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5 Housing and the Journey to Work in the Tokyo Metropolitan Area

Tatsuo Hatta and Toru Ohkawara

5.1 Introduction

Why are land prices in Tokyo so high compared to those in other major cities of the world? Many explanations have been given, such as Land Lease and Building Lease Laws, low assessments of land under the inheritance tax, and the "bubble."[1] These are not mutually exclusive explanations, and no doubt the accumulated effect of these factors accounts for a good portion of the high land prices in Tokyo.

Yet the most basic factor is often neglected: Tokyo is by far the largest metropolitan area in the industrialized world. Figure 5.1, which is based on table 5.1, shows that it is twice as large as the second largest—New York—in both population and employment.[2]

As Mills (1967, 1972) and Muth (1969) pointed out, a city with lower com-

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The authors would like to dedicate this paper to Takao Fukuchi, their common teacher, who many years ago ignited their interest in the issues discussed here.

1. See Noguchi (ch. 1 in this volume) and Ito (ch. 9 in this volume), for example.

2. Kobayashi, Komori, and Sugihara (1990) make a detailed comparison of Tokyo, London, and Paris, including the comparisons in table 5.1. However, they do not compare these cities against New York. Kakumoto (1986, 139–42, 154–56) conjectures that the population and employment sizes of the comparable metropolitan area of Tokyo must be twice as large as that of New York based on the comparison of employment in an area of six hundred square kilometers. Table 5.1 verifies Kakumoto's conjecture and fills the gap in the Kobayashi, Komori, and Sugihara study by supplying the New York data for an area of fourteen thousand square kilometers.

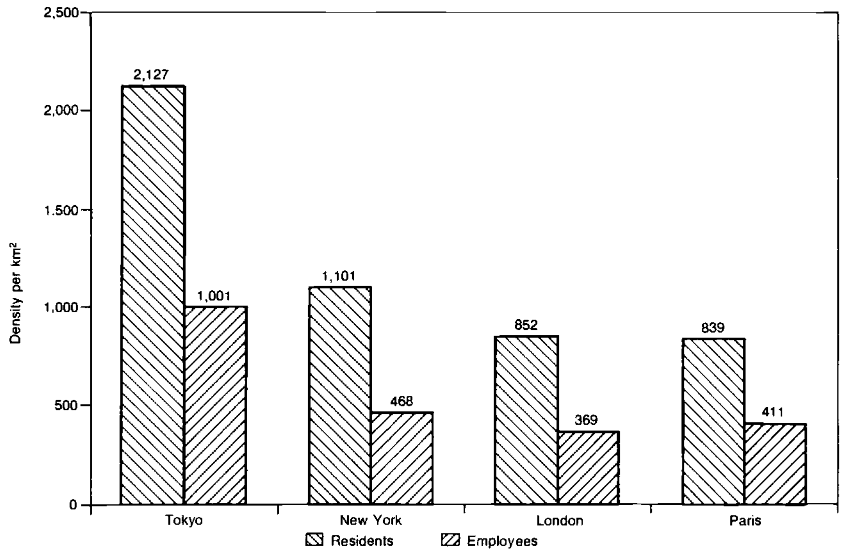

Fig. 5.1 Metropolitan areas of the world

Table 5.1 Metropolitan Areas of the World

	Toyko	New York	London	Paris
Area (km^2)	13,495	14,812	15,437	12,012
Year	1980	1980	1987	1982
Residents (in thousands)	28,699	16,303	13,152	10,073
Density (1000/km^2)	2.13	1.10	0.85	0.84
Employees (in thousands)	13,515	6,925	5,702	4,933
Density (1,000/km^2)	1.00	0.47	0.37	0.41

Sources: Tokyo: Shutoken Seibi Kyokai 1988, 2:10, 62, 190; New York: U.S. Bureau of the Census 1986, 202, 214–15; London: British Central Statistical Office (1989); Paris: INSEE (1988).

Notes: The metropolitan areas here cover Tokyo, Kanagawa, Chiba, and Saitama prefectures for Tokyo; seven PMSAs listed in table 5.2 for New York; Greater London and the surrounding six counties; and the Île de France. A more detailed comparison among Tokyo, London, and Paris is found in Kobayashi, Komori, and Sugihara (1990, 21), though New York is not included in the comparison. Kakumoto (1986) compares Tokyo and New York for the areas of six hundred square kilometers and less.

muting cost per kilometer will have a larger population and higher residential land prices than another city with the identical labor productivity at its central business district (CBD) but with a relatively higher commuting cost per kilometer. If the population of New York were doubled, keeping the current commuting facilities intact, traffic congestion would become prohibitive. In this sense, the availability of a network of well-developed commuter railroads keeps the commuting cost in Tokyo lower than in New York. This may be the main reason why population size and land price are higher in Tokyo than in New York.

Government intervention also contributes to make the commuting cost in Japan artificially low. In fact, Japanese commuters generally pay no commuting expenses at all; their employers reimburse them. Employers do this because the additional wage payment earmarked to cover the commuting expenses is, up to a generous limit, not taxable under personal and corporate income taxes. Employers can reduce the combined tax payments made by themselves and their employees by reimbursing the commuting fares while reducing the average of the regular wage rate. Note that under this scheme the larger the city size is, the larger the government subsidy given to the average resident.

Free commuter riding gives strong incentives to the employees to live farther from the city center. This makes the city grow in terms of both geographical size and population. Moreover, the free ride makes the population density and land price distribution from the CBD flatter than otherwise, as the Mills-Muth theory implies.

The present study has three major aims. First, we study differences in the population and employment distributions of Tokyo and New York, and examine how the different commuting environments of the two areas explain these distributions. As the Mills-Muth theory shows, the population density function in the residential district of a city has an intimate relationship with the land price function there. The employment density function in the CBD also has a close relationship with the land price function there. Although data on land prices are not available for New York, population and employment density data are available for both Tokyo and New York. A comparison of the latter will shed light on the distribution of land prices in Tokyo.

Kakumoto (1970, 1986) and Mills and Ohta (1976) compare population densities between Tokyo and New York for 1960, 1970, and 1980, respectively. In this article, we examine the two metropolitan areas for 1980, but larger and more detailed areas than Kakumoto (1986) does. This reveals that even in 1980 the CBD of Tokyo had much lower employment density than that of New York, unlike the implication of Kakumoto's data. Our data also show that the difference in population densities between the two CBDs is more dramatic than Kakumoto's data show. While Mills and Ohta show that the density of manufacturing employment in the CBD of Tokyo is greater than that of New York, we reveal the opposite for the total employment.

Second, we will empirically examine the impact of abolishing the preferential tax treatment of free commuter riding upon the land price structure and the size of the Tokyo metropolitan area. Our result shows, for example, that the land price at Toyoda, which is fifty-four minutes away from the Tokyo station, would be realized in Nishikokubunji, which is forty-seven minutes away from the Tokyo station, if commuters themselves are made to pay commuter-pass fares. To this end, we will first estimate the land price function for Tokyo using microdata on residential land price and distance from the Tokyo station.

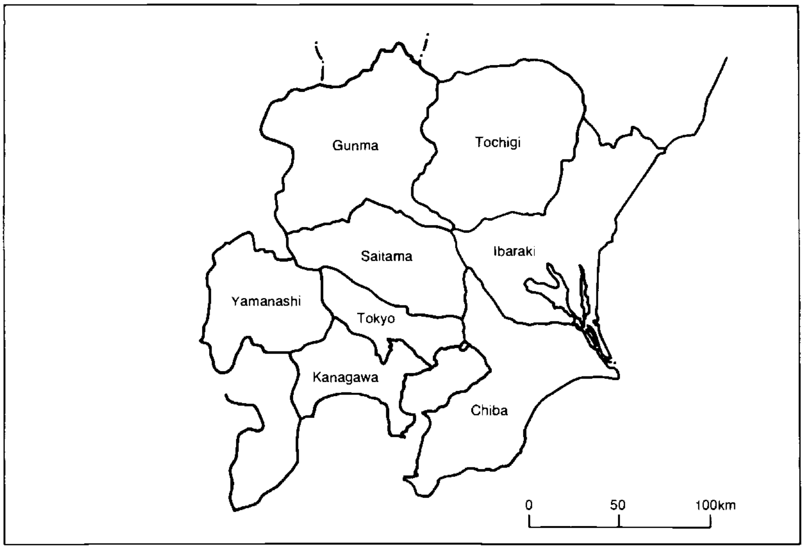

Fig. 5.2 Prefectures around Tokyo
Note: A more detailed map of Tokyo prefecture is found in figure 5.10.

Third, we will evaluate the current urban economic policies in Tokyo regarding the CBD development and commuter transportation from the viewpoint of whether they help attain an efficient resource allocation. It will be shown that the various existing policies have consistently made both population and employment density distributions flatter than efficiency requires.

The existing literature on the estimation of the land price function, such as Muth (1969), Mills (1972), Kau and Sirmans (1979), Mills and Hamilton (1984), Ohkawara (1985), and Alperovich (1990), assumes that commuters pay the monetary expense of commuting. In estimating our land price function for Tokyo, we take into account the fact that commuters actually pay commuting costs only in terms of time and fatigue.

Haurin (1983) studies the effects of the reimbursement of commuting expenses upon profits of the CBD firms, the population density distribution, and efficiency, assuming that the city is closed. When an open city is considered, however, entry of new firms bids up the land price until profits are wiped out. In the present paper, we examine the effect of the reimbursement on the land price as well as on population density, assuming that such competition exists at least in the long run.

Section 5.2 compares the population and employment densities of Tokyo and New York and makes three observations. Section 5.3 presents a simplified version of the Mills-Muth model. Section 5.4 explains the observations in the theoretical framework of section 5.3. Sections 5.5 through 5.7 empirically estimate the land price function of Tokyo. Section 5.8 discusses the policy implications of our theoretical and empirical observations. A summary of the paper is given in section 5.9.

5.2 Tokyo's Population and Employment: Facts

5.2.1 Residential Population

Table 5.1 compares the residential population in the metropolitan areas of Tokyo, New York, London, and Paris. It shows that the residential population of the Tokyo metropolitan area, 29 million, is approximately twice as large as that of New York, 16 million, and more than twice as large as London or Paris.

The metropolitan area of Tokyo in this table consists of Tokyo, Kanagawa, Chiba, and Saitama prefectures, shown in figure 5.2. For the three other metropolises, areas of similar geographical size were chosen. In the case of New York, for example, the seven most densely populated primary metropolitan statistical areas (PMSAs) in the New York–New Jersey–Connecticut consolidated metropolitan statistical area (NY-NJ-CT CMSA) are chosen, as listed in table 5.2. This area is the NY-NJ-CT CMSA minus Monmouth-Ocean, the NJ PMSA and Orange County, and the NY PMSA; the area includes Fairfield, CT, Middlesex, NJ, and Hunterdon, NJ, for example.

The above statistics are apparently in conflict with the obvious observation that downtown Tokyo has far fewer skyscrapers than Manhattan. Indeed, figure 5.3 and table 5.3 show that the population density of the central sixty square kilometers in Tokyo is one-half of that in New York. (In this paper, the population density measures the gross density, which is population/urban area, rather than the net density, which is population/residential area.) The area of Tokyo we chose for this comparison consists of the Chiyoda, Chuo, Minato, and Shinjuku wards, the map of which is shown in figure 5.4. The counterpart in New York is Manhattan. Table 5.3 shows that the population density of the Chiyoda ward is less than one-sixth of a CBD area in Manhattan that has a population twice as large the Chiyoda ward. This is also illustrated in figure 5.3.

Tables 5.4 through 5.6 further break down the population density figures of the various areas of the Tokyo metropolitan area in table 5.7. Table 5.8 breaks down the figures for the New York metropolitan area. Figure 5.3 is ultimately based on these tables.

Figure 5.3 indicates that the population density of New York is the highest near the CBD and declines as the area expands. In Tokyo, on the contrary, population density is very low at the central districts and increases as the area is expanded up to 240 square kilometers. As a result, Tokyo has a higher population density than New York in an area with the size of Manhattan plus Brooklyn. As the area becomes larger, the gap in the population density grows. Thus the population density of New York starts out at a high level near the center

Table 5.2 **PMSAs in the New York Area, 1980**

Primary Metropolitan Statistical Area (PMSA)[a]	Area		Population		Employment[b]				
	mi²	km²	Size (1,000s)	Density (1,000s/km²)	Private Sector (1,000s)	Federal Govt. (1,000s)	Local Govt. (1,000s)	Total (1,000s)	Density (1,000s/km²)
Jersey City	46	119	557	4.68	180	11	22	213	1.79
New York	1,146	2,968	8,275	2.79	3,282	85	392	3,759	1.27
Bergen-Passaic	424	1,098	1,293	1.18	527	5	42	574	0.52
Nassau-Suffolk	1,198	3,103	2,606	0.84	778	18	96	892	0.29
Newark	1,226	3,175	1,879	0.59	731	20	74	825	0.26
Fairfield[c]	632	1,637	807	0.49	364	4	24	392	0.24
Middlesex, etc.[d]	1,047	2,712	886	0.33	248	2	21	271	0.10
Total	5,719	14,812	16,303	1.10	6,110	145	671	6,926	0.47

Source: U.S. Bureau of the Census 1986, 202, 214–15.

[a]The seven most densely populated PMSAs in the NY-NJ-CT CMSA.

