, 1971–2001

Year	Housing Units	Absolute Increase	Average Annual Increase	Compound Annual Growth Rate (%)	Persons per Unit
1971	657,788				5.3
1981	902,771	245,150	24,515	3.2	5.1
1991	1,223,136	320,365	32,079	3.1	4.8
2001	1,583,031	359,895	35990	2.6	4.4

The differences between the trends in the spatial distribution of housing stock and that of population corroborate the above story about density and population. The area between 6–10 kilometers of the city center increased significantly in its share of the city's population (Figure 5), yet the percentage of the city's housing stock in that area did not. This seems to indicate that much of the housing was already there in 1971. It just began to accommodate more people, thus the density per urbanized hectare increased dramatically. Additionally, the housing stock in the area between 11–15 kilometers of the city center has increased at a faster rate than the population in the same area. This indicates that either this is where density growth is soon to occur, or that perhaps this is a lower density type of housing stock. Finally, the fact that similar density and population patterns are observed in the 16–20 kilometer band, though there is very little housing stock, indicates that these data do not account for informal settlements.

The average number of dwelling units per hectare of residential area per zone increased over the CMA from 66 in 1971 to 104 in 2001. This is consistent with the increase in gross density during the same period. However, in the city's core (within 5 kilometers of the center), the number of housing units per hectare of residential land increased much more dramatically than population density (Figures 2 and 6). This means that either more housing units were added and there were fewer people per unit, or the residential area got smaller as commercial activities increased. The CMA outside the CCC had a similar increase in housing units per hectare of residential land to its change in density.

FIGURE 5.
Spatial Distribution of Housing Stock, 1971–2001

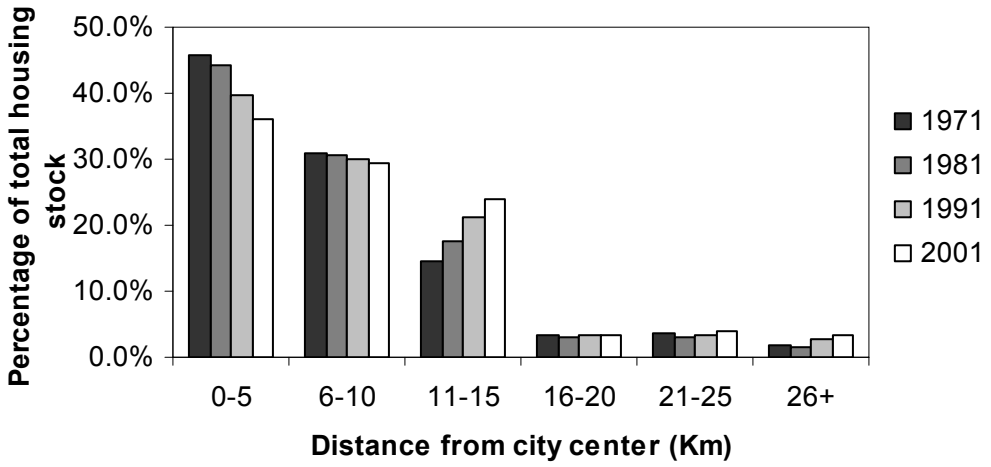
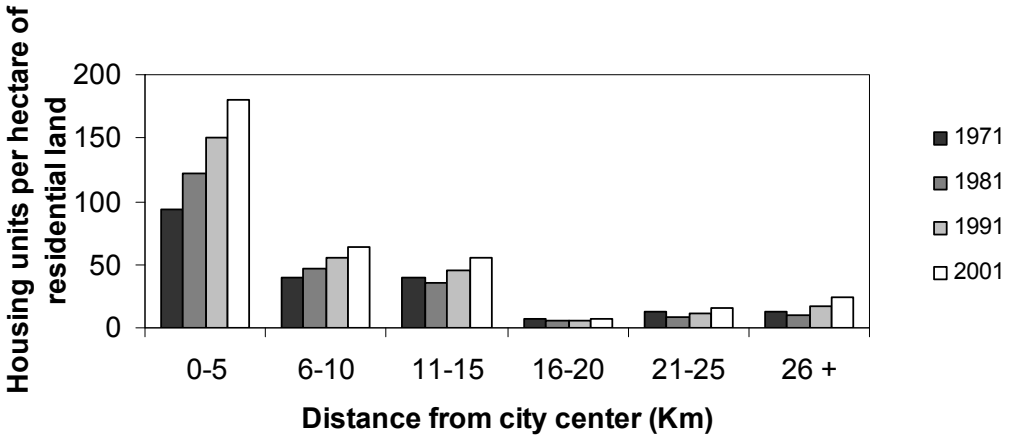


FIGURE 6.
Number of Housing Units per Hectare of Residential Land by Distance from City Center, 1971–2001

