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Do Urban Amenities Drive Housing Rent?*

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Abstract

What brought the concentration of people to certain areas? And how much are households prepared to pay in exchange for being part of such concentrations? Focusing on the Tokyo metropolitan area, which is one of the world's largest urban areas, this paper aggregates individual data relating to urban amenities in small areas and explores its relationship to population concentration, as well as clarifying its relationship to rent (housing service prices). It is understood from the obtained results that a concentration of urban amenities produces population concentration and also raises housing rent. In addition, it is shown that when measuring the degree of amenity concentration, it is the diversity of amenities, not simply the total number of amenities that is important. Concentration of diverse amenities enhances an area's appeal, and as a result, households will seek to reside there even if rents are high. Among the various types of amenities, it was observed that amenities such as recreational classes, educational facilities and convenience facilities such as restaurants have positive externality. On the other hand, a clear negative relationship was found between housing rent and amenities with negative externality, such as cemeteries and video arcades.

JEL Classification: C31 - Cross-Sectional Models; Spatial, R31 - Housing Supply and Markets.
Key Words: amenity concentration; population concentration; housing service prices; hedonic approach; Geographic Information System (GIS).

1 Introduction: Urban Amenities and Rent

What brings about the growth of cities?

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In recent years, the concept of urban growth has gained increasing importance. Storper and Scott (2009)[26] argued that the growth of cities is profoundly related to characteristics of residents in cities and how the population characteristics change over time. Cities are defined as places that attract many and diverse people, and they promote sharing, exchanging, and generating new information (Florida 2009[7], Jacobs 1969[14]). Because of these characteristics of cities, Jacobs (1969)[14] and Florida (2009)[7] mentioned that cities can generate new ideas and technologies that make possible their strong and stable growth.

In other words, the growth of cities today depends heavily on the skills of the people attracted to them—especially their creativity, which generates new knowledge, ideas, and technology. Clark (2004)[4] and Howkins (2002)[13] argued that, unlike past days, the most important driver of economic growth is not land or capital, but people's creativity. Knowledge and ideas, as the nature of public goods, are repeatedly and endlessly transmitted and shared among people, and new ideas are generated by linking them to other ideas (Storper and Scott 2009[26]). Based on this characteristic, cities—places where many people gather and interact—are advantageous in terms of producing new creative knowledge and ideas, and it encourages their continuous development (Jacobs 1969[14], Florida 2009[7]).

How, then, can we stimulate the migration and concentration of the creative class which supports the growth of cities? It has been noted that, to decide where to live, creative people have a tendency to place importance on cultural factors—especially lifestyle quality, typified by access to urban amenities (hereafter referred to as "amenities")—rather than economic factors such as high wages and low rent (Glaeser et al. 2004[11]; Adamson et al. 2004[1]). Vibrant music and arts communities, movie theaters, restaurants, grand buildings, high-quality schools, libraries, museums, and so forth have been mentioned as specific examples of amenities which improve people's lifestyle quality (Silver et al. 2010[25]). In terms of the reasons why people have come to focus on cultural consumption opportunities produced by such amenities, it has been mentioned that there has been a shift from an economic structure mainly comprised of labor-intensive companies to one now dominated by information- and knowledge-based industries, so people have more opportunities to take advantage of free time and leisure in their daily lives (Fogel 2000[8], Glaeser et al. 2004[11]). In the wake of this trend, it has been said that the role of cities has also shifted from being a "place of production" to a "place of consumption" (Glaeser et al. 2004[11]). In other words, the "cultural consumption" available in a city has become a key factor in determining whether it can attract the creative class who will support its development. Florida (2002)[6] has shown in particular that it is important for cities to provide for more diverse and plentiful cultural consumption in order to attract the affluent class and the creative class.

There are various indicators that show the degree of a city's growth, such as increased employment opportunities, growth of the overall residential population or of the affluent class population, and rises in income or rent. Based on these indicators, many studies have established that amenities have an impact on the growth of cities. For example, past research has shown that there is a strong association between amenities and the social attributes of local residents. It is recognized that there is a relationship between the social attributes of local residents and the accessibility of parks, green spaces, medical facilities, elementary schools, and many other amenities, and it has been shown that in many cases, the affluent class has superior access to such amenities, and that amenities tend to attract this demographic group (Yasumoto et al. 2014[30], Comber et al. 2008[3], Christie and Fone 2003[2], Talen 2001[28]).

Furthermore, Glaeser et al. (2001)[10] have shown that in the United States, cities with more amenities have greater population, whilst Navarro et al. (2012)[16] have demonstrated that in Spain, higher income groups live in cities where opportunities for higher quality of cultural consumption through amenities are available. Although several indicators of urban growth (i.e. the total population or increases in the affluent class, changes in people's labor-related circumstances such as income) have already tested in previous study, there are few studies that focused on rent fluctuations as a city growth indicator. If one considers a city's land supply as fixed, population fluctuations will be reflected on the economic market as rent fluctuations. In other words, via the rental market, it is possible to measure how much households are prepared to pay in exchange for a concentration of amenities.