[b]Private sector, federal govt., and local govt. stand for private nonfarm, federal government, and state and local government employments. Private nonfarm and state and local government employment data are for 1982, while federal government employment data are for 1983.

[c]Fairfield is the CT–New England County metropolitan area called Bridgeport-Stamford-Norwalk-Danbury.

[d]Middlesex, etc., is the NJ PMSA called Middlesex-Somerset-Hunterdon.

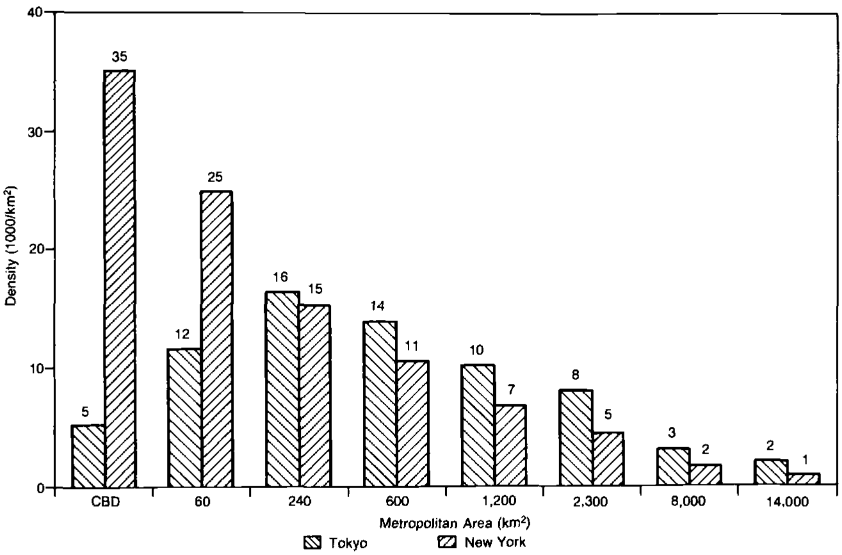

Fig. 5.3 Population density: Tokyo versus New York

and drops sharply as the area is expanded, while the density of Tokyo starts out at a lower level, increases first, and then declines more slowly than that of New York.

5.2.2 Employment

Table 5.1 shows 13.5 million people employed in the Tokyo metropolitan area while the New York metropolitan area has only 6.9 million (roughly one-half of the employment in the Tokyo metropolitan area), and London and Paris metropolitan areas have even less. Table 5.7 compares the employment densities of Tokyo and New York for various area sizes, and figure 5.5 illustrates this. Tokyo has twice as many people employed as New York in six hundred square kilometers, which is the twenty-three ward district in Tokyo and the combined area of Manhattan, Queens, the Bronx, and Brooklyn in New York. Moreover, this table shows that Tokyo has more people employed than New York even in a central sixty square kilometers, which is the combined area of Chiyoda, Chuo, Minato, and Shinjuku wards in Tokyo and Manhattan in New York.[3]

Near the center of the city, however, the opposite is observed. Figure 5.5, which is based on table 5.7, illustrates that the combined twenty square kilometers of Chiyoda and Chuo wards has a smaller population than a comparable area of south Manhattan. Moreover, the Chiyoda ward itself has less than three-

3. Kakumoto (1986, 154–56) was the first to make comparisons of the two cities with respect to areas of sixty and six hundred square kilometers.

Table 5.3 **Tokyo versus New York: Population Density, 1980**

Tokyo			New York		
Area (km²)	Residents (1,000s)	Density (1,000s/km²)	Area (km²)	Residents (1,000s)	Density (1,000s/km²)
		CBD area			
	Chiyoda ward[a]			Midtown[b]	
10.4	55	5.29	3.6	128	35.16
		60 km² area			
	Four central wards[c]			Manhattan	
58	683	11.68	57	1,423	24.96
		240 km² area			
	Fifteen central wards[d]			Manhattan and Brooklyn	
236	3,889	16.48	237	3,659	15.44
		600 km² area			
	All twenty-three wards			Manhattan, Queens, Bronx, and Brooklyn	
598	8,352	13.97	629	6,719	10.68
		1,200 km² area			
	"Urban area"[e]			Top six counties	
1,232	12,746	10.35	1,230	8,479	6.89
		2,300 km² area			
	"Urban area" plus "suburban area"[f]			Top nine counties	
2,292	18,736	8.17	2,240	10,305	4.60
		8,000 km² area			
	Tokyo metropolitan area[g]			Top fifteen counties[h]	
8,415	27,348	3.25	8,107	14,642	1.81
		14,000 km² area			
	Four prefectures[i]			Top seven PMSAs[j]	
13,495	28,699	2.13	14,812	16,303	1.10

Sources: Tokyo: Shutoken Seibi Kyokai 1988, 2:10, 62, 190, 204, 205–12; New York: New York City 1988; U.S. Bureau of the Census 1986, 202, 214–15; CACI 1990, 425.

[a]The part of the Imperial Palace that is closed to the public is excluded from the area figure of Chiyoda ward in the first three rows. It is included in the area figures of larger areas of Tokyo, since its inclusion hardly affects density figures.

[b]"Midtown" is defined as the area bounded by 59th Street, 14th Street, and Lexington Avenue. It is District 5 of New York City (1988).

[c]The four central wards are Chiyoda, Chuo, Shinjuku, and Minato.

[d]The fifteen central wards are the first fifteen wards listed in table 5.4.

[e]"Urban area" (Kisei Shigaichi) is defined by the Tokyo Metropolitan Area Refurbishment Act. (Shotoken Seibi Ho) and consists of the twenty-three wards of Tokyo Musashino, and Mitaka, Kawasaki, Kawaguchi, and Yokohama except for Seya ward.

[f]Table 5.6 lists the thirty-eight suburban cities of Tokyo in the "suburban area" (Kinko Seibi Chitai) as defined by the law.

[g]"Tokyo metropolitan area" (Tokyo Daitoshi Chiiki) combines the "urban area" and "suburban area" defined above.

[h]The fifteen counties in the New York area with the highest population densities are listed in table 5.8 in order of density.

[i]Tokyo, Kanagawa, Chiba, and Saitama prefectures.

[j]The seven SMSAs in the New York area with the highest population density are listed in table 5.2.

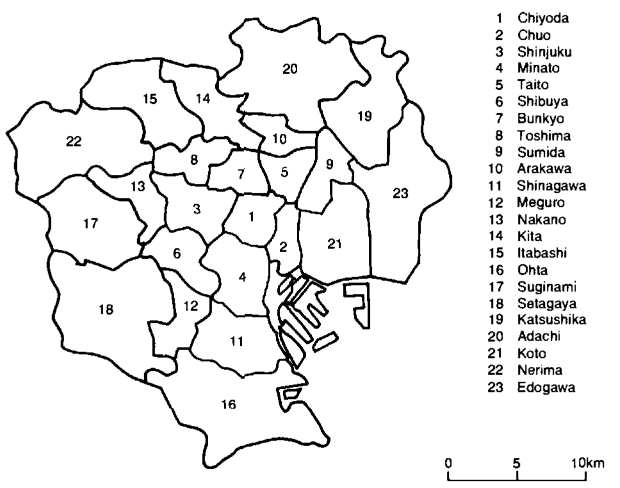

Fig. 5.4 The ward district of Tokyo
Notes: Wards are listed in the order of the density of population during the day, as in tables 5.4 and 5.9. Figure 5.10 locates the ward district of Tokyo within Tokyo prefecture.

fourths of the number of employees that New York has, with roughly the same area.[4] A detailed breakdown of population densities is given in table 5.9 for the ward district of Tokyo, and in table 5.10 for south Manhattan.

5.2.3 Summary Observations

Our observations may be summarized as follows:

1. Population and employment sizes of the entire metropolitan area of Tokyo are twice as large as those of New York.

2. The CBD of Tokyo is underutilized relative to the CBD of New York. The employment density of the CBD of Tokyo is less than three-fourths of the corresponding area in New York, while population density of the CBD of Tokyo is less than one-sixth of that of New York.

3. The population density curve is flatter in the Tokyo suburbs than in the New York suburbs. (As the area size increases, the population density increases first and then declines in Tokyo, while it monotonically declines in New York.) The employment density curve is flatter in Tokyo than in New York in all area sizes.

4. The Tokyo figure includes government as well as private-sector employees, but the New York figure does not include employees of federal or local governments. Thus the actual employment density of New York is even higher than the figure given in table 5.7.

Table 5.4 **The Twenty-three Wards of Tokyo: Population, 1980**

Day Population Density[a] (1,000s/km²)	Ward	Area (km²)	Residential Population (1,000s)	Density (1,000s/km²)	Cumulative Area (km²)	Cumulative Population (1,000s)	Cumulative Density (1,000s/km²)
94.2	Chiyoda	10.39[b]	55	5.3	10.39	55	5.3
65.5	Chuo	10.05	83	8.3	20.44	138	6.8
38.1	Shinjuku	18.04	344	19.1	38.48	482	12.5
35.3	Minato	19.99	201	10.1	58.47	683	11.7
33.7	Taito	10.00	186	18.6	68.47	869	12.7
30.8	Shibuya	15.11	247	16.3	83.58	1,116	13.4
29.4	Bunkyo	11.44	202	17.7	95.02	1,318	13.9
28.5	Toshima	13.01	289	22.2	108.03	1,607	14.9
19.5	Sumida	13.82	233	16.9	121.85	1,840	15.1
19.4	Arakawa	10.34	198	19.1	132.19	2,038	15.4
19.1	Shinagawa	20.91	346	16.5	153.10	2,384	15.6
19.0	Meguro	14.41	274	19.0	167.51	2,658	15.9
16.9	Nakano	15.73	346	22.0	183.24	3,004	16.4
16.6	Kita	20.55	387	18.8	203.79	3,391	16.6
14.5	Itabashi	31.90	498	15.6	235.69	3,889	16.5
13.4	Ohta	49.42	661	13.4	285.11	4,550	16.0
12.3	Suginami	33.54	542	16.2	318.65	5,092	16.0
11.6	Setagaya	58.81	797	13.6	377.46	5,889	15.6
10.7	Katsushika	33.90	420	12.4	411.36	6,309	15.3
10.2	Adachi	53.25	620	11.6	464.61	6,929	14.9
10.1	Kota	36.89	362	9.8	501.50	7,291	14.5
9.6	Nerima	47.00	564	12.0	548.50	7,855	14.3
9.1	Edogawa	48.26	495	10.3	596.76	8.350	14.0
Total[c]		597.89	8,352	14.0			

Souce: Shutoken Seibi Kyokai 1988, 2:204, 205.

[a]The density of population during the day, which includes employees, students, and residents who are in the ward during the daytime.

[b]The area of Chiyoda ward is 11.52 km². The part of the Imperial Palace that is closed to the public is 1.13 km². The area listed here is what is open to the public.

[c]The last row gives the total area of the ward district including the Imperial Palace. The total population figure is corrected for rounding error. The impact of these corrections upon the total population density is negligible.

Table 5.5 **Cities in the Urban Area of Tokyo: Population, 1980**

City	Area (km^2)	Population (1,000s)	Density (1,000s/km^2)
23 wards of Tokyo	598	8,352	14.0
Musashino	11	137	12.5
Mitaka	17	165	9.7
Kawasaki	136	1,041	7.7
Kawaguchi	56	379	6.8
Yokohama	414	2,673	6.5
Urban area total	1,232	12,746	10.3

Source: Shutoken Seibi Kyokai 1988, 2:205–12.
Note: "Urban area" is defined in the notes to table 5.3.

5.3 A Theory of Commuting Costs, Land Prices, and Population Densities

As a preparation to explaining the reasons for the above differences between Tokyo and New York in section 5.4, we now discuss the relevant aspects of the Mills-Muth model of an urban economy.

5.3.1 Commuting Cost and Metropolitan Size

The fundamental reason why megalopolises like Tokyo and New York exist is the agglomeration economies in production, that is, the benefits that firms can obtain from each other when they are located in the same city. When a firm is located in the CBD of a large city, costs of communication with other firms in the city are reduced both in terms of face-to-face and telephone contacts. Besides, a firm in a large city can enjoy business support services, such as computer maintenance, elevator maintenance, office cleaning, and business consulting. Moreover, public facilities such as communication and transportation facilities are subject to considerable scale economies. Thus new firms are attracted to a large city. These newcomers to the city further emit external economies to other firms in the same city, and encourage even more firms to move into the city.

This virtuous cycle of agglomeration economies increases the productivity of the firms at the CBD, enabling them to pay much higher wage rates than the rural firms. This wage-rate difference attracts workers from the rural area to the city.

But the immigration will not continue indefinitely. The urban workers have to pay commuting costs, which consist of train fares, auto expenses, time, and fatigue. We will call the CBD wage rate minus the monetary equivalent of the commuting cost at a given location the *net urban wage rate* at the location. It declines as the distance between the CBD and the location increases. At a location too far from the CBD, the net urban wage rate would become lower than the rural wage rate.