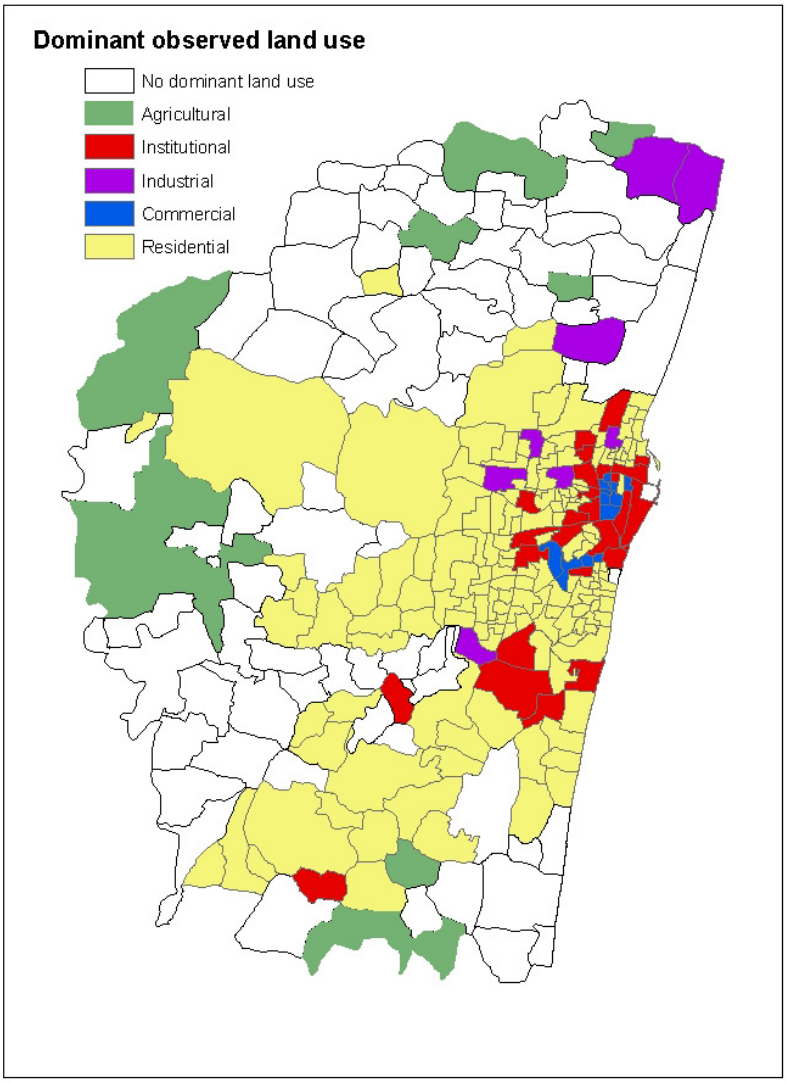


VI. Land Use

Together with population growth and density trends, land use is another key determinant of land market outcomes and performance. Thus, it is essential to understand patterns in the conversion of land from

agricultural uses to urban use. In fact, the basic model of urban land price, the monocentric city model, places the border of the city at the distance from the center where rent from agriculture is equal to rent from urban use. 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. Map 3 provides a land use map of the region based on IKONOS satellite imagery.

MAP 3.
Dominant Observed Land Use[5] in the Chennai Metropolitan Area



[5] This was determined by calculating the percent of land dedicated to a certain land use. A zone is classified as residential, agricultural and institutional if more than 30% of the area is dedicated to that use and industrial and commercial if it exceeds 20%.

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,[6] it is clear that the rate of growth in hectares of urban land has decreased. In fact, population has grown at a rate faster than land has been urbanized over the last twenty years, which has logically led to the increase in density discussed previously.

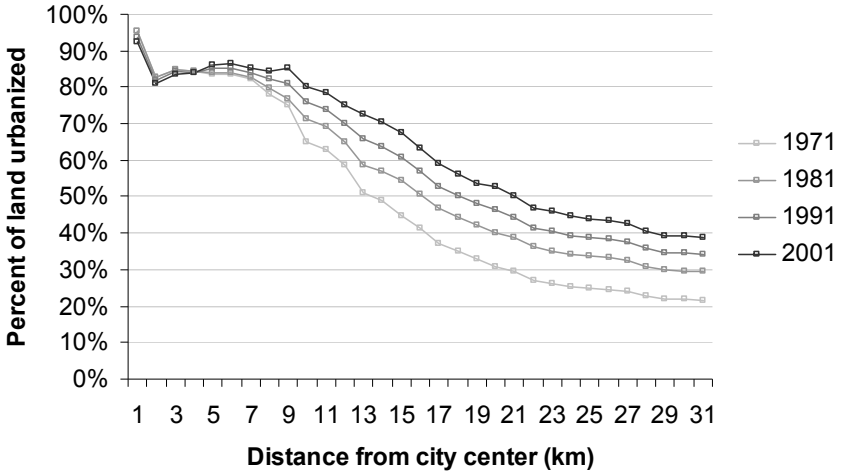
TABLE 9.
Total Land Area and Urbanized Land Areas in Chennai, 1973–2001

Year	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%–100% of the land is urbanized (Figure 7), and probably has reached the upper limit due to zoning, land use regulations and government ownership. There is a sharp drop in the percentage of urbanization beyond the old city area — due to the dominance of the fort area (which is mostly open space), the river corridor and the coastal strand. Figure 7 also illustrates how 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.