Based on the above points, this paper analyzes how various types of amenities impact rent and the characteristics of people drawn to live in the vicinity of these amenities. Specifically, focusing on the Tokyo metropolitan area, which is one of the world's largest urban areas, it aggregates individual data relating to amenities at the small area level and explores its relationship to population concentration, as well as clarifying its relationship to housing rent. The results obtained show that along with a concentration of amenities, the diversity of these amenities is a key factor. This result is consistent with Florida (2002)[6]'s finding that the diversity of amenities is important for the growth of cities.

2 Empirical Model and Data

2.1 Small Area Data

Prior to the analysis, we shall examine the spatial distribution of amenities, population, and housing service prices. For population-related statistics we used the 2010 census, while for amenity-related data, we used Zenrin telepoint data,'Tel Point Pack!'[*1] In addition, for analysis using small areas, it is important to consider what kind of spatial unit should be used.

For this paper, we decided to conduct analysis using a mesh of 500-meter square blocks. In analysis that aims to clarify changes over time in the population composition for each area based on information obtained from the census, how the census district boundaries change over time is highly significant. Also, for cross-sectional analysis, there were many cases where comparative analysis of all data at the same survey time was difficult.

However, in cases where census data is not published based on mesh blocks, like in the U.S., and only census data compiled based on census districts whose boundaries change over time (Census track, zip code, etc.) is available, it is difficult to determine whether a given change in population composition over time occurred because the census district boundary changed or due to some other factor (Mohai 2008[15], Saha and Mohai 2005[20]). In the U.K. and other countries, there are many cases where mesh block statistics are not published, and if conducting similar research in such countries, considerable resourcefulness and effort may be needed in order to circumvent this problem (for an example of such effort, see Saha and Mohai 2005[20]). Moreover, in cross-sectional analysis, a similar problem may happen to combine data for which the survey time varies.

With regard to this issue, as demonstrated by their actual use in the present research, a major benefit of the mesh block statistics available in Japan is that they make it possible to significantly reduce the costs of conducting research when attempting to develop analysis that incorporates temporal changes from cross-sectional analysis of spatial differences.

In order to observe amenity concentration, it is important to first clarify the definition. This is because each amenity may be differently related to social composition or social demand in terms of its characteristics, and as a result the spatial density and location behavior will change. As shown in Table 1, amenities extracted from Zenrin telepoint data are divided into

[*1] Zenrin telepoint data is created from the Yellow Pages phonebook database. Data is supplied in conjunction with coordinates from NTT.

24 categories. This categorization was made in terms of the urban role of each amenity.

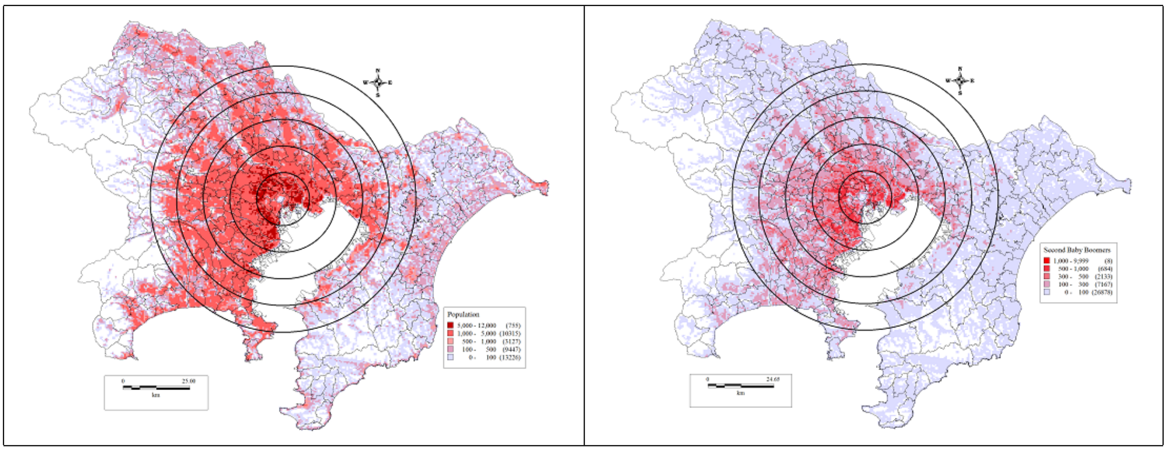
We will clarify the relationship between population concentration and rent (housing service prices) in conjunction with this amenity-related data. We decided to use census data for population data and individual data relating to contracted rent per dwelling for housing rent data.