Table 5.6 Cities in the Suburban Area of Tokyo: Population, 1980

City	Area (km^2)	Population (1,000s)	Density (1,000s/km^2)
Komae	6	71	11.8
Hoya	9	91	10.1
Tanashi	7	67	9.6
Hatagaya	6	56	9.3
Koganei	11	102	9.3
Kami Fukuoka	7	58	8.3
Kokubunji	11	91	8.3
Higashi Kurume	13	107	8.2
Chofu	22	181	8.2
Kunitachi	8	64	8.0
Kodaira	21	155	7.4
Higashi Murayama	17	119	7.0
Soka	28	187	6.7
Matsudo	61	401	6.6
Ichikawa	56	364	6.5
Fuchu	30	192	6.4
Kiyose	10	62	6.2
Narashino	21	125	6.0
Seya, Yokohama	17	101	5.9
Tachikawa	24	142	5.9
Shigi	9	51	5.7
Funabashi	85	480	5.6
Hino	27	145	5.4
Akishima	17	89	5.2
Zama	18	94	5.2
Niiza	23	119	5.2
Urawa	71	358	5.0
Asaka	18	90	5.0
Fussa	10	49	4.9
Sagamihara	91	439	4.8
Chigasaki	36	171	4.8
Higashi Yamato	14	66	4.7
Tama	21	95	4.5
Ooi	8	36	4.5
Toda	18	78	4.3
Kamakura	40	173	4.3
Fujisawa	70	300	4.3
Yokosuka	99	421	4.3
Total	1,060	5,990	5.7
Urban area[a]	1,232	12,746	10.3
Grand total	2,292	18,736	8.2

Source: Shutoken Seigi Kyokai 1988, 2:205–12.

Note: These are the thirty-eight most densely populated cities within the "suburban area" (Kinko Seibi Chitai) as defined by the Act on Suburban Development in the Tokyo Metropolitan Area (Shutoken no Kinkou Seibi Chitai oyobi Toshi Kaihatsu Kuiki no Seibi ni Kansuru Horitsu).

[a]"Urban area" is defined in table 5.3.

Table 5.7 Tokyo versus New York: Employment Density

Tokyo			New York		
Area (km²)	Employment (1,000s)	Density (1,000s/km²)	Area (km²)	Employment (1,000s)	Density (1,000s/km²)
		11 km² and less			
	Chiyoda ward[a]			Midtown amd Downtown[b]	
			(a) 5.34	760	142.4
10.39	768	73.9	(b) 10.99	11,961	108.4
		20 km² area			
	Two central wards			South Manhattan[c]	
20	1,386	69.3	21.48	1,609	74.9
		60 km² area			
	Four central wards			Manhattan	
59	2,406	40.8	57	1,949	34.2
		600 km² area			
	All twenty-three wards			Manhattan, Queens, Bronx, and Brooklyn	
598	6,234	10.4	629	3,223	5.1
		14,000 km² area			
	Four prefectures			Top seven PMSAs	
13,495	13,515	1.0	14,812	6,925	.05

Sources: Tokyo: Shutoken Seibi Kyokai 1988, 2:62, 204, 205; New York: U.S. Bureau of the Census 1986, 202, 214–15; CACI 1990, 425.

Notes: Data for Midtown, Downtown, and South Manhattan are for 1987 and include only private-sector employment. All other data are for 1980 and include both private-sector and government employment.

[a]The part of the Imperial Palace that is closed to the public is excluded from the area figure of Chiyoda ward.

[b]Midtown and Downtown of Manhattan (a) is the first eight zip code areas in table 5.10, while (b) is the first ten zip code ares of the same table.

[c]South Manhattan is defined to be the area consisting of the first eighteen zip code areas in table 5.10. See notes to table 5.3 for the definitions of other areas.

Assume that people are homogeneous and free migration takes place between the city and the rural area. Then a resident at a border between the metropolitan area and the rural area should be indifferent between commuting to the CBD and working in the rural area. If we assume that the rural workers pay zero commuting costs, the net urban wage rate at the border must be equal to the rural wage rate.

Figure 5.6(a) illustrates the determination of the boundary of the metropolitan area. The rural wage rate, $\bar{w}$, and the CBD wage rate, w^0, are marked on the vertical axis. The net urban wage rate at each location is depicted by the thick line, under the assumption that the commuting cost is proportional to the distance from the CBD. The metropolitan area ends at a distance where

Table 5.8 Counties in the New York Area: Population, 1980

County	Area (mi²)	Area (km²)	Population Size (1,000s)	Population Density (1,000s/km²)	Cumulative Area (km²)	Cumulative Population (1,000s)	Cumulative Density (1,000s/km²)
Manhattan	22	57	1,428	25.0	57	1,428	25.0
Brooklyn	70	181	2,231	12.3	238	3,659	15.4
Bronx	42	109	1,169	10.7	347	4,828	13.9
Queens	109	282	1,891	6.7	629	6,719	10.7
Jersey City, NJ	46	119	557	4.7	749	7,276	9.7
Essex, NJ	127	329	851	2.6	1,077	8,127	7.5
Richmond	59	153	352	2.3	1,230	8,479	6.9
Union, NJ	103	267	504	1.9	1,497	8,983	6.0
Nassau	287	743	1,322	1.8	2,240	10,305	4.6
Bergen, NJ	238	616	845	1.4	2,857	11,150	3.9
Passaic, NJ	187	484	448	0.9	3,341	11,598	3.5
Westchester	438	1,134	867	0.8	4,476	12,465	2.8
Middlesex, NJ	316	818	596	0.7	5,294	13,061	2.5
Rockland	175	453	260	0.6	5,747	13,321	2.3
Suffolk	911	2,359	1,321	0.6	8,107	14,642	1.8

Source: U.S. Bureau of the Census 1986, 202.

Note: Listed are the fifteen most densely populated counties in the NY-NJ-CT CMSA. The sixteenth is Fairfield County, CT.

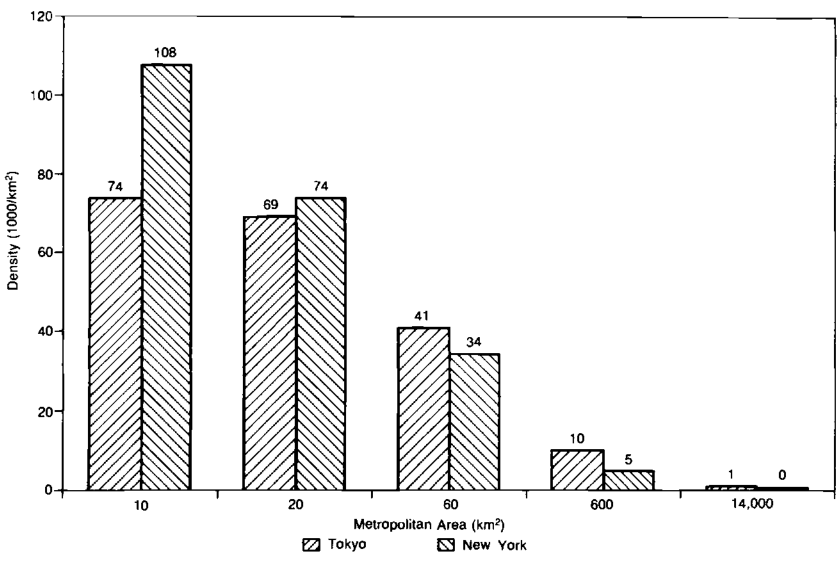

Fig. 5.5 Employment density: Tokyo versus New York

Table 5.9 **The Twenty-three Wards of Tokyo: Employment, 1980**

Day Population Density[a] (1,000s/km²)	Ward	Area (km²)	Emp.[b] (1,000s)	Density (1,000s/km²)	Cumulative Area (km²)	Cumulative Employees (1,000s)	Cumulative Density (1,000s/km²)
94.2	Chiyoda[c]	10.39	767	73.8	10.39	767	73.8
65.5	Chuo	10.05	619	61.6	20.44	1,386	67.8
38.1	Shinjuku	18.04	446	24.7	38.48	1,832	47.6
35.3	Minato	19.99	574	28.7	58.47	2,406	41.1
33.7	Taito	10.00	257	25.7	68.47	2,663	38.9
30.8	Shibuya	15.11	285	18.9	83.58	2,948	35.3
29.4	Bunkyo	11.44	167	14.6	95.02	3,115	32.8
28.5	Toshima	13.01	205	15.8	108.03	3,320	30.7
19.5	Sumida	13.82	173	12.5	121.85	3,493	28.7
19.4	Arakawa	10.34	112	10.8	132.19	3,605	27.3
19.1	Shinagawa	20.91	242	11.6	153.10	3,847	25.1
19.0	Meguro	14.41	130	9.0	167.51	3,977	23.7
16.9	Nakano	15.73	115	7.3	183.24	4,092	22.3
16.6	Kita	20.55	159	7.7	203.79	4,251	20.9
14.5	Itabashi	31.90	223	7.0	235.69	4,474	19.0
13.4	Ohta	49.42	360	7.3	285.11	4,834	17.0
12.3	Suginami	33.54	161	4.8	318.65	4,995	15.7
11.6	Setagaya	58.81	241	4.1	377.46	5,236	13.9
10.7	Katsushika	33.90	177	5.2	411.36	5,413	13.2
10.2	Adachi	53.25	246	4.6	464.61	5,659	12.2
10.1	Koto	36.89	211	5.7	501.50	5,870	11.7
9.6	Nerima	47.00	172	3.7	548.50	6,042	11.0
9.1	Edogawa	48.26	193	4.0	596.76	6,235	10.4
Total			597.89	6,234	10.4		

Source: Shutoken Seibi Kyokai 1988, 2:204, 205.

[a]The density of population during the daytime, which includes employees, students, and residents who are in the ward.

[b]Emp. stands for the number of employees.

[c]See note *b*, table 5.4.

the thick line reaches the level of the rural wage rate. The distance between the CBD and a border is represented by $\bar{x}$ on the horizontal axis.

The figure makes it clear that the commuting cost at the border reflects the labor productivity difference between the CBD and the rural area. If the CBD productivity is increased, the thick line in figure 5.6(a) will shift right, and the city size will increase both geographically and demographically. If the transportation cost is reduced, the thick line in figure 5.6(a) will become flatter and $\bar{x}$ will increase. This of course implies that, if the transportation cost of a city is cheaper in one city than in another city with an identical CBD productivity, the geographic and demographic sizes of the former city will be greater than the latter.

Table 5.10 **South Manhattan: Employment, 1987**

Zip Code[a]	Area (km²)	Employee (1,000s)	Density (1,000s/km²)	Cumulative Area (km²)	Cumulative Employee (1,000s)	Cumulative Density (1,000s/km²)
10020	0.09	41.5	441.9	0.09	42	441.9
10005	0.26	71.9	278.5	0.35	113	322.1
10047–48	0.12	33.7	276.1	0.47	147	310.3
10017	1.18	195.1	165.9	1.65	342	207.4
10006	0.28	39.4	142.8	1.93	382	198.1
10022	1.62	183.6	113.6	3.54	565	159.6
10004	0.67	73.0	108.7	4.21	638	151.5
10018	1.13	122.4	108.7	5.34	760	142.4
10016	1.20	110.4	92.2	6.54	871	133.2
10036	1.63	123.1	75.7	8.16	994	121.8
10038	0.92	65.1	70.6	9.09	1,059	116.6
10001	1.91	132.2	69.4	10.99	1,191	108.4
10019	2.35	145.2	61.9	13.34	1,337	100.2
10010	1.08	63.3	58.8	14.41	1,400	97.1
10007	0.92	33.4	36.2	15.34	1,433	93.4
10003	1.84	63.4	34.6	17.17	1,497	87.2
10013	2.09	57.8	27.6	19.26	1,554	80.7
10011	2.21	54.6	24.7	21.48	1,609	74.9
10012	1.24	21.9	17.7	22.72	1,631	71.8
10014	1.96	22.6	11.5	24.68	1,653	67.0
10002	2.51	20.1	8.0	27.19	1,674	61.6
10009	1.69	10.2	6.0	28.88	1,684	58.3
Total	28.88	1,683.7	58.3			

Sources: CACI 1990, 425, for the employment figures. Rehana Siddiqui of Columbia University computed the area of each zip code district from a Manhattan map.

Note: The employment figures are for the private sector only.

[a]Zip code 10020 is Rockefeller Center, 10005 is Wall St., and 10047–48 are the twin towers of the World Trade Center.

5.3.2 Land Prices and Population Density

Due to the assumption of free migration, a person must be indifferent between living at any location in the city and living in the rural area at an equilibrium. Suppose that a worker living close to the CBD enjoyed a higher living standard than a border worker. Then all of the rural residents would want to migrate near the CBD. Hence the housing rent near the CBD would go up until the living standard of the residents there became exactly equal to the living standard at the rural area.