[6] 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.

FIGURE 7.
Percentage of Zone Urbanized by Distance from City Center



The vast majority of urban land conversion over the last four decades occurred outside of the CCC. Between 1973 and 1980, the areas 11–15 kilometers and 21–25 kilometers 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 16–20 kilometer 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 kilometers 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.

TABLE 10.
Changes in Land Urbanization Rates by Distance from City Center

Distance	Hectares Urbanized 1973 – 1980	Percent of Total Change	Hectares Urbanized 1980 – 2001	Percent of Total Change
0–5	18	0.2	121	1.1
6–10	1,197	13.0	1,575	14.4
11–15	2,611	28.4	3,231	29.6
16–20	1,803	19.6	2,668	24.4
21–25	2,826	30.7	2,251	20.6
26 +	765	8.3	1,191	10.9
Total	**9,202**	**100.0**	**10,917**	**100.0**

Overall, the marginal rate of population growth has decreased faster than the marginal rate at which land has been converted to urban use over the last thirty years, from 31% to 26% and from 36% to 14%, respectively. Table 11 shows the marginal growth at different distances from the city center. In the area outside of the central 10 kilometers, the rate of population growth now exceeds the rate of land urbanization, where in the 1970s the opposite was true. As discussed previously, the land inside the CCC is reaching its limit of urbanization. Although the marginal rate of land in the central 5 kilometers has increased slightly, the absolute amount of land being converted to urban use is very small.

TABLE 11.
Marginal Rate of Population Growth and Land Development

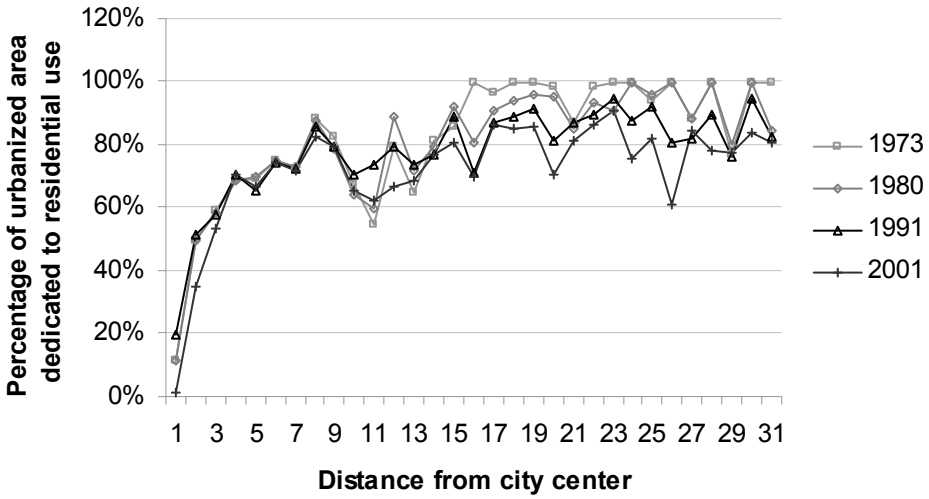
	Marginal Rate of Population Growth			Marginal Rate of Land Development		
Distance	1973–1980	1980–1991	1991–2001	1973–1980	1980–1991	1991–2001
0–5	11%	1%	5%	0%	1%	1%
6–10	46%	32%	19%	14%	9%	8%
11–15	53%	68%	46%	73%	26%	21%
16–20	46%	50%	39%	101%	37%	27%
21–25	48%	39%	31%	56%	14%	13%
26 +	17%	48%	29%	50%	26%	21%
Average	31%	26%	21%	36%	16%	14%

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 (Figure 8). 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 kilometers