Table. 1 Categories of urban amenities

Category	Amenities
Category1:Art/Galleries	Museum, Museum of Art, Museum of Science
Category2:Artists	literary profession, artist
Category3:Arts Instruction	Vocational school, such as music, art and crafts, other types of school, lessons for hobby
Category4:Associations	Business cooperative, political organization
Category5:Bars/Nightlife	Karaoke, dance hall, bar, Beer hall
Category6:Clothing/Fashion	Clothing store, jewelry store, bags shop
Category7:Community/Gov't Services	Nursery, child care center, social welfare and nursing care service business
Category8:Education/Health	Medical and other health business, elementary, middle and high schools, university, private cram school
Category9:Foreign Gov't Services	Foreign diplomatic offices, United Nations-related facilities
Category10:Literary Culture	Publishers, libraries, bookstores, and newspaper shops
Category11:Media Services	Broadcasting industry, advertising agencies, TV program production
Category12:Museums/Aquariums /Zoos/Historic Sites	Zoo, botanical garden, aquarium, planetarium
Category13:Music/Instrument Stores	Musical instruments, record·CD·DVD sales
Category14:OTHER	Graveyard, parking lot
Category15:Other Entertainment	Movie theater, arcade games, theme park
Category16:Parks and Nature	Camping ground, fishing pond, parks
Category17:Performance Arts	Theatrical company, orchestra, dance troupe, live house
Category18:Religion	Christian church, and other religious groups
Category19:Restaurants/Food	Restaurants, fast food, coffee shops, drive-in
Category20:Specialty Services	Law firm, interpretation, translation, art repair industry
Category21:Specialty Stores	Sales of medicine, antiques, liquor, tobacco, and toys
Category22:Sports and Recreation	Golf course, ski resort, tennis court, and other sports facilities
Category23:Tourism	Travel agency, Japanese-style hotel, hotel
Category24:Visual Arts	Printing business, Design, Photographs

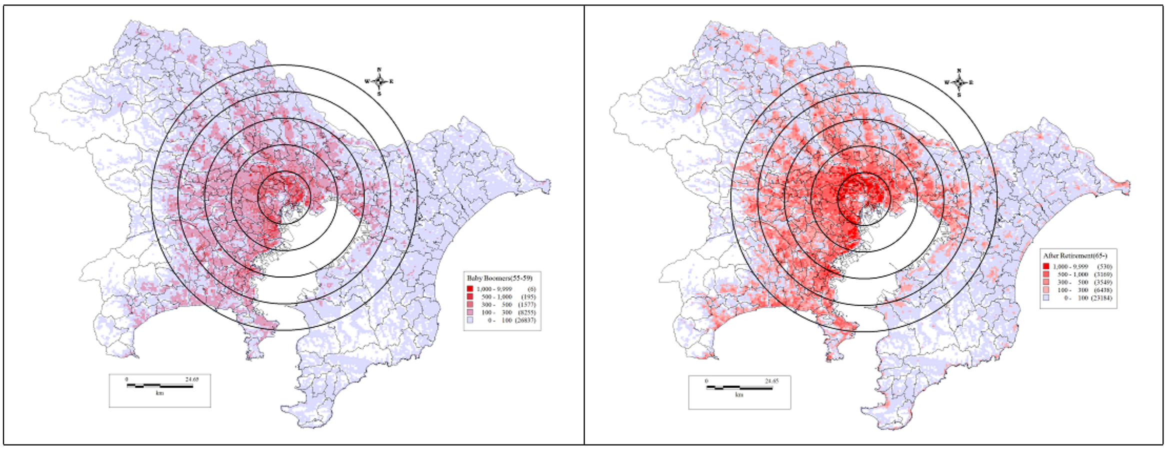
2.2 Spatial Distribution

Table 2 breaks down summary statistics for population indicators, housing service price indicators, and amenity indicators. In addition, Figures 1 show population-related indicators, Figures 2 shows the number of households by residence type, Figure 3 and 4 show spatial distribution of amenities. The figures show the 50 km area surrounding Tokyo Station, which is an economic center and transportation hub in Japan, in units of 10 km. In the following sections, we will analyze population, housing service prices, and major amenities.*2



(a) Total population

(b) Second-generation baby boomer: aged 35-39



(c) First-generation baby boomer: aged 60-64

(d) Aged 65 or more (retired people)