The thick line in figure 5.6(b) represents the housing rent curve, which is derived from the net urban wage rate curve depicted in figure 5.6(a). When nonhousing consumption is substitutable for housing floor space in consump-

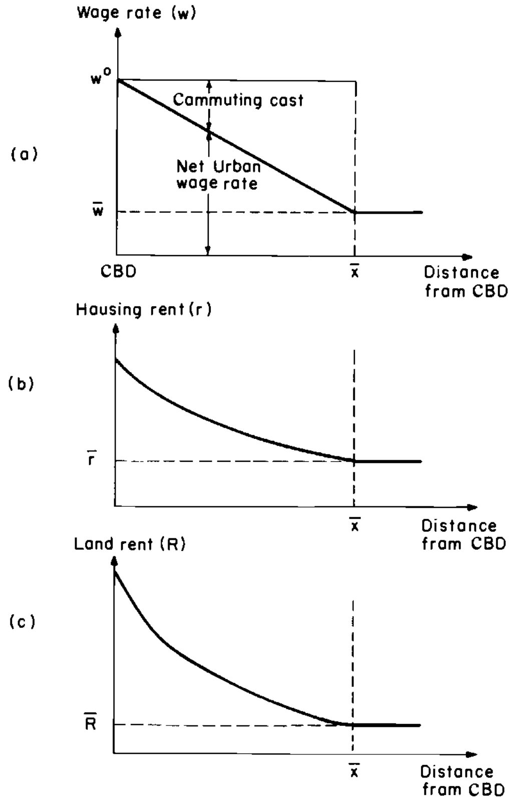

Fig. 5.6 The rent curves

tion, the population density increases as the location becomes closer to the city center, and hence the housing rent curve is convex to the origin.[5]

5. If the demand for housing floor space were fixed regardless of the level of rent, the housing rent curve would be linear. In fact, if we choose the unit of housing services so that each consumer consumes one unit of housing floor space, $r - \bar{r} = w - \bar{w}$ will hold at each location within the city. If housing floor space and nonhousing consumption are substitutable, however, the rent curve becomes convex to the origin. Suppose that the rent curve is linear in such a way that it just enables a resident at an interior location to purchase the same combination of floor space and nonhousing consumption as a border resident, guaranteeing at least the utility level of a border resident. If an interior resident chose this option, he would not be maximizing his utility under the given expenditure; he would be able to improve his utility by reducing the consumption of the floor space and increasing that of the nonhousing consumption goods. This is because he faces a higher relative price of the floor space than a border resident does. Thus the utility-compensating rent has to be higher than the rent that just enables this resident to buy the same bundle as the border resident. We can similarly compare this resident and the third resident living even closer to the center, showing that the rent for the third resident again has to be higher than a linear rent curve based on the second resident's consumption bundle. When nonhousing consumption is substitutable for housing floor space, therefore, the housing rent curve must be convex to the origin.

If land and capital are substitutable in housing production, moreover, the increase in the housing rent will encourage construction of high-rise buildings, and the floor space per square kilometer of land will expand near the CBD. The land rent curve then becomes more curved toward the origin in comparison to the housing rent curve.[6] Thus the shape of the housing rent curve and the factor substitutability in the housing industry determines the curvature of the land rent curve, as depicted in figure 5.6(c).

If either the utility function or the production function or both are substitutable, the land space per resident becomes smaller, that is, the population density increases for locations closer to the CBD. The reasoning above suggests that this causes the land rent function to be curved to the origin. We might conclude, therefore, that the steeper the population density curve, the steeper the land rent curve.[7] Indeed, we will show in equation (8) that the land rent curve and the population density curve are proportional in the economy with Cobb-Douglas utility and production functions when the commuting cost consists of only time and fatigue.

The land price curve is vertically proportional to the land rent curve if the land price is equal to the present value of the future land rent and if a proportional future increase in the land rent is expected regardless of the location. The equality between the land price and the present value of the rent income stream does not hold if "bubbles" prevent the fundamentals from being reflected in the land prices. But so long as the bubble effect is proportional to the present value of the future land rent stream regardless of the location in the city, we may still view the land price curve to be vertically proportional to the land rent curve.

These observations yield the following proposition regarding the effect of a change in the commuting cost upon the land price curve and the population density curve.

Proposition 1. Suppose that the commuting cost per kilometer is reduced, keeping the CBD productivity constant. Then the following hold: (1) the y-axis intercept of the land price curve remains the same. However, the slope of the land price curve becomes flatter, and the level of $\bar{x}$ increases. (2) The y-axis intercept of the population density curve remains the same, but the slope of the population density curve becomes flatter.

6. If a fixed amount of land is necessary to produce a given floor space, the housing rent difference between two locations will be proportional to the land rent difference. If land and capital are substitutable, the land rent difference will grow more than proportionally as the housing rent difference grows. The reason is similar to the one given for the convexity of the housing rent curve.

7. If housing and other consumptions are not substitutable in the utility function and if capital and land are not substitutable in the production function, population density at any location of the city should be equal to that in the rural area. The above argument suggests, moreover, that the land rent function should be linear in that case.

5.3.3 Agglomeration Economies

It was pointed out in section 5.3.1 that agglomeration economies are the source of the high labor productivity at the CBD in large metropolitan areas. In the present section, however, we have so far implicitly assumed that the labor productivity at the CBD is kept constant while the per-kilometer commuting cost is changed. Since a change in commuting cost implies a change in the urban population size, this amounts to implicitly assuming that the agglomeration economies are already exhausted at the CBD, and the production function obeys constant returns to scale at a high level of efficiency.

This artificial separation between the urban population size and the CBD productivity is conceptually convenient. But proposition 1 can be easily modified to the situation where an increase in the employment size at the CBD still causes agglomeration economies. We will assume external economies of scale. Thus each firm perceives its production function to be constant returns to scale, but the production in the CBD as a whole obeys increasing returns to scale.

Then we have the following proposition.

Proposition 2. Suppose that the commuting cost per kilometer is reduced in an economy where the CBD technology is subject to external economies of scale. Then the following hold: (1) The y-axis intercept of the land price curve increases, the slope of the land price curve becomes flatter for each land price, and the level of $\bar{x}$ increases. (2) The y-axis intercept of the population density curve increases, and the slope of the population density curve becomes flatter for each density level.

Roughly speaking, the effect of changing the per-kilometer transportation cost is magnified when the CBD technology is subject to external economies of scale.

5.3.4 Idiosyncratic Consumers

In deriving the above propositions, we assumed that all consumers are alike. But the existence of a relatively small number of idiosyncratic consumers does not affect the shapes of the land price and population density curves.

Suppose, for example, that there is a group of talented persons who get higher wages at the CBD than other workers, even though they earn the same wages as others if they work in the rural area. Their reservation land price at an urban location, that is, the one that would make them feel indifferent about the choice between that location and the border, will be higher than the reservation land price for the homogeneous consumers. If there is a sufficiently small number of these talented people, however, the amount of land demanded of a given location at their reservation land price will be below the amount supplied. In this case, the talented people will not be the marginal buyers of land;

the market clearing price will be the one obtained from the homogeneous consumers.[8]

5.3.5 Business Land Use

So far we have implicitly assumed that the CBD firms use a minuscule amount of land. Obviously this is not the case in reality. Suppose that the CBD production uses land, capital, and labor. Also assume that the productivity decreases as a firm is located farther from the city center. Then the line *AC* in figure 5.7(a) depicts the business land price curve that shows the land prices for various locations under which business firms would be indifferent in their locational choice. If the business firms demand large enough amounts of land in the CBD district to become the marginal buyers, they will outbid the demand for residential use; consequently, the business land prices become the market prices, and the line *ABD* will become the market price line.

The commuters working in the *AB* region may first go to the city center by train and then reach their workplace from the city center through other transportation modes. In that case, the firms must compensate the additional trip cost from the city center to the workplaces, and it will be a cause of the reduced productivity of the firms represented by the declining *AB* curve.

Some workplaces near *B* may be less expensive for commuters to reach directly without detouring through the city center. If these commuters received the same wage rate as the workers at the center, they would be better off than the workers at the center, which would entice more people to work near *B*. This would drive down the wage rate near *B* until it became equal to the location's net urban wage rate for the workers at the center.

Some grocery shops may find it more profitable to be located at *S* in the middle of the suburbs rather than near the CBD. Their demand curve for the land at *S* is downward sloping. For the CBD commuters, on the other hand, the land at *S* and any other suburban location is a perfect substitute. Their demand curve for the land at *S* is horizontal at the level of the land price given by figure 5.7(a). The combined demand curve of the grocery shops and the commuters for the land at this location is downward sloping at first and becomes flat at the demand price level of the CBD commuters. If the vertical supply curve of this land intersects with the combined demand curve at the flat portion, we say the CBD commuters are the "marginal land buyers" and the grocery shop owners "inframarginal land buyers." If the grocery shops are not marginal land buyers, they will not affect the market land prices.

8. As another example, suppose that there is one deviant person in this economy who hardly minds commuting up to twenty minutes but dislikes the additional commuting more intensely than others. Then the price curve that would make him indifferent about the choice of residential location is relatively flat at a high level near the CBD up to a location with the twenty-minute commuting distance and then precipitously declines. At the location within twenty minutes of the CBD, he is thus willing to pay more for the land than others. But to the extent he is a minority, he will not be the marginal buyer, and his taste will not affect the land prices.

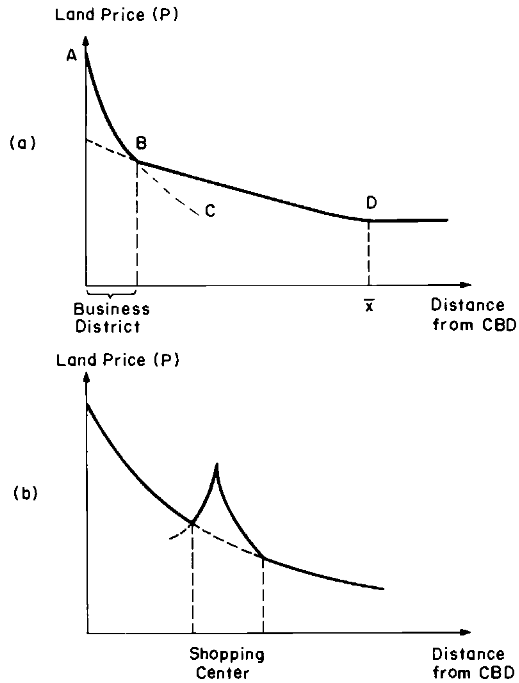

Fig. 5.7 Land price curves

If a shopping center in a suburb is large enough to be a local marginal land buyer, however, it will outbid the residents, and the land price curve will become like figure 5.7(b). Workers commuting to these suburban workplaces will bid down their wage rates at the center.

These observations suggest that, when small workplaces are spread all over the metropolitan area, workers commute from suburbs farther away from the CBD to non-CBD workplaces, but they do not affect the shape of the market land price curve for the residential districts. Figure 5.7(b) suggests that, even if a major shopping center exists, it will not necessarily affect the residential land prices in the area away from the CBD and the shopping center.

5.3.6 Summary

In the present section, we have shown that, in a Mills-Muth model of a concentric city, a reduction in transportation costs makes a city larger both geographically and demographically, while it makes the land price and population density curves flatter. We have also demonstrated that the land price and population density curves will stay the same even if the assumptions of homogeneous consumers and concentration of employment at the city center are violated to some extent.

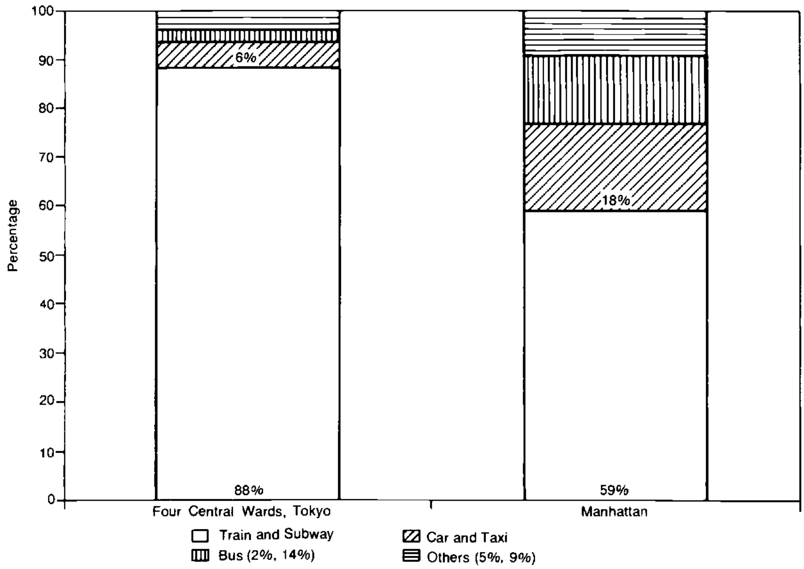

Fig. 5.8 Modes of transportation for commuting

5.4 Tokyo's Population and Employment: An Explanation

We are now in a position to explain the three major differences between Tokyo and New York in structural characteristics, using the theoretical framework outlined above.

5.4.1 The Size of the Metropolitan Area

Dependence on the Railroad System

We have seen in the previous section that the higher the productivity at the CBD is and the lower the cost of commuting is, the larger is the city size. Since the major source of the high productivity at their CBD of Tokyo or New York is the agglomeration economies, the size of the CBD employment itself affects the productivity of the city. Thus commuting cost must be the major independent factor that determines the difference in the sizes of New York and Tokyo.

Figure 5.8, which is based on table 5.11, indicates that 59 percent of the commuters to Manhattan and 88 percent of the commuters to the four central wards of Tokyo use the railroad. Table 5.11 shows that 93 percent of the commuters to the Chiyoda ward use the railroad for commuting.

Passenger cars play a negligible role in commuting to the CBD of Tokyo. In 1980, only 5 percent of the commuters to the four central wards of Tokyo used passenger cars and taxis. On the other hand, 18 percent used passenger cars and taxis to commute to Manhattan. Moreover, many railroad commuters to Manhattan use passenger cars from home to railroad stations, while Tokyo

Table 5.11 Mode of Transportation for Commuting, 1980 (%)

	Tokyo[a]		
Mode of Transportation	Chiyoda	4 Wards[b]	Manhattan[c]
(a) Train and subway[d]	93.0	88.2	59.1
(b) Car	3.2	4.2	16.5
(c) Taxi	1.0	1.1	1.3
(d) Bus	0.9	1.6	13.9
(e) Bicycle and motorcycle	0.3	0.9	0.3
(f) Walk	1.0	3.1	8.2
(g) Other means[e]	0.6	0.8	0.7
Total commuters (1,000s)	753	2,313	1,921

Sources: New York: Barry 1985; Tokyo: Japanese Agency of General Affairs 1985.