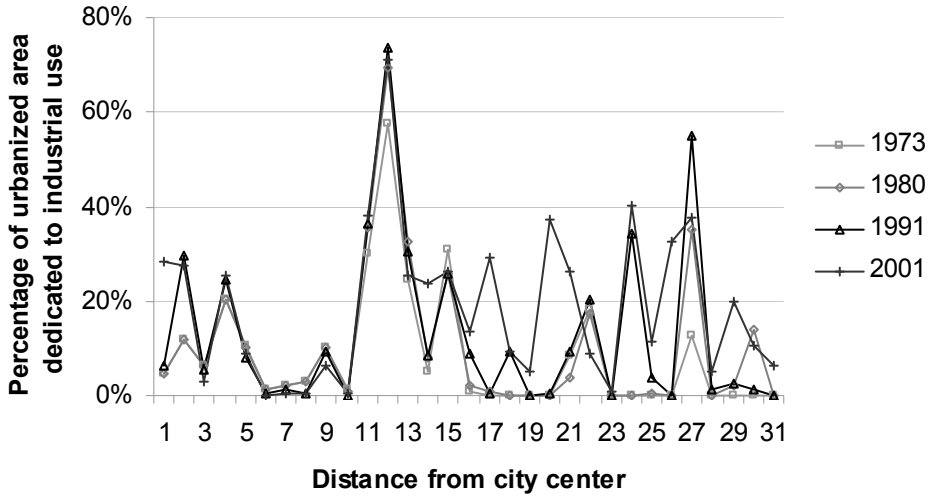
of the city center. The drop in residential use at 12 kilometers distance from the city center, as will be clear in the next section, is due to a preponderance of industrial use. However, as industry suburbanizes in Chennai, the land at the periphery of the city begins to be converted to industrial use. This is clear in the decrease in the percent of urbanized land in residential use beyond 15 kilometers from the city center in recent years.

FIGURE 8.
Percent of Urbanized Area Classified as Residential by Distance from City Center



Industrial Land. The spatial pattern of industrial land use in the Chennai Metropolitan Area seems very erratic (Figure 9). Until recently, the appreciable concentrations of industrial use were at 4, 12 and 15 kilometers from the city center, the largest by far being at 12 kilometers, where more than half the urbanized area is 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 kilometers distance from the city center. Industrial activity in the center of the city has also increased in recent decades.

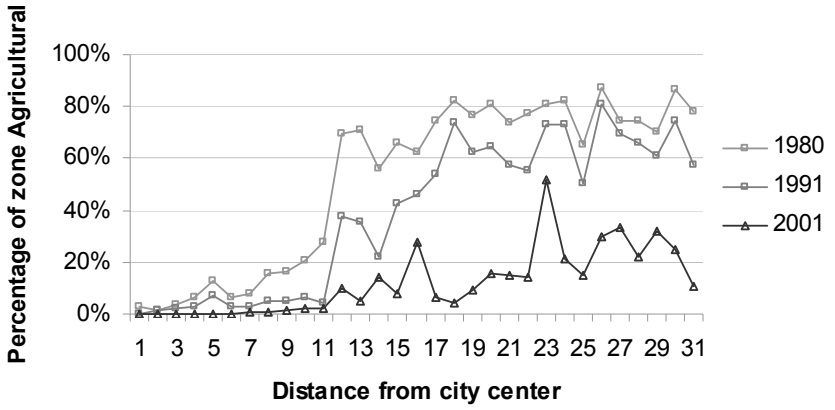
FIGURE 9.
Percent of Urbanized Area Dedicated to Industry by Distance from City Center



Agricultural Land. As the rents that can be obtained from converting agricultural land to urban land at the edge of an urban area begin to exceed the rents from the use of land in agriculture, such land will be urbanized. The farther the distance from the city center, the more land will be dedicated to agriculture. The process is often complicated by regulations and the relative productivity of different parcels of land as farmland (e.g., parcels near a water source are likely to be more valuable as farm land) and their potential for use as urban land (e.g., parcels near a transportation corridor are likely to be more valuable as residential or industrial land). Thus, the loss of farmland will not be linear by distance; however, we should observe more farmland the further we are from the city center.

The observed amount of agricultural land per zone by distance from the center of Chennai is consistent with the theoretical intuition described above (Figure 10). As Chennai increases in population, more land is converted away from agricultural uses. Although more land is not converted the further away from the city center in a direct linear relationship, there is an observable trend. Additionally, it can be observed that the percent of land used in agriculture doubles at the border of the CCC in 1981 and 1991. This 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 10.
Percent of Zone Dedicated to Agriculture by Distance from City Center



Much more land was converted away from agricultural use between 1991 and 2001 than in the previous decade. Additionally, according to these data, more land has been taken out of agricultural use than has been incorporated into urban use, roughly 41,000 hectares (1991–2001) versus about 6,000 hectares (1981–1991). While some part of this large discrepancy might be due to problems with the data (see footnote 5), the size of it is significant. One possible cause is land speculation, the purchase of land for later development, which can be problematic for even urban growth. Clearly, more detailed research is needed to clarify matters.

Overall Spatial Dynamics. Chennai has experienced a larger decrease in the rate at which it urbanizes land than the decrease in population growth trends. This means that less land is being urbanized for each person that is added to the population, and is consistent with the densification of its city center. This is despite the disappearance of almost all of its agricultural land.