Figure 1 Distribution of population groups in Tokyo metropolitan area

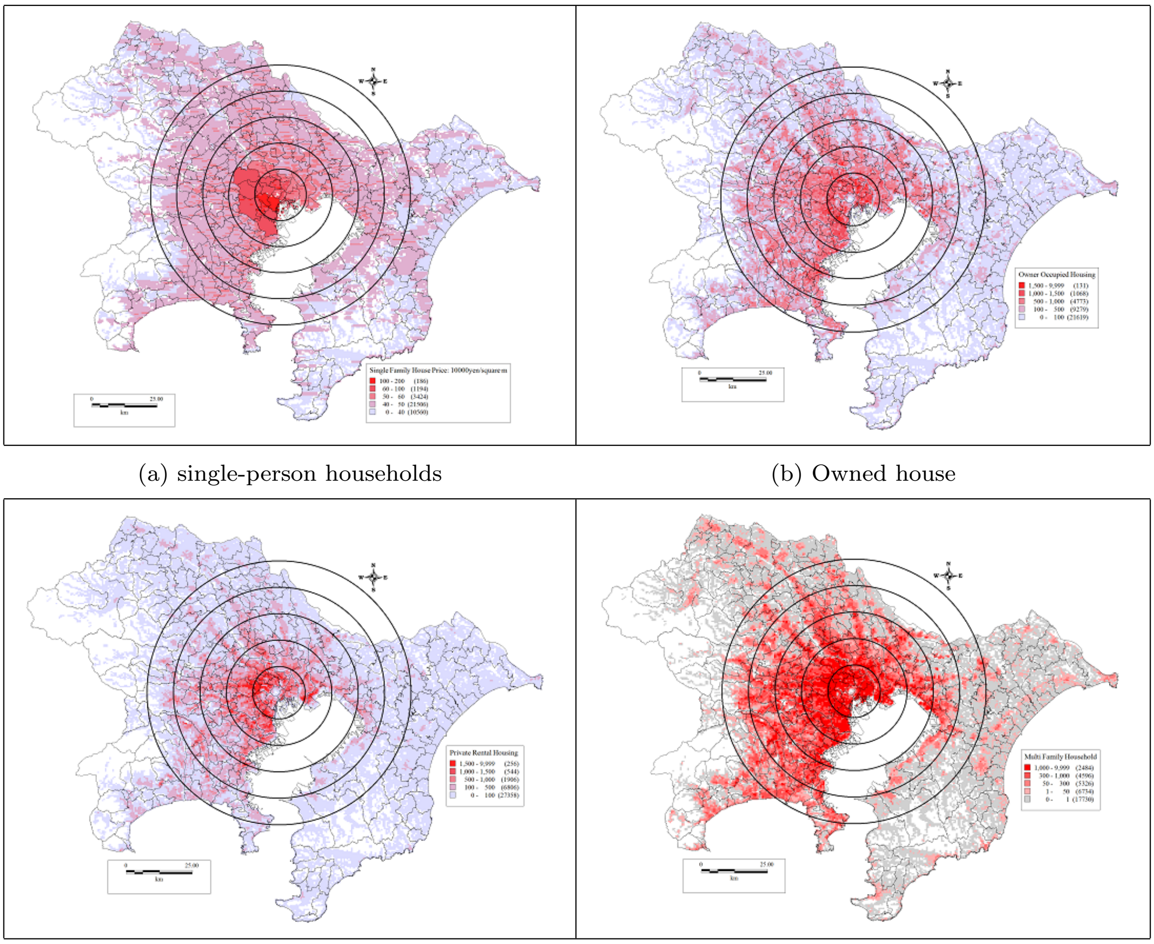
Population Distribution

With regard to population distribution, we observed first-generation baby boomers (ages 60-64), second-generation baby boomers (ages 35-39), post-retirements (ages 65+), along with the total population. As a general trend, older people tended to be concentrated closer to the city center. The second-generation baby boomers were not concentrated in specific areas but instead distributed across the entire Tokyo metropolitan area. The background of these trends was that the generation that had purchased housing prior to the bubble and older generations who tended to be comparatively wealthy were concentrated in the city center area where housing prices are high, while people of child-rearing age were spread out across the suburbs.

Distribution of residence type

*2 The analysis is restricted to mesh blocks with a population of at least 1 in the 2010 census. In the Tokyo metropolitan area, there were 36,870 corresponding 500 metre mesh blocks.

The proportion of single-person households is extremely high in the Tokyo metropolitan area, and these are distributed across the entire area (Figure 2-(a)). The concentration is particularly high in the city center. Owned homes spread out from the city center to the suburbs and are relatively uniformly distributed (Figure 2-(b)), private rental housing is concentrated in the city center (Figure 2-(c)). In addition, there are a very large number of apartment residences, not only in the city center but also across the entire Tokyo metropolitan area (Figure 2-(d)).



(a) single-person households

(b) Owned house

(c) Praivate rental housing

(d) Multi family household

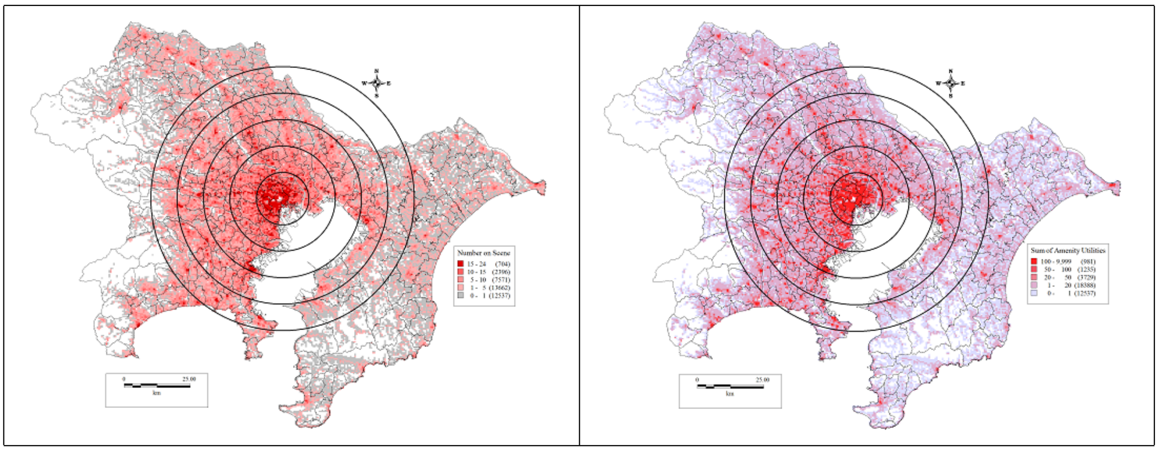
Figure 2 Spatial distribution of housing types

Amenity Concentration

To understand the importance of amenity concentration, it is necessary to focus on both the number of amenities and types of amenities (i.e., diversity). What also needs to be considered is that some amenities positively affect housing service values, whilst others may have a negative effect on housing values, and these different types of amenities may be mixed together in an area.