[a]Tokyo figures include those who commute to attend schools as well as those who commute to work. The figures for *b* through *f* represent those who use the respective mode only.

[b]The four wards are Chiyoda, Chuo, Minato, and Shinjuku.

[c]The New York figures represent only those who commute to work in Manhattan. The figures represent the percentage of those who use the respective mode for the most distance. The only exception is mode *e*.

[d]Includes Tokyo commuters who use train or subway in conjunction iwth another mode. A commuter who uses three or more modes is also classified in this category, since the original data do not decompose this category. Those who use three or more modes are 8.8 percent of the total in both four wards and Chiyoda.

[e]"Other means" for Tokyo represents a combination of two means among *b*–*e*. "Other means" for New York represents a mode other than *a*–*f* for the most distance.

railroad commuters walk, bicycle, or take the bus to railroad stations. Compared with New York commuters, therefore, Tokyo commuters rely less on passenger cars and more on railroads.

Table 5.12 shows that subways carry twice as many passengers in Tokyo as in New York. Moreover, suburban commuter trains play a even more important role than subways in Tokyo, while the opposite is the case in New York. The subway system carries only 21 percent of the railroad passengers in Tokyo, while it carries 83 percent of them in New York.

Indeed, the Tokyo railroad system carries at least five times as many commuters as the New York system. In 1980, the total number of passengers with commuting passes was 7.1 billion for the railroad system in the Tokyo commuting area as defined by Unyu Keizei Kenkyu Center. In the same year, the total number of commuters (to work) was 1.4 billion for the railroad system in the Tri-State region as defined by the Tri-State Regional Planning Commission.[9] The Tri-State region has an area of more than twice the size of the Tokyo commuting area.

9. The size of Tokyo commuting area is 6,400 square kilometers and is smaller than the Tokyo metropolitan area defined in table 5.3. Its population was 25.804 million. In 1980, the total number of passengers with commuting passes in this area per year was 7,117 million for the entire railroad system, while it was 1,486 million for subways. See Unyu Keizai Kenkyu Center (1989, 108–9).

Table 5.12 International Comparison of Subway Networks

City	Annual Volume of Passengers (millions) (*A*)	Kilometers of Services Provided (km) (*B*)	Annual Number of Kilometers Served (millions, km) (*C*)	Average Passengers per Operating Kilometer (*A*)/(*C*)
Moscow	2,417	184	408	5.9
Tokyo	2,181	199	230	9.5
Paris	1,376	295	248	5.5
Mexico City	1,038	78	134	7.7
New York	991	370	434	2.3
Osaka	857	91	74	11.6
Leningrad	763	73	141	5.4
London	498	388	325	1.5
Nagoya	414	58	47	8.9
Budapest	362	26	27	13.5

Source: Union Internationale de Transport Publique 1983.

If the population of New York were doubled, keeping the current commuting facilities intact, traffic congestion would become prohibitive. In this sense, the availability of a network of well-developed commuter railroads keeps the commuting cost in Tokyo lower than in New York. This may be the main reason why population size is higher in Tokyo than in New York.

Demand and Supply for the Railroad Systems

In Tokyo, a higher railroad-to-automobile ratio than in New York is demanded for commuting for two reasons.

First, the commuter train service runs more frequently in Tokyo than in New York, making a train ride more attractive to commuters in Tokyo than those in New York. For example, a Chuo Line train for Tokyo station stops at Mitaka every two minutes during the rush hour, but a New Haven Line train for Grand Central Station stops at Larchmont every twenty minutes; both Mitaka and Larchmont are thirty minutes away from the respective terminal stations.

Second, commuting cost from home to the nearby suburban train station is cheaper in Tokyo than in New York. Frequent and inexpensive bus service is available to most suburban train stations in Tokyo, while driving passenger cars is often necessary to reach suburban train stations in the New York area. Suburban communities in Tokyo were developed in such a way that the residents can walk, ride a bicycle, or take a bus to railroad stations, because suburbs were developed before motorization. The resulting high population den-

The Tri-State region is an area greater than the top seven PMSAs defined in table 5.3. In 1980, the total number of people commuting to work in this region was 1.443 million, while it was 1.150 million for subways. See Barry (1985, 17, 19).

sity in suburbs makes frequent bus service to the train station possible. In the New York area, where many suburbs were developed after motorization, it was taken for granted that most commuters drive cars to the suburban railroad stations. Hence suburban communities with low population densities emerged. As a result, relatively few people live within walking distance of a suburban train station, and bus service to many suburban train stations is not even available.

On the supply side, the railroad services in Tokyo are widespread and frequent for two reasons.

First, a higher level of fixed investment was made in the train system than in the highway system during the period when Tokyo was suburbanized. This is because the suburbanization of Tokyo took place before passenger cars became affordable to most residents.

Second, the high population density in the Tokyo area makes frequent commuter services profitable. Except for interest subsidies for certain types of investments, commuter train firms in Tokyo operate in the black without government subsidies.[10] This makes them remarkably different from their American and European counterparts.

An examination of demand and supply factors above implies that agglomeration economies exist in the production of mass transit services. Scale economies can always give rise to multiple equilibria. Once the density exceeds a critical level, an equilibrium in a metropolitan area is reached with high population density and with a profitable mass transit system. But if the critical level is not attained, a different equilibrium is reached, with a low density requiring passenger cars as a mode of commuting. It appears that the historical accident helped Tokyo reach the level of suburban density above the "critical level."

5.4.2 Underutilization of the CBD

Employment

The Tokyo metropolitan area has a population size twice as large as that of the New York metropolitan area, owing partly to a better-developed transit system. Thus it would be only natural if the CBD of Tokyo should have a higher employment density than that of New York.

In reality, the employment density of Tokyo is lower than that of New York; the space of the CBD area of Tokyo is considerably underutilized relative to that of New York. Three historical and institutional factors explain this phenomenon.

The first factor is the building code used to restrict the height of buildings in Japan until 1970, when advancement in aseismic construction technology made the restriction unnecessary. In the area with convenient traffic access,

10. See Nippon Min'ei Tetsudo Kyokai (1989, 12–13, 44–47).

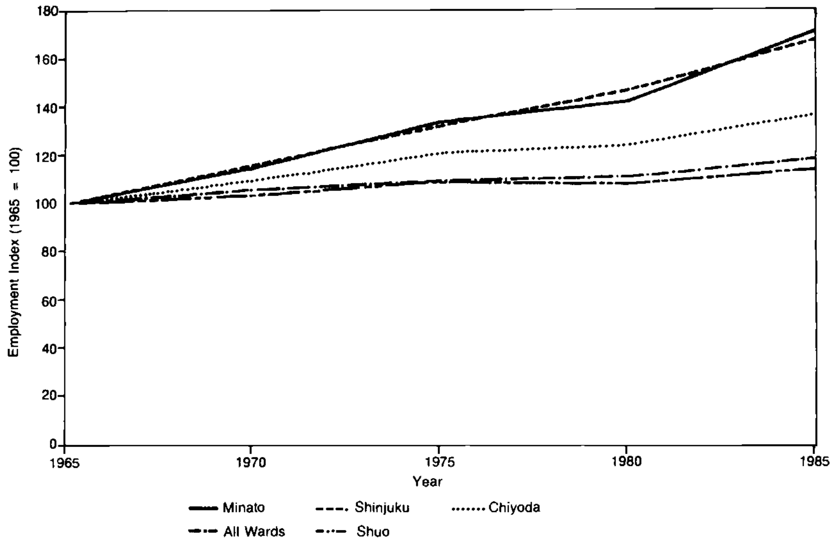

Fig. 5.9 Employment trend, central wards in Tokyo

low-level buildings had been constructed by the time the restriction was removed.

Second, Land Lease and Building Lease Laws have prevented conversions of one- and two-story residential housing into skyscrapers.[11]

Third, other restrictions on building size such as the Sunshine Law make construction of skyscrapers more expensive.

Owing to these historical and institutional frictions, therefore, Tokyo is out of equilibrium with respect to its CBD employment density. It appears, however, that the CBD in Tokyo is in the adjustment process and is moving toward an equilibrium with a high employment density. Evidence for this is that the employment in the Tokyo CBD has been rapidly expanding relative to the larger business districts, as figure 5.9 and table 5.13 indicate.

Besides, the market seems to realize that the CBD in Tokyo is in an adjustment phase. Noguchi (ch. 1 in this volume) points out that the land price in Tokyo is much higher than the present value of the future office rent stream if the rent is assumed to increase in proportion to GNP. When the potentially high employment density is realized in the future by overcoming the above frictions, a square kilometer of land in the CBD will be able to command a much higher land rent than now. In a competitive economy, such future productivity increases in land must be already capitalized in the present land price. Noguchi's observation seems to imply that the market expects such a rapid increase in the land productivity at the CBD.

11. See Noguchi (ch. 1 in this volume) and Ito (ch. 9 in this volume) for details.

Table 5.13 **Dynamics of Employment in the CBD of Tokyo (in thousands)**

	1965	1970	1975	1980	1985	Growth Rate 1965–85 (%)
Chiyoda	610	673	745	767	850	39.3
		10.3%	10.7%	3.0%	10.8%	
Chuo	565	587	621	619	658	16.5
		3.9%	5.8%	−0.3%	6.3%	
Minato	398	461	537	574	694	74.4
		15.8%	16.5%	6.9%	20.9%	
Shinjuku	300	351	400	446	512	70.7
		17.0%	14.0%	11.5%	14.8%	
Total, ward district	5,537	5,891	6,118	6,234	6,681	20.7
		6.4%	3.9%	1.9%	7.2%	

Note: The percentage under each employment figure gives the growth rate of employment in the preceding five years.
Sources: Japanese Agency of General Affairs 1986; Shutoken Seibi Kyokai 1988.

Moreover, the market seems to expect Tokyo to have an even higher CBD land rent than New York. Currently, we observe a higher CBD land price in Tokyo than in New York despite a lower employment density. It is certainly possible to explain a part of this gap in terms of the "bubble," as Noguchi does. But the gap is also consistent with the hypothesis that the market expects Tokyo to have a higher employment density in the CBD than New York will, to match Tokyo's larger population and employment in the entire metropolitan area. Suppose that the equilibrium is restored and the CBD of Tokyo attains a higher employment density than that of New York. Then agglomeration economies would enable Tokyo to have a higher labor productivity, and hence higher rents and land prices, than New York. The gap in the CBD land prices of the two cities is consistent with such a business expectation.

Residential Population

The population density of the CBD is also lower in Tokyo than in New York. But Tokyo's low CBD density does not require special explanations; the business sector can outbid the household sector for the CBD land use in any city in any country. Moreover, the three explanations for the low employment density in the CBD of Tokyo account for the low population density.

It is the high density in the CBD of New York that requires a special explanation, although we will not venture into this topic here except to note that strict zoning in New York protects residential areas in the middle of its CBD.

5.4.3 Flat Population Density Curve

Figure 5.3 shows that the population density curve for the suburbs of Tokyo is flatter than the curve for New York. One possible explanation may lie in the fact that the commuter trains in Tokyo maintain fast, accurate, and frequent services, which keep the per-kilometer cost of travel in Tokyo low.

In addition, employers' reimbursements of commuting expenses help keep the per-kilometer cost of travel low. Indeed, among those who bought commuter passes for the railroad in major metropolitan areas of Japan in 1985, only 5 percent paid the full amount of the commuting passes by themselves.[12] Employers reimburse commuting expenses because the additional wage payment earmarked to cover the commuting expenses, up to 50,000 yen per month, is not taxable under the personal income tax. This preferential tax treatment encourages employers to shift a portion of the initial total wage payment to the reimbursement of commuting expenses.[13]

Free commuter riding gives strong incentives to employees to live farther from the city center than otherwise. This flattens the population density and land price distribution from the CBD. Moreover, the free ride makes the city grow in terms of both geographical size and population. In 1985, the average commuter working in Chiyoda, Chuo, and Minato wards spent sixty-seven minutes in commuting one way, according to the Ministry of Transportation (1985).

5.5 The Land Price Function: The Model

In sections 5.5–5.7 we will expound on the impact of the reimbursement of commuting expenses by estimating the residential land price functions with and without reimbursement.

The basic idea for the estimation is simple. Tokyo commuters pay no monetary expenses for commuting. Hence the nonmonetary costs of commuting, time and fatigue, are the only reason why the land prices in Tokyo fall as the distance of a location from the CBD increases. Thus the observed land price distribution will reveal the nonmonetary costs of commuting, and we should be able to estimate the parameters of the utility function and the housing production function from the land price distribution. Once these parameters are estimated, we can derive the land price equation that would prevail when commuters have to pay their monetary commuting expenses as well.

The model we use is a formal version of the model developed in section 5.3. The readers not interested in technicalities may want to skip to section 5.7.3.