It seems that the urbanization patterns of the most recent decade (1991–2001), "make more sense according to a market logic" than those of previous years. We saw that less land was urbanized between 11–15 kilometers from the city center than in distance bands beyond that between 1973 and 1980. However, in the more recent twenty years, this is the area with 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-kilometer zone. We no longer see a huge increase in the amount of

land dedicated to agricultural in the area 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 is concerning.

The overall trends suggest that a market-driven land market is operating in Chennai and that is it producing outputs similar to those found in other market-driven urban systems. One point, though, is very interesting; it may be that Chennai went through a period of significant sprawl between 1971 and 1991, reflecting the influential role of the state. Since then, market forces have led to a more rational system of urban land development, and the metropolitan region is in the process of infilling and densifying. Also, investments in infrastructure and the liberalization of land use regulations may also have had an impact on the spatial pattern of urban land development.

VII. Land Prices

The per-square-meter 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, and 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 the recent growth in urbanization.

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 historical data and a comparison of two years does not lead to much discussion of trends because land prices often fluctuate significantly. However, we can draw several conclusions from the land price dataset 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 proven insight of the monocentric city model presented earlier. In the Chennai Metropolitan Area in 2003, a simple regression of distance on the log of the price of land in residential plots tells us that, for each kilometer of distance between the center of the zone

the lot is located in and the center of the city, the price falls by 12% (Table 12). We use the log form of price because, as with population density, price falls at a negative exponential rate from the center of the city. The price decrease of 12.4% per kilometer is equivalent to a price gradient of .124. Recall that the density gradient of the city in 2001 was .183. Although these gradients are not from the same year, it is interesting to note that the population density seems to fall at a greater rate than the land price for residential land. This difference is probably the result of two factors; first, nonresidential uses out-compete with residential uses (therefore dominating land use) at certain distances and, second, population and housing density are very sensitive to land prices, leading households to trade-off space for proximity to the central city.

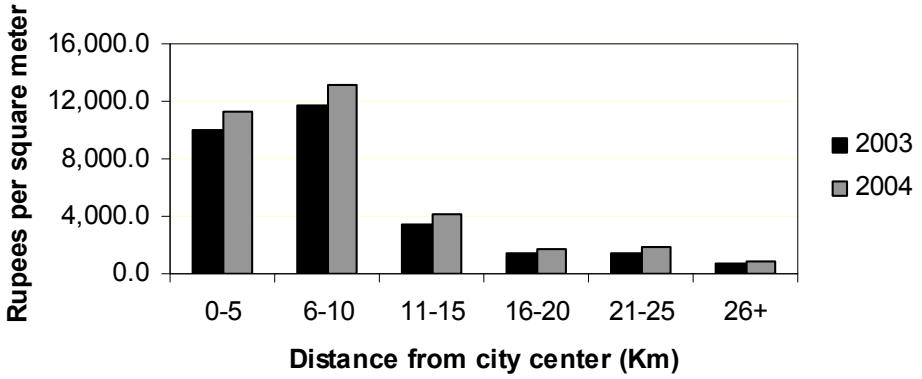
TABLE 12.
Price Gradient Regression Results for Residential Plots

Regression	Intercept*	Gradient**	R^2
Distance (2003)	19,186	-1.24 (-28.9)	.54
Distance (2004)	20,892	-.119 (-28.14)	.53

* The intercept is given in rupees per square meter
** The gradient is given in log form

The land price gradient regression model presented in Table 12 only considers the effect of distance. However, there are many additional factors that shape residential land prices, including the age and quality of the housing stock, quality of urban services and environmental conditions. Figure 11 provides a more detailed look at land prices for residential plots and indicates that residential land prices in the city center (0–5 kilometers) 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 kilometers of the region.

FIGURE 11.
Mean Price of Land in Residential Plots by Distance from City Center



Similarly, it seems residential parcels tend to decline in value with distance. Data was not available on the price of residential parcels within the CCC. This most likely results from a lack of parcel-sized pieces of land in the central 10 kilometers of the CMA. Additionally, complete data were not available on all zones outside of the CCC, probably for the same reason. Nevertheless, the 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%.