Table 2 reports summary statistics for various variables of the $36,870$ 500-meter square mesh blocks (mesh blocks where no people live were removed in advance). A notable point is that for all of the amenity categories from 1 to 24, the minimum value was 0. There was also significant deviation in the maximum value (ranged from 6 to 1,293). This indicates that to test the relationship between distributions of amenities and housing services, it is necessary to consider not only the concentration density but also the differences between areas where an amenity exists and areas where no amenity exists. Accordingly, focusing on the proportion of zero-amenity areas by category (Table 3), 86% of mesh blocks are zero-amenity areas on average. In other words, each category of amenity only exists in certain areas.

Therefore, based on Table 1, we looked at how many of the 24 amenity categories are represented with facilities in each area (Figure 3-(a)) and the total number of facilities that exist in each area when all types of amenity are aggregated (Figure 3-(b)). Compared to the spatial variation in population, one can see that amenities are heavily concentrated in the city center and that there are significant differences between areas.



(a) Number on scene

(b) Sum of Amenity utilities

Figure 3 Diversity in amenities and amenity concentration

In particular, one can clearly understand that it is possible to enjoy a greater diversity of amenities the closer one gets to the city center. Looking at the concentration level for individual amenity types, restaurants (Figure 4-(a): Restaurants/Food) are evenly represented in most areas, but if limited to bars, pubs, and so on (Figure 4-(b): Bar/Night Life), one can see that they are clustered in certain areas. In addition, clothing (Figure 4-(c): Clothing/Fashion) amenities are concentrated in an area that is broader than the city center. Compared to these amenities that are present across a large spatial range in varying degrees of concentration, international-related government institution facilities such as embassies (Figure 4-(d): Foreign Gov't Services) are concentrated in specific areas of the city center, while for museums, aquariums, zoos, etc., the number of facilities is limited to begin with, and there are cases where there is only one amenity every few kilometers.

Table. 2 Descriptive statics of major variables

Variable	Mean	Standard deviation	Min	Max	Data source
Population (unit: N of people)					
Total	934.358	1360.595	1	10,423	*
Aged 0-4: pre-school children	39.328	60.353	0	609	*
Aged 5-14: compulsory education	80.319	114.865	0	1,063	*
Aged 30-34: 2nd-generation baby boomers	81.145	130.506	0	1,212	*
Aged 55-59: the baby boomers	73.975	106.451	0	1,246	*
Aged 65 or more: retired people	162.336	243.337	0	2,570	*
Aged 75 or more: elderly people	66.296	103.223	0	1,334	*
Price of housing service (unit: 10,000 yen)					
Rent	0.246	0.047	0	1	**
Amenity (unit: N)					
Category1	0.018	0.191	0	13	***
Category2	0.02	0.169	0	6	***
Category3	0.194	0.794	0	21	***
Category4	0.309	1.724	0	66	***
Category5	1.52	12.157	0	1,293	***
Category6	0.889	6.447	0	399	***
Category7	0.173	0.559	0	14	***
Category8	1.217	3.645	0	96	***
Category9	0.005	0.136	0	16	***
Category10	0.317	2.478	0	298	***
Category11	0.283	2.561	0	142	***
Category12	0.003	0.069	0	6	***
Category13	0.088	0.616	0	29	***
Category14	0.08	0.473	0	26	***
Category15	0.033	0.318	0	20	***
Category16	0.046	0.262	0	12	***
Category17	0.041	0.428	0	18	***
Category18	0.111	0.446	0	17	***
Category19	4.387	16.752	0	721	***
Category20	1.873	5.75	0	254	***
Category21	2.055	5.017	0	101	***
Category22	0.391	1.636	0	55	***
Category23	0.115	0.849	0	54	***
Category24	0.537	3.357	0	200	***