12. According to the Japanese Ministry of Transportation (1987, 164), 94.9 percent of those who bought commuter passes for the railroad in Tokyo, Osaka, and Nagoya metropolitan areas in 1985 received some reimbursement from their employers, 93.4 percent were reimbursed more than one-half of the purchase amount, and 86.5 percent received full reimbursement.

13. Suppose a firm decides to reimburse its employees' commuting expenses by appropriating a portion of the initial total wage payment. This action will reduce its employees' aggregate income tax payments without increasing the firm's total labor costs.

5.5.1 The Demand Price Equation

Consider a household that consumes h square meters of housing services, z units of composite consumption good, and ℓ minutes of leisure. Let

$$u(h, z, \ell) = h^{\beta} z^{1-\beta} \ell^{\alpha}$$

represent its utility function. Suppose that the hours of work is fixed. Let δ represent leisure endowment minus the sum of the time for work and the time required for minimum subsistence such as sleeping and eating. Then the leisure time ℓ is obtained by subtracting the commuting time from δ. Assume that the household is at a point with the commuting distance of x minutes from the CBD (hereafter we will refer to it simply as a point with distance x). Then we have $\ell = \delta - x$. We define the reduced utility function U by substituting this for ℓ in the function u to get

$$U(h, z, x) = h^{\beta} z^{1-\beta} (\delta - x)^{\alpha}. \tag{1}$$

We assume that the household located at a point with distance x maximizes its utility level under the following budget constraint:

$$r(x)h + z = Y - tx, \tag{2}$$

where $r(x)$ is the housing rent at distance x, Y is income, and t is the per-kilometer fare for commuting that the commuter has to pay. The unit of the compound good is so chosen as to make its unit price equal to one.

A consumer living at distance x will maximize the value of (1) subject to (2) by choosing h and z for the given Y, t, x, and $r(x)$. The maximum utility level that the household attains under the budget constraint is given by the indirect utility function $v^0(r(x), Y - tx, x)$.

It is assumed that the rural residents do not have to commute to work, and their utility level is $\bar{v}$. Since we assume that the household can freely migrate between the metropolitan area and the rural area seeking a higher utility level, the utility level of a household living in the metropolitan area has to be equal to that in the rural area, regardless of the distance of the residence from the CBD. At the equilibrium of the model, therefore, $r(x)$, $Y - tx$, and x have to satisfy[14]

$$v^0(r(x), Y - tx, x) = \bar{v}. \tag{3}$$

14. If the housing rent $r(t)$ at an x were so low that $v^0(r(x), Y - tx, x) > \bar{v}$ holds, every household would want to move to this location and the housing rent will be bid up until equation (6) is restored. Were $r(t)$ so high so as to make this inequality reversed, households would leave this location until equation (6) holds.

Merriman and Hellerstein (1993) use discrete choice techniques to estimate the parameters of utility function similar to equation (1) with the data on commuting flows in Tokyo. They find strong empirical evidence that commuters are sensitive to both land prices and commuting times when choosing residential locations.

Let

$$r(x) = r^*(Y - tx, x, \bar{v})$$

be the solution function for $r(x)$ in equation (3). Since Y, t, and $\bar{v}$ are constant in our model, this shows that the housing rent is a function solely of the commuting distance x. The function r^* is the *demand price equation* for the housing service at distance x. This is drawn in figure 5.6(b).

5.5.2 The Supply Price Equation for Housing Services

We assume that the production function of the housing service industry is given by

$$H(x) = \lambda L(x)^{\nu} K(x)^{(1-\nu)},$$

where $L(x)$ is the size of the land area that the housing service industry employs at distance x, $K(x)$ is the amount of capital that the housing service industry employs at distance x, and, $H(x)$ is the floor space of housing that the housing service industry produces at distance x. We assume that each firm maximizes profit under the given technological constraint, taking prices as given, and that free entry takes place in this industry, deriving the profit to zero. Then $r(x)$, the price of unit output of housing, must be equal to the unit cost. Thus we must have

$$r(x) = c(R(x), i),$$

where $c(R(x), i)$ is the unit cost function, $R(x)$ is the land rent at distance x, and i is the interest rate. This is the *supply price equation* for the housing service that governs the relationship among the housing rent $r(x)$, the land rent $R(x)$, and the interest rate i at the distance x from the CBD.

5.5.3 The Market Equilibrium

The market equilibrium requires that the demand and supply prices must be equal, and we have

$$c(R(x), i) = r^*(Y - tx; x, \bar{v}). \tag{4}$$

This equilibrium condition implicitly determines the land rent function. Let

$$R(x) = R^*(Y - tx, x, \bar{v}, i) \tag{5}$$

be the solution function for $R(x)$ in (4). This is depicted in figure 5.6(c).

Let us assume that the land price of a given location is the present value of the future stream of the land rent at that location. Then the land price function $P(x)$ is obtained by dividing (5) by i. Under our specifications of the utility and the production functions, $P(x)$ is explicitly written as[15]

15. First consider the following cost minimization problem for unit output:

$$\text{Min } r \equiv R\frac{L}{H} + i\frac{K}{H}$$

(6) $$P(x) = B(Y - tx)^{1/\beta\nu}(\delta - x)^{\alpha/\beta\nu},$$

where B is a constant containing i. Clearly, the first and the second parentheses on the right-hand side represent the contributions of the monetary and non-monetary commuting costs, respectively, in determining the land price. This is the basic equation in our model determining the land price at each distance from the CBD.

5.5.4 Estimation Procedure

Equation (6) is the land price equation to be estimated.

We cannot, however, directly estimate equation (6). The Japanese commuter does not have to pay the monetary expense of commuting, and hence $t = 0$ holds in (6), yielding

(7) $$P(x) \equiv C(\delta - x)^{\alpha/\beta\nu},$$

where $C \equiv BY^{1/\beta\nu}$. We will estimate the parameters C, $\alpha/\beta\nu$, and δ by running a regression of equation (7).

Although this does not give us an estimate of the parameter mix $1/\beta\nu$ that appears in equation (6), we can estimate it by taking advantage of the relation-

---

$$\text{S.T. } 1 = \lambda\left\{\frac{L}{H}\right\}^{\nu}\left\{\frac{K}{H}\right\}^{1-\nu}$$

The solution functions for L/H and K/H are

$$\frac{L}{H} = \frac{1}{\lambda}\left\{\frac{\nu i}{(1-\nu)R}\right\}^{1-\nu} \quad \text{and} \quad \frac{K}{H} = \frac{1}{\lambda}\left\{\frac{\nu i}{(1-\nu)R}\right\}^{-\nu},$$

respectively. At the free-entry, perfectly competitive equilibrium, the minimized unit cost is equal to the housing price. Hence we have

$$r = \frac{R}{\lambda}\left\{\frac{i\nu}{(1-\nu)R}\right\}^{1-\nu} + \frac{i}{\lambda}\left\{\frac{i\nu}{(1-\nu)R}\right\}^{-\nu}.$$

Thus we get the supply price function

$$r(x) = ER(x)^{\nu},$$

where

$$E \equiv \frac{1}{\lambda}\left[\frac{1}{\nu}\right]^{\nu}\left\{\frac{i}{(1-\nu)}\right\}^{1-\nu}.$$

The expenditure minimization under the given utility level $\bar{v}$ similarly specifies the demand price equation as

$$r(x) = A(Y - tx)^{1/\beta}(\delta - x)^{\alpha/\beta},$$

where

$$A \equiv \beta(1 - \beta)^{(1-\beta)}\bar{v}^{1/\beta}.$$

Equating the demand and supply price equations and applying the fact that $P(x) = R(x)/i$, we get equation (6), where

$$B \equiv \frac{1}{i}\left[\frac{c}{D}\right]^{1/\nu}.$$

ship between the land price function and the population density function. Define the population density function $M(x)$ by

$$M(x) = \frac{H(x)}{L(x)h(x)}$$

Then we obtain[16]

$$M(x) = \frac{1}{\beta\nu} \cdot \frac{i}{Y} \cdot P(x). \tag{8}$$

Since i and Y are constant, we can estimate the parameter mix $1/\beta\nu$ by running a regression of this equation.

5.6 The Land Price Function: Data

We estimate the land price function (7) and the population density function (8) by using the land price and population density data along the Chuo Line, which is a major commuter line in the Tokyo metropolitan area. (Figure 5.10 is a map of this line and a few stations along it.) The income variance of the suburban residents along different commuter lines is considered to be wider than that along a given line. In particular, the Chuo Line is among those that are recognized for the homogeneity of income and social class along them. Besides, this line takes commuters directly to the Tokyo station without transferring. These are our reasons for choosing the Chuo Line as our object of study.

To estimate the two equations we need the following data: residential land price per square meter (P), the number of households per square meter (M), and the commuting time cost (t) at various locations along the Chuo Line; the average income (Y); and the interest rate (i).

For the land price and the time distance, the government benchmark land prices (Koji Chika) of 1985 are employed. The data contain the land price, the name of the nearest train station, and the distance from the nearest train station for each sample. We employ only the residential household samples along the Chuo Line, but exclude those samples whose nearby stations are closer than Nakano station to the CBD. We deem that the land prices of the residential area to the east of Nakano station strongly reflect the commercial value of the land.

16. Since the production function of the housing service industry is Cobb-Douglas, the share of the land rent $R(x)L(x)$ in the total revenue $r(x)H(x)$ of this industry is ν. Thus we have $R(x)L(x) = \nu r(x)H(x)$. This and the definition of $M(x)$ yield

$$M(x) = \frac{R(x)}{\nu r(x)h(x)}.$$

When $t = 0$, on the other hand, the Cobb-Douglas utility function yields $r(x)h(x) = \beta Y$. Thus we get equation (8).

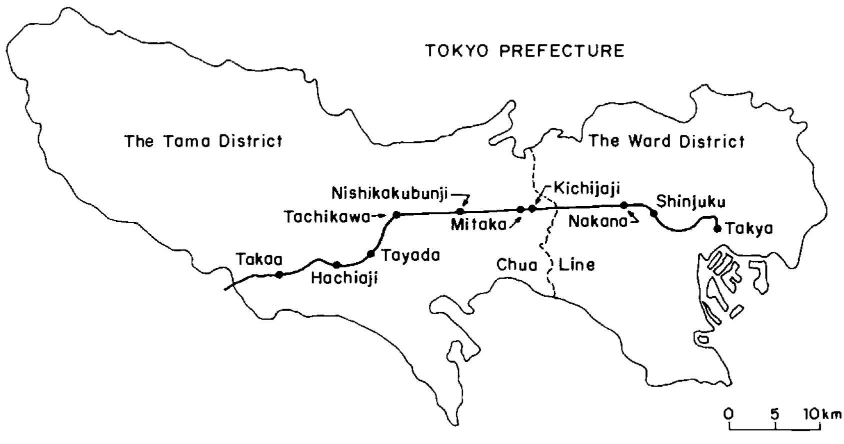

Fig. 5.10 Tokyo prefecture and the Chuo Line

Notes: The ward district consists of twenty-three wards, as shown in figure 5.4. The Tama district consists of counties and cities, some of which are listed in tables 5.5 and 5.6. Figure 5.2 locates Tokyo prefecture within the Tokyo metropolitan area.

Among these data we choose all that are located within 1.5 kilometers, that is, walking distance, of the nearest station. It would be difficult to estimate the commuting time between the train station and the residential location for those who live farther away from the train station for a number of reasons. First, they may use a variety of traffic modes. Second, even if we assume that most of them use buses, the bus route may be roundabout and the actual time cost of riding the bus may not be proportional to the geographical distance found in the data. Third, the different frequency of the bus service would greatly affect the actual time cost. Fourth, many passengers may take trains at stations that are not geographically closest to their residences. On the other hand, the households living relatively near the station mostly walk or ride a bicycle, and in case they use the bus, the time cost is likely to be monotonically related to the geographical distance from the nearby station.

Seventy-seven samples in the data satisfy the above qualifications. The unit of measurement of the land price in the present study is 10,000 yen per square meter.

The commuting consists of the trip from the residential location to the nearby station and the train ride from the nearby station to the CBD. We estimate the former from the data of the geographical distance between the residential location and the station. The latter is estimated from the data on the trip time by the rapid train (*kaisoku*) and by the special rapid train (*tokubetsu kaisoku*). The unit of measurement of the time distance from the CBD is minutes required for one-way commuting per day. Table 5.14 lists the one-way commuting time to Tokyo station from each station of the Chuo Line west of

Table 5.14 **Time Distance from Tokyo Station**

		One-Way Commuting Time		
Station[a]	S	Rapid Train	Special Rapid Train	X[b]
*Shinjuku	0	14	14	14.00
Okubo	0	16	16	16.00
Higashi Nakano	0	18	18	18.00
*Nakano	0	18	18	18.00
Koenji	0	20	20	20.00
Asagaya	0	22	22	22.00
Ogikubo	0	24	24	24.00
Nishi Ogikubo	0	27	27	27.00
Kichijoji	0	29	29	29.00
*Mitaka	1	32	28	27.53
Musashi Sakai	0	34	30	31.63
Higashi Koganei	0	36	33	34.22
Musashi Koganei	1	39	36	35.12
Kokubunji	0	42	38	39.63
Nishikokubunji	0	44	40	41.63
Kunitachi	0	46	42	43.63
*Tachikawa	0	54	40	45.69
*Hino	0	57	43	48.69
*Toyoda	0	61	46	52.10
*Hachioji	0	65	50	56.10
*Nishi Hachioji	0	68	54	59.69
*Takao	0	72	57	63.10

Source: Japan Travel Bureau 1985.