FIGURE 12.
Mean Price of Land in Residential Parcels by Distance from City Center

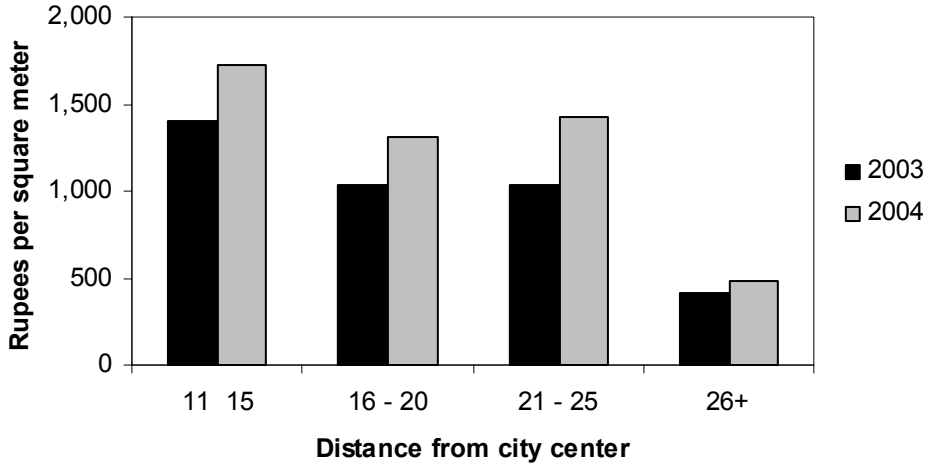
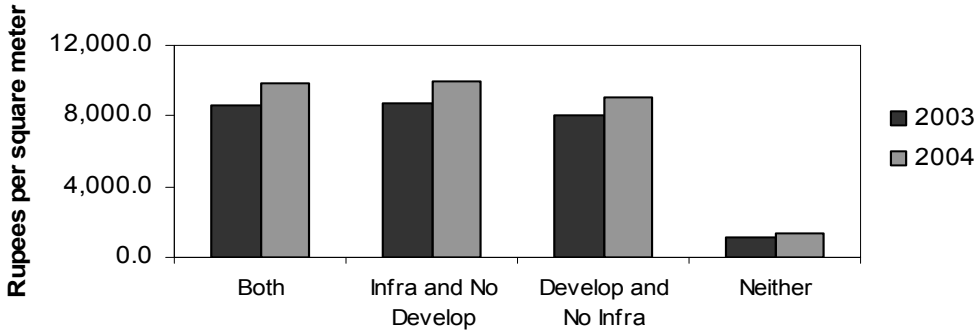


Figure 12 shows how the parcel prices decrease with distance. Although this seems drastically different from the figure describing the price of land in residential plots by distance, it should be noted that this is only for land outside of the central 10 kilometers. With that in mind, it is very similar to Figure 11. Both residential plots and parcels seem to fit into three price ranges by distance: the first is land directly outside the CCC (between 11 and 15 kilometers), the second is between 16 and 20 kilometers, and the last is beyond that.

In addition to the distance of land from the city center, the potential to develop land is an important factor in determining its price. In the developed world, a common indication of the potential for development is how the land is zoned. 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. Many empirical studies have documented a premium on having a formal title to a lot.

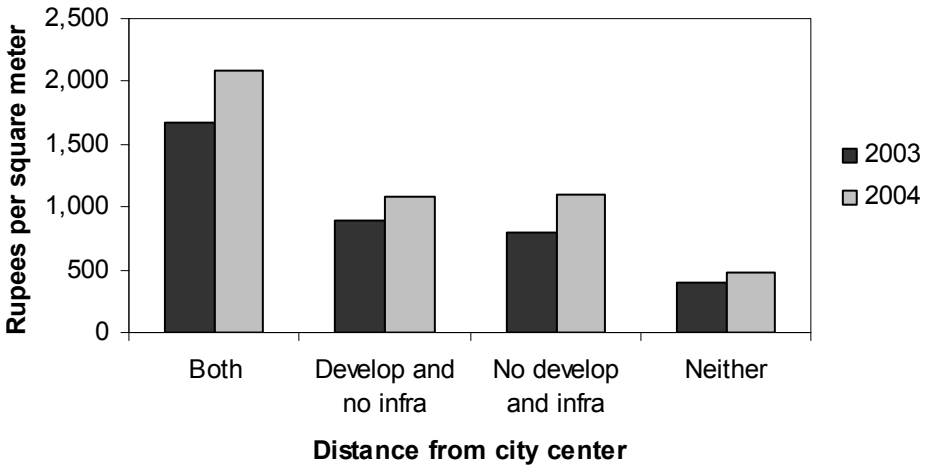
In the case of Chennai, approval for development and connection to infrastructure seem to be almost inseparable, indicated by the minimal variation in price between lots that have development approval, infrastructure or both (Figure13). However, Figure 13 also indicates a very large premium on having 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 approval for development, it becomes much easier to get infrastructure installed, and vice versa.

FIGURE 13.
Mean Price of Land in Residential Plots
by Infrastructure and Development Approval



The premium on land with development and infrastructure is different for land sold in parcels. While in the case of residential plots, it seems that having either infrastructure or development approval has about the same premium as having both, in the case of parcels, having one roughly doubles the price of land, while having both more than quadruples the price. This relationship makes sense; the combination of services has a multiplicative effect on their individual premiums. 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.

FIGURE 14.
Mean Price of Land in Residential Parcels
by Infrastructure and Development Approval



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 our dataset is not complete enough.