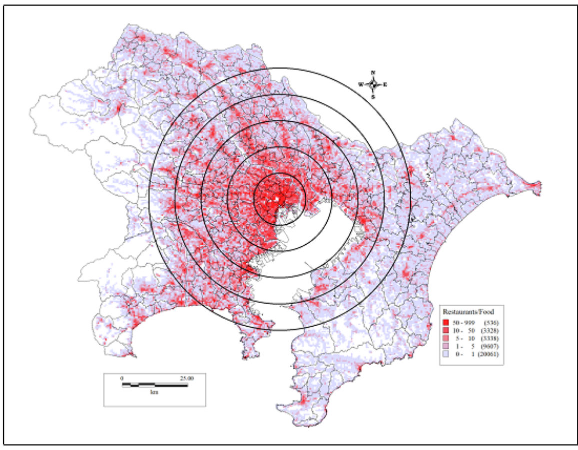
Number of Areas = 36,870

* Census (2005), ** Recruit Residential Information, *** Zenrin·Tele Point Pack

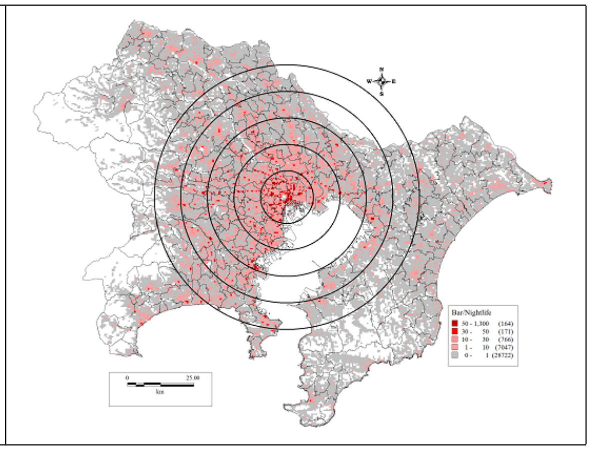
Table. 3 Frequency distribution of amenity variables

	0 ratio	0	0 – 9	10 – 29	30 – 49	50 – 99	100 – 299	300 – 499	500 – 999	1000 –
Category01	98.71%	36,395	474	1	0	0	0	0	0	0
Category02	98.38%	36,271	599	0	0	0	0	0	0	0
Category03	89.81%	33,112	3,737	21	0	0	0	0	0	0
Category04	87.25%	32,170	4,552	119	24	5	0	0	0	0
Category05	77.90%	28,722	7,158	664	168	100	49	7	1	1
Category06	83.28%	30,706	5,577	411	84	65	26	1	0	0
Category07	88.15%	32,502	4,366	2	0	0	0	0	0	0
Category08	68.25%	25,165	10,849	747	93	16	0	0	0	0
Category09	99.72%	36,768	101	1	0	0	0	0	0	0
Category10	87.52%	32,268	4,460	122	11	7	2	0	0	0
Category11	91.77%	33,835	2,850	126	42	13	4	0	0	0
Category12	99.81%	36,800	70	0	0	0	0	0	0	0
Category13	95.17%	35,089	1,758	23	0	0	0	0	0	0
Category14	95.03%	35,036	1,828	6	0	0	0	0	0	0
Category15	97.93%	36,105	761	4	0	0	0	0	0	0
Category16	96.23%	35,481	1,388	1	0	0	0	0	0	0
Category17	97.97%	36,122	735	13	0	0	0	0	0	0
Category18	91.93%	33,895	2,973	2	0	0	0	0	0	0
Category19	54.41%	20,061	13,334	2,446	503	359	149	16	2	0
Category20	57.93%	21,360	14,301	977	140	76	16	0	0	0
Category21	58.11%	21,425	13,776	1,420	210	38	1	0	0	0
Category22	83.89%	30,931	5,766	158	14	1	0	0	0	0
Category23	94.16%	34,716	2,111	40	2	1	0	0	0	0
Category24	83.92%	30,941	5,627	209	58	29	6	0	0	0
Total	34.00%	12,537	14,974	5,547	1,648	1,197	769	111	73	14

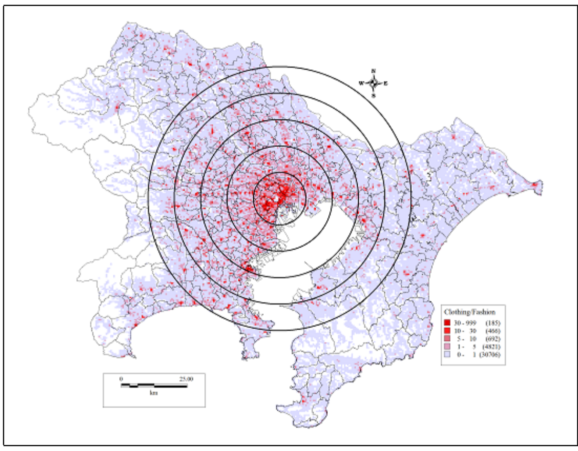
Number of areas = 36,870



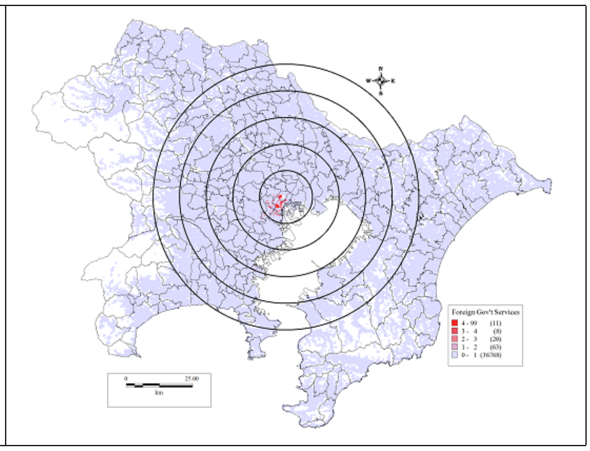
(a) Restaurants/Food



(b) Bar/Night Life



(c) Clothing/Fashion



(d) Foreign Gov't Services

Figure 4 Amenity concentration by amenity type

3 Impact of Amenity Concentration on Population Concentration and Housing Service Prices

3.1 Hedonic modeling

This paper considers two issues. The first is the relationship between amenity concentration and population concentration. The second is the relationship between amenity concentration and rent (housing services price).