[a]Asterisks indicate the stations where special rapid trains stop.

[b]The constructed time distance.

Shinjuku. Figure 5.11 shows the relationship between the time distance, which is estimated by the procedure discussed later, and the land price.[17]

The benchmark land price data do not include population density in the location of each sample. We use the census data of 1985 instead. First, for each of our samples, we compute the population density (N) in the basic cell district of the survey in which the sample is located. (Each cell is five hundred meters square.) Second, assuming that each household has one commuter to the CBD, we estimate the density of the commuters denoted M by $M = N/2.52$, where 2.52 represents the average number of household members in Tokyo metropolitan prefecture, based on the *Basic Survey of the Residents* of 1985.

For the sake of consistency, we use the same time period in measuring com-

17. Each selected station in figure 5.11 shows the one-way commuting time distance to the Tokyo station. On the other hand, each sample in the figure is located at the time distance that includes the commuting time from home to the nearby station as well as the time from the nearby station to the Tokyo station. Thus samples for which the nearby station is Mitaka are shown in the figure midway between Mitaka and Tachikawa, for example.

muting time, interest rate, income, and commuting expense. Since we have used one-half day for the strategic variable of commuting time, we also use one-half day for measuring the other two variables. It is assumed that commuters work twenty-two days a month. To convert monthly figures of income and interest into a half-day basis, we therefore divide them by forty-four.

We assume that the personal income of all of the residents in the metropolitan area is constant regardless of the distance from the CBD. Our estimate of income of the representative resident is based on the figure of 4,932 thousand yen, which is the average annual earnings of an employee in the Tokyo metropolitan prefecture in 1985, as reported in Japanese Economic Planning Agency (1988). Assuming that there is only one employee (i.e., commuter) in each household, monthly income per household is 493.2/12 = 41.1 (10,000 yen per one-half day). Half-day income per household is y = 41.1/44 = 0.93409.

As for the data of interest rates, we employed the national average loan interest rate of banks converted to one-half day as reported by the Japanese Economic Planning Agency (1989), which is 0.012 percent.

5.7 Land Price Function: Estimation

5.7.1 Estimation of Equation (7)

Before explaining the estimation procedure, let us first state the final form of our estimation of equation (7):

$$P = e^{-9.7091+D}(174.89 - X)^{2.6750}, \tag{9}$$

where D is the dummy variable for the samples near Nakano and Kichijoji stations (see fig. 5.10). The variable D takes the value of 0.23309 for the sam-

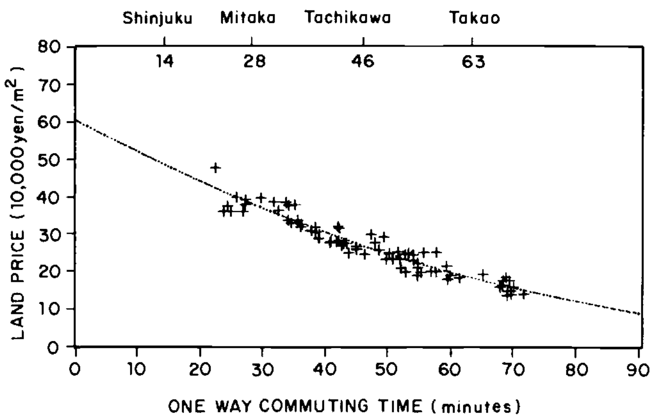

Fig. 5.11 Land price distribution

ples near Nakano station, 0.1458 for those near Kichijoji station, and zero for all other samples. It reflects the fact that the residential land prices of Nakano and Kichijoji are shifted upward because of their proximity to the commercial districts. Figure 5.11 gives a scatter diagram of $(X, P/e^D)$ combinations, which means that the samples of Nakano and Kichijoji are adjusted by the dummy variables. This figure also depicts the graph of equation (9) with $D = 0$.

The time distance variable X is the sum of the trip time from home to the station and the trip time on the train, and it is defined by

$$X = 5.2911L + (X_R + 0.59332D_E - 2.0969S), \quad (10)$$

where L is the geographical distance between the residential location of the sample and the nearby station; X_R is the time period of a one-way ride by rapid train between Tokyo and the nearby station of the sample; X_E is the time period of a one-way ride by special rapid train between Tokyo and the nearby station of the sample; $D_E = X_E - X_R$ if the special rapid train stops at the nearby station of the sample, and zero otherwise (the special rapid train stops at Mitaka, Tachikawa, and all the stations to the west of Tachikawa); and S is the dummy that takes the value of one for the samples near Mitaka or Koganei and zero otherwise.

The coefficient of L indicates that it takes an average commuter 5.2911 minutes per kilometer (approximately 11 kilometers per hour) to make a trip between residence and station. This implies that many of the residents living within 1.5 kilometers of a station use either bicycles or buses.

The terms in the parenthesis of equation (10) represent time spent on the train. If the special rapid trains do not stop at the nearest station for the given sample, and if the station is not Nakano or Mitaka, both D_E and S take the value of zero, and hence the time cost of the train ride is equal to the time required by the rapid train.

If special rapid trains stop at the nearby station of a given sample, and if the station is not Nakano or Mitaka, the terms inside the parentheses become

$$X_R + 0.59332\, D_E = 0.40668\, X_R + 0.59332\, X_E.$$

This implies that the resident living near a station where special rapid trains stop takes these trains about 60 percent of the time and rapid trains 40 percent of the time.

An additional number of trains run between Koganei and Tokyo stations, and even more trains run between Mitaka and Tokyo stations. This means that the passengers from Koganei or Mitaka for Tokyo can take the unoccupied trains that originate at these stations, and the passengers have a better chance of getting seats rather than standing during the train ride. The coefficient of S indicates that this privilege is worth the extra 2.1 minutes of the train ride, or 4.2 minutes per day.

Finally, note that equation (9) indicates that $\delta = 175$ (minutes per one-half day). the value of δ, therefore, is approximately six hours per day, a quite reasonable number in view of its definition.

Equation (9) is based on the following estimation based on the maximum likelihood method:

$$\log P = \underset{(-0.8822)}{-9.7091} + \underset{(3.3644)}{0.2331D_N} + \underset{(2.7875)}{0.1452D_K}$$

$$+ \underset{(1.4189)}{2.6750}\log[\underset{(1.9689)}{174.89} - \{\underset{(3.2247)}{5.2911L} + (X_R + \underset{(4.1913)}{0.59332D_E} - \underset{(-2.6358)}{2.0969S})\}],$$

$$R^2 = 0.923748,$$

where the numbers in the parentheses are t values.

5.7.2 Estimation of Equation (6)

Let us now derive equation (6). For this purpose, we need to estimate $1/\beta\nu$ by estimating the population density function, as we argued earlier. The OLS estimate of (8) is

$$M = \underset{(36.3666)}{5.58861} \cdot \frac{i}{Y} \cdot P, \qquad \hat{R}^2 = 0.686902.$$

Thus we obtain

$$\text{(11)} \qquad \frac{1}{\beta\nu} = 5.5886.$$

Finally, we have to estimate t in equation (6). We assume that for our samples households have to pay monetary travel expense only for the train. Thus we run a regression of the half-day-equivalent of the cost of a one-month train pass (Z, unit 10,000 yen) against commuting time required for a one-way trip to Tokyo station.

$$F = \underset{(118.20)}{0.00065824}\, X \qquad \hat{R}^2 = 0.951762$$

Thus our estimate of t is 0.00065824.

From this, (6), (9), and (11), we obtain the following:

$$\text{(12)}\ P = e^{-9.32806+D}(0.93409 - 0.00065824X)^{5.5886}(174.89 - X)^{2.6750.}$$

The power of e is chosen so that the right-hand sides of equations (9) and (12) give the same land price when $X = 0$. Equation (12) gives the land price at the hypothetical residential location with a zero distance to the station that is X minutes away from the Tokyo station.

5.7.3 Implications of the Estimated Land Price Function

The thick line in figure 5.12 depicts the graph of equation (12) for the case where $D = 0$. This shows the land price function after commuters are made to pay the train fare equal to the commuter pass in 1985. The dotted line of figure 5.11 is duplicated in figure 5.12. The difference between the two curves shows

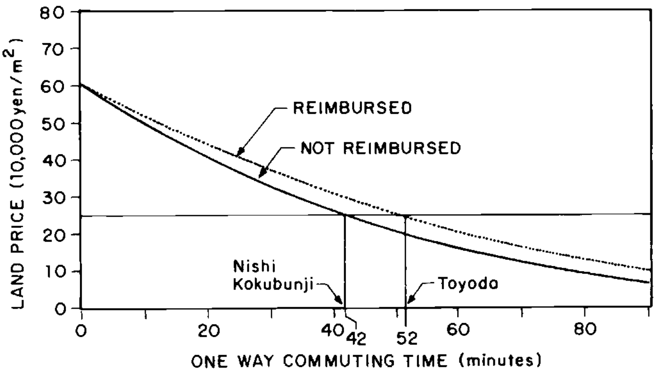

Fig. 5.12 The effect of fare reimbursement upon land prices

the effect of the reimbursement of the commuting fare on the structure of the land price in the Tokyo metropolitan area. For example, figure 5.12 indicates that the land price that was realized at Toyoda, which is fifty-four minutes away from Tokyo in 1985, would have been realized in Nishikokubunji, which is forty-seven minutes away from Tokyo.

It should be noted at this point that the effect of stopping reimbursements represented by figure 5.12 is a long-run effect that would be realized after the emigration process from the urban area had been completed. Immediately after the reform, the utility level of the suburban residents living near the border would be reduced. People living closer to the city center, who have lower commuting costs, would suffer a milder loss in utility. It is perhaps unrealistic to assume that many suburban residents can change jobs and emigrate to the rural area within several years after the reform. But it is likely that many of them would migrate to a location closer to the city center, keeping their jobs at the CBD. This would increase the land price curve near the CBD more than figure 5.12 indicates until the urban utility became equal regardless of location. This would discourage young people looking for jobs for the first time from working in the Tokyo metropolitan area. The population size of the metropolitan area would be reduced, and the urban land price curve would come down in the long run until the land price curve as indicated by the thick line of figure 5.12 is restored. In this sense, figure 5.12 represents the long-run impact of stopping of reimbursement.

As pointed out earlier, firms in Tokyo reimburse the commuting expenses of their employees because of the preferential treatment of the commuting expenses in personal income taxes. We can interpret the thick curve in figure 5.12 to represent the land price curve after the preferential tax treatment is eliminated.

Let us now decompose the effect of the elimination of the deductibility of commuting expenses in two stages. Suppose that in the first stage the firms continue to reimburse commuting expenses, and that only at the second stage do the firms stop reimbursement. At the first stage, a Tokyo resident has to pay income tax for the reimbursement, which becomes his only monetary commuting expense. In this first stage, the land price curve will become steeper than the dotted curve in figure 5.12, but its change will be smaller than the change indicated by the thick line.

This, however, is not the end of the story for the first stage. Since the government subsidy for commuting is now eliminated, the population size of the Tokyo area will shrink. Proposition 2 indicates that this will reduce the CBD productivity. Thus the land price curve in the first stage has to start at a point lower than the y-axis intercept of the dotted curve in figure 5.12.

At the second stage, firms stop reimbursements. A firm adds the average of what it formerly paid as the reimbursement to the regular wage rate. This incremental payment, which is lump sum regardless of the residential locations of the workers, will raise the y-axis intercept of the land price curve.

Thus the first- and the second-stage effects work in opposite directions on the y-axis intercept, and the net effect is uncertain. Our thick curve in figure 5.12, starting at the same point as the dotted curve, may be taken as an approximation to this net effect.

5.8 Policy Implications

There are varied opinions as to whether the expansion of the population size of the Tokyo metropolitan area should be encouraged or discouraged. Kakumoto (1986), for example, reasons that investment in infrastructure in the business districts of Tokyo should be discouraged, because the commuting capacity has reached its limit. Hatta (1983), on the other hand, argues that, once the commuter industry is deregulated, the fare structure and the capital equipment size in the commuter industry will become optimal. He claims that given such deregulation, the government should encourage the expansion of employment in Tokyo so that the economy can take full advantage of agglomeration economies.

In this section, we examine the policy implications of our theoretical and empirical observations in earlier sections. In the process, we discuss the issues of whether the population of Tokyo has exceeded its efficient size and whether capital stocks in transportation and in the CBD infrastructure are at their efficient levels.

5.8.1 Efficiency Measure

We first need to establish a measure of efficiency. For this purpose, let us examine the welfare impact of a productivity improvement in the CBD in the model of section 5.3. By assumption, producers are competitive, and hence earn zero (economic) profit both before and after the productivity change. Also by assumption, people are mobile, and hence if there is any improvement in the urban living standard, rural residents will migrate into the city until the land price curve is shifted up by such an amount that the living standard at any location of the city becomes equal to the rural level. In the end, the owners of land—the immobile factor—reap all the benefit of the technological change.

Proposition 3. If productivity improvement takes place at the CBD, all of its fruits fall on the landowners. No one else makes economic gains: producers continue to get zero profits, and the living standard of the urban resident remains exactly the same as that of the rural resident.

In the model of section 5.3, therefore, the efficiency impact of technological improvement is measured by the increase in the total land value.