Regression Analysis of Residential Plots. A simple regression of dummy variables for infrastructure and development approval indicates that having development approval increases the price of land in residential plots by 138% and having infrastructure increases the price of land by 141%. However, this is an oversimplification. The problem with the above story lies in the separation of the different factors and their influence. The number of lots with infrastructure and development approval almost definitely increases closer to the center of the city, thus some of the apparent effect infrastructure or development

approval has on the price of land is actually due to its distance from the city center. A regression with multiple independent variables allows us to untangle the effects of the different attributes of land.

In this case, we use a stepwise regression process, which allows for observation of the interaction between the influences of different variables. As mentioned above, distance became a less important predictor of price when the dummy variable for CCC was added. Similarly, the final regressions below show that distance explains less of the variation in price when you incorporate the other influences.

We conducted a stepwise regression for 2003 and 2004 land price data (Tables 13 and 14), adding data on factors that might influence land prices and taking them out if they did not. An important caveat is that you can never really know causality, and we do not include many variables (for lack of data) that urban economists agree to be important influences on the price of land, such as disaggregated household income data. Nevertheless, we have a robust regression that explains 66% percent of the variation in land prices for the city of Chennai.

TABLE 13.
Stepwise Regression Results for the Price of Land in Residential Plots, 2003

	Coefficients						
Distance	-1.24 (-28.9)	-.074 (-9.1)	-.067 (-7.55)	-.06 (-6.78)	-.036 (-4.02)	-.044 (-4.95)	-.046 (-5.30)
CCC		1.004 (7.08)	.955 (6.08)	1.29 (7.86)	.749 (4.71)	.943 (5.78)	.715 (4.39)
Municipality				.536 (1.89)			
Town				.773 (6.20)	.484 (4.01)	.55 (4.59)	.49 (4.19)
Infrastructure			.508 (4.61)	.463 (4.30)	.439 (4.34)	.445 (4.46)	.426 (4.40)
Development Approval			.479 (4.30)	.44 (4.06)	.421 (4.12)	.422 (4.18)	.404 (4.12)
Percent Urban 2001					1.51 (8.31)	1.18 (6.00)	1.49 (7.56)
Urban Change 1991–2001						.734 (4.26)	.874 (5.18)
Percent Industry 2001							-2.04 (-5.98)
Number of Observations	688	688	570	570	570	570	570
Adjusted R^2	.548	.578	.596	.622	.661	.671	.69
Root MSE	.981	.947	.912	.884	.837	.824	.799

TABLE 14.
Stepwise Regression Results for the Price of Land in Residential Plots, 2004

	Coefficients						
Distance	-.119 (-28.14)	-.071 (-8.87)	-.064 (-7.29)	-.057 (-6.59)	-.031 (-3.64)	-.042 (-4.82)	-.044 (-5.17)
CCC		.965 (6.88)	.901 (5.83)	1.22 (7.55)	.657 (4.22)	.879 (5.55)	.652 (4.12)
Municipality				.496* (1.67)			
Town				.759 (6.15)	.458 (3.86)	.534 (4.56)	.475 (4.17)
Infrastructure			.562 (5.18)	.522 (4.93)	.462 (4.97)	.502 (5.19)	.485 (5.16)
Development approval			.531 (4.84)	.495 (4.64)	.469 (4.69)	.473 (4.83)	.455 (4.79)
Percent urban 2001					1.59 (8.93)	1.20 (6.27)	1.51 (7.86)
Urban change 1991 – 2001						.859 (5.12)	.997 (6.07)
Percent industry 2001							-2.02 (-6.09)
Number of Observations	698	698	577	577	577	577	577
Adjusted R^2	.532	.561	.582	.607	.653	.668	.688
Root MSE	.973	.942	.904	.876	.823	.805	.780

* Significant only at the .1 level

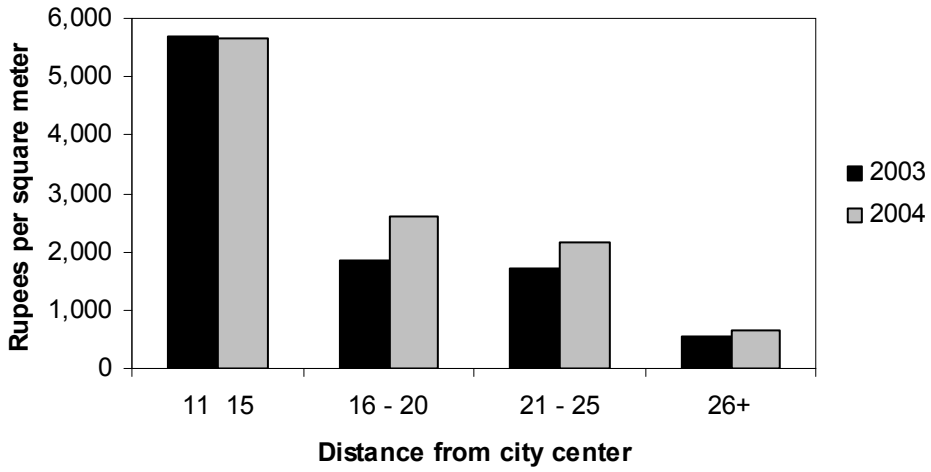
The price gradient flattened slightly from 2003 to 2004, dropping from .124 to .119. A flattening of the price gradient in the city is consistent with the expansion of the city and the flattening density gradient observed in section I. Similar to the density trends, the flattening of the price gradient does not stem from a decrease in central city prices, rather an increase in overall prices between 2003 and 2004 and an slight increase in the relative price of land further from the center in the same years.