In order to clarify how the amenity concentration impacts both population concentration and housing service prices, the hedonic approach was applied in this study.

The hedonic model proposed by Rosen (1974)[19] developed a market equilibrium theory for products differentiated according to the proposition of Tinbergen (1959)[29]. This theory shows how differentiated assets such as housing can be analyzed from both an economic theory and econometric model perspective. Specifically, the relationship between the product supplier's offer function, the product consumers' bid function, and the hedonic price function structure is carefully scrutinized, and the product's market price is defined based on consumer and producer behavior.

In addition, the relationship between amenities and population is supported by capitalization theory. Considering household housing selection behavior, it is thought that decisions are made based on housing features and on the residential environment where housing exists that falls within the household's budget constraints. If we ignore housing features here, areas where there is a high level of amenities exert strong attractiveness of location, with families that demand to live there. Therefore, if we assume land supply as fixed, there will be a higher population concentration in areas with a high level of amenities compared to other areas, and as a result, land and housing rent will be higher.

First, in estimating the hedonic function, there is a problem on selection of housing price data. In this paper, we decided to use newly contracted housing rent data for housing service prices. In consumer price statistics and the like, the housing rent measured as an actual living cost is the paid rent. However, since paid rent is not always determined based on current market rent but is sometimes paid based on past leases, it is not determined as a result of the behavior of market participants such as population movement.[*3]

Therefore, we will look at what kind of effect an amenity has based on newly contracted rents.

Based on the above considerations, we specified the two estimation models for housing rent per property i, P_i shown below. With regard to continuous quantity, we decided to perform logarithmic conversion for housing rent only since the distribution of antilogarithm of rent is highly skewed, and there is a need to estimate the regression coefficient of each variable as a value of rent elasticity.

First, we will derive the effect that the number of amenity types and the amenity concentration level (number of amenities) has on housing rents (Model 1).

Let V_i be the number of categories of facilities located in the mesh block, which property i is included in and AM_i be the number of amenity facilities located in the mesh block, which the property i is included in.

The housing rent can be expressed as in Equation 1; the l characteristic vectors for the property i, $X_{l,i}$, m characteristic vectors for the neighborhood effect, $NE_{m,i}$. With regard to amenities, we converted them into category data because the distribution was notably skewed.[*4] In addition, we controlled for mesh block's n characteristic vectors for population

[*3] Shimizu, Nishimura, and Watanabe (2012)[24] clarifies the difference between actual paid rent and market rent and its structure.

[*4] When it comes to conversion into category data, we faced the problem of how to specify the bandwidths. In this regard, as proposed by Shimizu, Karato, and Nishimura (2014)[22], using an SWR (Switching Regression Model), GAM (Generalized Additive Model), or the like may be considered, but one faces the problem that interpretation is difficult. Therefore, after confirming the distribution of the total number of amenities, we specified bandwidths at our own discretion. Specifically:
1: Not even 1 amenity is present.
2: Number of amenities is from 1 to 9
3: Number of amenities is from 10 to 29
4: Number of amenities is from 30 to 49
5: Number of amenities is from 50 to 99
6: Number of amenities is from 100 to 299
7: Number of amenities is from 300 to 499
8: Number of amenities is from 500 to 999
9: Number of amenities is $1,000$ or more
Diewert and Shimizu (2014)[5] also estimated hedonic functions by generating similar dummy variables to analyze non-linear structure.

factor ($POP_{n,i}$) at the same time. ϵ_i is an iid normal disturbance.

$$\log P_i = a_0 + a_1 V_i + a_2 AM_i + \sum_l a_{3l} X_{l,i} + \sum_m a_{4m} NE_{m,i} + \sum_n a_{5n} POP_{n,i} + \epsilon_i \quad (1)$$

In addition, in order to find the individual effect of amenities, we inserted the type h ($h = 1, 2, 3, \ldots, 24$, i.e., the 24 types of amenities) into the hedonic function as an individual variable (Model 2). The total number of facilities per amenity categories h ($H = \{1, 2, ..., 24\}$) expressed as $CAM_{h,i}$.We can get 24 individual variables corresponding to amenities categories.

$$\log P_i = a_0 + a_1 V_i + \sum_h a_{2h} CAM_{h,i} + \sum_l a_{3l} X_{l,i} + \sum_m a_{4m} NE_{m,i} + \sum_n a_{5n} POP_{n,i} + \epsilon_i \quad (2)$$

Furthermore, as a method of adjusting for differences in distribution between amenities, we estimated Models 3 and 4 in addition to Models 1 and 2 by introducing various indicators that normalized the amenity concentration level.