5.8.2 Urban Land Tax

The fruit of technological progress that goes to the landowners can be recouped and be shared by others if the land tax is imposed on the difference between the value of such urban land and the value of rural land the same size.

The urban land tax is an efficient tax. It will reduce the urban land price curve, but the sum of the urban land price and the present value of the future land tax obligations remain the same as the pretax land price at any location. This tax therefore will not affect the population density curve or the city size.

Often an urban land tax has been proposed in Japan on efficiency grounds, since it is considered to discourage the idle use of land. But this tax is neutral on efficiency. Its virtue lies in its redistribution capacity.

5.8.3 Government Subsidies for Commuting

The government subsidies on commuting expenses reduce efficiency. To see this, take a worker who commutes to the CBD from the city border. For him the rural wage rate is equal to his net urban wage rate. His net social productivity in the city is equal to his net urban wage rate minus government subsidies for commuting, while his social productivity in the rural economy is equal to the rural wage rate. Thus his net productivity is higher in the rural area than in the city by the amount of government subsidies. Social efficiency would require him to work in the rural economy. This indicates that the preferential tax treatment on commuting expenses creates inefficiency.

5.8.4 Efficient Fare Structure

Tokyo's commuter trains are notorious for their rush hour congestion. Indeed, the congestion rate during the rush hours in the national railroad in the Tokyo metropolitan area was estimated to be 244 percent, where the National Land Agency (1987) defines the congestion rate of 100 percent as a situation where "passengers can either be seated or hold onto poles or hanging rings comfortably."[18]

18. When the rate is 200 percent, "passengers feel considerable pressure from each other but can manage to read weekly magazines." When the degree is 250 percent, "passengers cannot move

Whether or not this is an excessive level of congestion for Tokyo, however, requires scrutiny. For this purpose, examining the fare structure is useful. Hatta (1983) has shown that in a large metropolitan area where many commuter railroad companies compete for customers, free market fare setting and no limitations on investment would automatically internalize congestion, resulting in efficient marginal cost pricing and efficient investment.

Thus the current free-ride system in Tokyo inefficiently encourages the demand for transit rides, causing an excessive degree of congestion during the rush hour and for a long-distance ride. Requiring the commuters to pay the current commuter-pass fares would reduce congestion and improve efficiency. In deriving the thick line in figure 5.12, we assumed that after the tax reform the commuters have to pay the train pass fares of 1985.

These commuter-pass fares, however, are much lower than profit-maximizing ones, and hence are below the socially efficient levels. This is because the following regulations force Japanese railroad companies to set pass fares artificially low: (1) A discount of approximately 50 percent is given on the commuter pass, making the peak-load fare 50 percent less than the off-peak fare. (2) Fares are set on a per-kilometer basis regardless of the degree of congestion. (3) Full cost pricing is required.

If correct peak-load prices were imposed on passengers, therefore, the fares during the rush hour would have to rise substantially beyond the monthly pass rates assumed in our study. Note that the inefficiently low fares not only cause excessive congestion in the short run, but also stymie incentives for the commuter rail firms to invest in improving the service in the long run.

If these regulations as well as the tax deductibility of commuting expenses were eliminated, the land price curve in figure 5.12 would become substantially steeper than the thick line. Besides, through the effect indicated by proposition 2, the y-axis intercept would come down. It is possible that the Tokyo population would be reduced. Our equation (12) can be modified for studying the impact of a further fare increase.[19]

5.8.5 Subsidizing the CBD Production

So far in this section we have explicitly ignored the agglomeration economy of the CBD production. Once this is taken into account, a free market mecha-

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hands." When the degree reaches 300 percent, the official description states that "passengers can be physically endangered."

19. If train fares were increased to the level of the social cost of commuting, the combined monetary and nonmonetary commuting cost would not increase as much because of the reduced congestion level. In the long run, the offsetting reduction in the combined commuting cost would become even stronger for the following reasons: The fare increase would cause a substantial excess profit, since by and large Japanese commuter lines already make a profit. When profit induced the competitive commuter lines to expand, congestion would further decline, and the nonmonetary trip cost would be further reduced to offset the increase in monetary trip cost even more. Despite this possibility of moderation, increasing the fare to the efficient level would increase the combined commuting cost. After all, current commuters are facing the average rather than the marginal cost of congestion.

nism alone does not attain efficiency; the government needs to deliberately encourage production in the CBD area, since the proximity of many offices in a concentrated area increases productivity. Such policy measures include (1) elimination of the status quo–preserving regulations on construction and lease laws, (2) subsidies on the construction of high-density buildings in the CBD, and (3) an increased investment in the infrastructure in the CBD, such as water, sewage, and local streets, so as to accommodate high-density employment.

5.8.6 Summary

Efficiency requires two sets of policies. The first is the CBD development policies, such as revamping construction and lease laws, heavily investing in the infrastructure of the CBD, and subsidizing high-rise building construction. The second is marginal cost pricing of transportation and public utility services, such as the elimination of preferential treatment of commuting expenses, deregulation of fare and investment determination in the commuter industry, increasing the price of water, and charging a congestion tax on parking places.

The CBD development policies would increase the employment and population sizes, while making the employment density curve steeper. The marginal cost pricing would make the employment and population sizes smaller and the density curves steeper.

Thus various policies and regulations governing Tokyo have affected both population and employment sizes in conflicting directions relative to the efficient sizes. It is not clear whether Tokyo has exceeded optimal size. What is clear is that population and employment are allocated inefficiently within the metropolitan area. The current policies and regulations have consistently made both density distributions flatter than efficiency requires.

5.9 Conclusion

In the present paper, we compared the population and employment structures of the metropolitan area of Tokyo against those of New York. We made three empirical observations and explained the difference in the framework of the Mills-Muth urban model.

First, Tokyo is twice as large as New York with respect to both population and employment. The well-developed mass transit system in Tokyo is an essential factor that supports this size. In order for a mass transit system to be economically viable for the suppliers and convenient for the commuters, a critical level of suburban population density is necessary. Only then can the train system and the suburban bus system supply frequent service. The fact that the suburbanization of Tokyo took place before motorization occurred helped Tokyo attain a level of suburban density above the "critical level."

Second, the CBD of Tokyo is underused in terms of both employment and residential population densities. This may be explained by the technological limitations that existed until 1970 regarding constructing aseismic skyscrapers and by the Land Lease and Building Lease Laws.

Third, the residential area of Tokyo is more spread out, and its suburban population density curve is flatter than that of New York. This can be explained by the lower cost of commuting time due to the well-developed suburban transit system. In addition, it may be explained by the fact that the commuting expenses of the employees in Tokyo are reimbursed by their employers, which in turn is caused by the exclusion of commuting expenses under the personal income tax in Japan. Our empirical results shown in figure 5.12 demonstrate a substantial impact of this preferential tax treatment of commuting expenses upon the land price structure of the Tokyo metropolitan area.

The low cost of commuting time in Tokyo resulting from the well-developed commuter train system, which has enabled Tokyo to attain a large population size and high population densities in the suburban areas, explains the high residential land prices in Tokyo. Besides, government subsidies through preferential tax treatment make the land prices in the suburbs even higher.

On the other hand, high land prices should be accompanied by high employment densities in the business district. In the Tokyo CBD, however, relatively high land prices are accompanied by relatively low employment densities. This appears to reflect the fact that the Tokyo CBD is in the adjustment process toward an equilibrium with a high employment density as a result of the removal of the technological constraint on aseismic construction. In other words, the market seems to have capitalized the future high CBD productivity that will be attained when the potentially high density is realized in the eventual equilibrium. Also, a more rapid increase in the employment density at the CBD relative to the surrounding business districts seems to confirm that the Tokyo CBD is in the adjustment process.

Finally, we examined the normative economics of Tokyo. It was shown that a combination of the following two policies will attain an efficient resource allocation in the Tokyo metropolitan area: (1) a major redevelopment in the infrastructure of the CBD and (2) a substantial increase in the commuter fares through deregulation and the elimination of the preferential tax treatment.

These two policies will have offsetting effects on the total population size: the first will encourage the population inflow into the metropolitan area, while the second will discourage it. Thus the efficient size of the population in Tokyo may be greater or less than its current size. The efficient population and employment densities achieved by the above policies will be steeper than the current ones.

The two policies will also make the land price curve steeper. The first policy seems already expected as inevitable, and its future effects are capitalized in the current land prices in the CBD, but the second policy will reduce the land prices in the suburbs. In other words, to improve efficiency in the Tokyo metropolitan area, a substantial increase in the train fares is necessary, which in turn will depress the suburban land prices sharply.

References

Alperovich, G. 1990. An Empirical Test of a Model of the Urban Housing Market. Mimeo.

Barry, J. J. 1985. 1980 Census Comparisons No. 13: Tri-state Region, Journey-to-Work Tables, County-to-County. New York Metropolitan Council.

British Central Statistical Office. 1989. *Regional Trend 1989.* London: Central Statistical Office.

CACI. 1990. *The Sourcebook of Zip Code Demographics.* 7th ed. Arlington, VA: CACI Marketing Systems.

Hatta, T. 1983. Competition and Nationally Optimum Resource Allocation under the Presence of Urban Traffic Congestion. *Journal of Urban Economics* 14:145–67.

Haurin, D. R. 1983. The Effect of Reimbursement on Worker's Transport Costs: The Case of Urban Areas in Japan. *Journal of Urban Economics* 13:205–15.

Institut Nationale de Statistique de la France (INSEE). 1988. *Annuarire Statistique de la France.* Paris: INSEE.

Japanese Agency of General Affairs. Statistical Bureau. 1985. *Population Census of Japan.* Vol. 5. *Commutation; Part 4: Means of Transport to Work or to Attend School.* Tokyo: Ministry of Finance Printing Office.

———. 1986. *1986 Establishment Census of Japan.* Vol. 2. *Results for Prefectures; Part 13: Tokyo-to.* Tokyo: Ministry of Finance Printing Office.

Japanese Economic Planning Agency. 1989. *Keizai Yoran* (Economy in brief). Tokyo: Ministry of Finance Printing Office.

———. 1988. *Kenmin Keizai Keisan* (the annual report on prefectural accounts. Tokyo: Ministry of Finance Printing Office.

Japanese Ministry of Home Affairs. 1985. *Jumin Kihon Daicho ni Motozuku Zenkoku Jinko-Setai-su Hyo* (The basic survey of the residents). Tokyo: Ministry of Finance Printing Office.

Japanese Ministry of Transportation. 1987. *Daitoshi Kotsu Sensasu 1985* (Transportation census of metropolises 1985). Tokyo: Ministry of Finance Printing Office.

Japanese National Land Agency. 1985. *Chika Koji* (Government benchmark land prices). Tokyo: Ministry of Finance Printing Office.

Japan Travel Bureau. 1985. *Timetables, July 1985.* Tokyo: Japan Travel Bureau.

Kakumoto, R. 1970. *Toshi Kotsu Ron* (Urban transportation). Yuhikaku Press.

———. 1986. *Tokyo mo Bocho o Tomeru.* (Tokyo will also stop expanding). Tokyo: Waseda University Press.

Kau, J. B., and C. F. Sirmans. 1979. Urban Land Value Functions and Price Elasticity of Demand for Housing. *Journal of Urban Economics* 6:112–21.

Kobayashi, M., M. Komori, and H. Sugihara. 1990. Tokyo Ikkyoku Shuchu o Kangaeru (On the recent phenomenon of centralization into Tokyo). *Chosa* no. 142. Tokyo: Japan Development Bank.

Merriman, D., and D. Hellerstein. 1993. Compensation for Commuters in the Land and Labor Markets: Some Evidence from the Tokyo Metropolitan Area. Mimeo.

Mills, E. 1967. An Aggregative Model of Resource Allocation in a Metropolitan Area. *American Economic Review* 57:353–59.

———. 1972. *Studies in the Structure of the Urban Economy.* Baltimore: Johns Hopkins University Press.
Mills, E., and B. W. Hamilton. 1984. *Urban Economics.* 3d edition. Glenview, Ill.: Scott Foresman.
Mills, B., and K. Ohta. 1976. Urbanization and Urban Problems. In H. Patrick and H. Rosovsky, eds., *Asia's New Giant.* Washington, DC: Brookings Institution.
Muth, R. F. 1969. *Cities and Housing.* Chicago: University of Chicago Press.
New York City. Department of City Planning. 1988. *Community Districts: Facts-at-a-Glance: Manhattan.* New York: Department of City Planning.
Nippon Min'ei Tetsudo Kyokai (Japan Association of Nongovernment Railways). 1989. *Oote Mintetsu no Sugawo.* (The true picture of large nongovernment railway companies). Tokyo: Nippon Min'ei Tetsudo Kyokai.
Ohkawara, T. 1985. Urban Residential Land Rent Function: An Alternative Muth-Mills Model. *Journal of Urban Economics* 18:338–49.
Shutoken Seibi Kyokai. 1988. *Daitoshi Ken no Seibi* (Refurbishment of great metropolitan areas). Tokyo: Shutoken Seibi Kyokai.
Union Internationale de Transport Publique. 1983. *UITP Handbook.*
U.S. Bureau of the Census. 1986. *State and Metropolitan Area Data Book 1986.* Washington, DC: U.S. Government Printing Office.
Unyu Keizai Kenkyu Center. 1989. *Toshi Kotsu Nempo* (Annals of urban transportation). Tokyo: Unyu Keizai Kenkyu Center.

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