Overall, the results indicate that the independent variables all have the expected signs and are consistent with urban land economic theory. Despite the fact that the FSI is constant at 1:1.5 across the CMDA region, actual observed construction and land prices seem to follow the patterns found in less regulated cities. So this again raises the importance to distinguish between de jure and de facto land use controls.

Industrial Plots. In this section, we present data on the price of land in industrial plots. We only have data from only about 40 zones out of the 291 zones into which the CMA is divided, 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 kilometers. Additionally, there is little or no price data available for industrial plots in the central 10 kilometers without development approval or infrastructure, which is also logical since most of the land is already urbanized in this central 10 kilometers, and so previously undeveloped land is not likely to be as available.

The overall per-square-meter 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 for residential plots; however, we did not regress it due to missing 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.

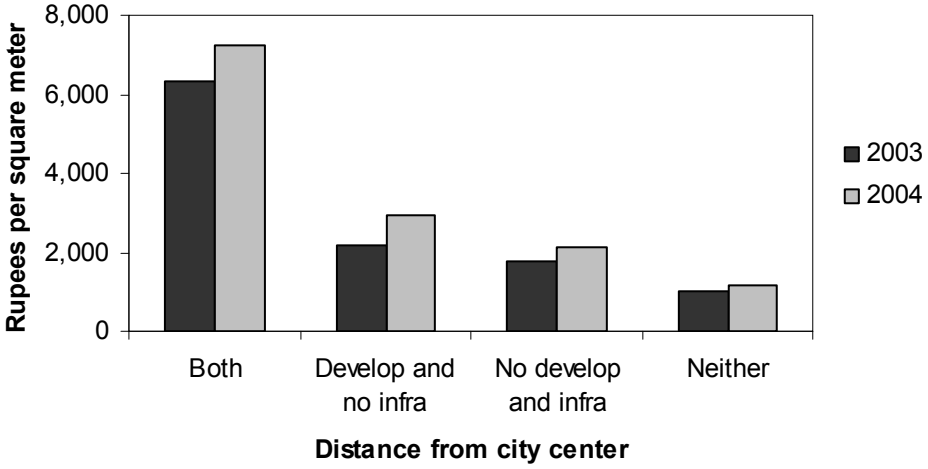
FIGURE 15.
Mean Price of Land in Industrial Plots by Distance from City Center



We expect infrastructure and development approval to be more important for industrial land because industrial activity needs infrastructure more than residential land, and government is more likely to overlook informal housing than informal industrial uses. The pattern of

premium on infrastructure and development approval as seen in Figure 16 corroborates this theory. 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.

FIGURE 16.
Mean Price of Land in Industrial Plots
by Infrastructure and Development Approval



Finally, in the case of industrial land, we find that there are more observations with infrastructure and development approval than without and that there are more observations with infrastructure only than development approval only. Although this is not certain evidence of anything, it suggests that industrial land is more likely to be formal than not. Also, it suggests that infrastructure is easier to install than development approval is to get, although this is speculation. Perhaps this is an area for future research.

Price Trends. Unfortunately, there is no historic price data for the city of Chennai. Thus, price trends cannot be commented on with much certainty. Nevertheless, we can speculate a thing or two.

Residential parcels have had the largest marginal increase, and industrial plots have also increased more than residential plots.

TABLE 15.
Average Price of Land in Residential Plots and Parcels

	2003	2004	Increase
Residential plots	8,200	9,250	13%
Residential parcels	1,000	1,250	25%
Industrial plots	3,623	4,344	20%

VIII. Conclusions

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 principal findings of the paper are as follows:

- Chennai, despite its relatively small size (compared to other Indian cities), has a very dense center.
- Changes in land use indicate that the region is starting to fill-in areas outside the center and is increasing suburban population densities.
- Very restrictive FSI regulations seem not to profoundly affect residential land price patterns, raising the question of de jure versus de facto FSI regulatory control.
- The combination of development approval and infrastructure provision again shows to have a highly significant positive effect on land prices, especially for industrial uses.

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