3.2 Amenity Concentration and Population Concentration

Prior to the analysis, we looked at the correlation between population and the various amenities (Table 4). There is a certain positive relation between the total number of amenities and total population, with a correlation coefficient of 0.628. In addition, there is also a positive relationship between amenities and housing rent at 0.662. In other words, amenity concentration generates population concentration and increases housing rent. Specifically there is a strong correlation between amenities and a population of those aged 30 or more. Since people begin buying housing from this age, there could be a certain relationship between amenities and housing selection.

Furthermore, we estimated the relationship between population concentration and diversity of amenities (number of amenity types) and amenity concentration (Table 5). To focus on the relationship between amenity diversity and amenity concentration, we set the total population logarithmic value as an explained variable. We tried to derive the relationship between amenities and population by controlling the convenience of each mesh block based on its distance from Tokyo Station. Looking at the estimation results, both determination coefficients adjusted for degrees of freedom had a certain explanatory power, at 0.534 and 0.573. First, amenity diversity was estimated to be positive and significant in all cases. We did not see any significant results for amenity concentration level. Furthermore, if we focused on the number of each individual amenity, there were some coefficients that were estimated as positive and significant and some that were estimated as negative. In other words, depending on the type, an amenity may have a positive relationship with population concentration or it may produce a negative effect. As a specific example, educational facilities such as elementary and junior high schools (Category 8) are supplied in areas where population is concentrated, and people gather in such areas. As a result, they are estimated to have a positive, significant relationship. However, cemeteries and the like (Category 14) are recognized to have a negative effect.

Drawing on this basic analysis, we will estimate a hedonic function using housing rent.

Table. 4 Correlation between amenities and population

	Total population	Population (0 – 4)	Population (05 – 14)	Population (30 – 34)	Population (55 – 59)	Population (≥ 65)	Population (≥ 75)	Rent
Total N of amunities	**0.628**	**0.601**	**0.595**	**0.639**	**0.618**	**0.622**	**0.609**	**0.662**
Category01	0.077	0.069	0.067	0.082	0.078	0.085	0.091	0.143
Category02	0.139	0.129	0.124	0.144	0.141	0.151	0.158	0.219
Category03	0.357	0.349	0.344	0.374	0.361	0.374	0.375	0.400
Category04	0.352	0.347	0.339	0.374	0.357	0.365	0.362	0.429
Category05	0.431	0.414	0.407	0.445	0.429	0.439	0.432	0.467
Category06	0.405	0.390	0.384	0.422	0.408	0.423	0.421	0.473
Category07	0.306	0.290	0.291	0.303	0.295	0.305	0.299	0.288
Category08	**0.556**	**0.540**	**0.542**	**0.570**	**0.552**	**0.557**	**0.542**	**0.554**
Category09	0.060	0.048	0.044	0.068	0.062	0.067	0.072	0.184
Category10	0.386	0.375	0.368	0.404	0.389	0.402	0.403	0.481
Category11	0.303	0.290	0.281	0.324	0.306	0.321	0.325	0.459
Category12	0.013	0.016	0.014	0.021	0.021	0.020	0.020	0.038
Category13	0.246	0.236	0.229	0.260	0.247	0.259	0.263	0.320
Category14	0.182	0.171	0.164	0.189	0.183	0.192	0.196	0.269
Category15	0.134	0.131	0.124	0.145	0.135	0.136	0.135	0.185
Category16	0.123	0.118	0.120	0.127	0.126	0.132	0.133	0.137
Category17	0.168	0.153	0.144	0.180	0.170	0.183	0.192	0.297
Category18	0.309	0.296	0.293	0.318	0.311	0.326	0.329	0.345
Category19	**0.552**	**0.527**	**0.520**	**0.563**	**0.545**	**0.548**	**0.538**	**0.594**
Category20	**0.541**	**0.501**	**0.501**	**0.537**	**0.522**	**0.517**	**0.500**	**0.550**
Category21	**0.574**	**0.550**	**0.548**	**0.582**	**0.565**	**0.562**	**0.544**	**0.568**
Category22	0.367	0.361	0.351	0.388	0.369	0.376	0.375	0.453
Category23	0.184	0.166	0.159	0.188	0.182	0.196	0.202	0.268
Category24	0.405	0.393	0.386	0.425	0.407	0.418	0.416	**0.528**

Table. 5 Population concentration and amenity concentration

		coefficient	t value	coefficient	t value
Constant term		6.161	223.420	5.797	205.630
$\boldsymbol{A}$: Effect of amenities					
A_{ct}:	Number of amenity types	0.246	52.100	0.405	59.080
A_{all}:	Total N of amenities	0.013	0.850		
A_n:	Category01			−0.498	−8.490
A_n:	Category02			−0.268	−6.130
A_n:	Category03			−0.225	−9.850
A_n:	Category04			−0.277	−12.430
A_n:	Category05			−0.153	−9.240
A_n:	Category06			−0.254	−13.430
A_n:	Category07			−0.113	−5.450
A_n:	Category08			0.204	10.260
A_n:	Category09			−0.678	−6.070
A_n:	Category10			−0.292	−13.800
A_n:	Category11			−0.274	−11.650
A_n:	Category12			−0.754	−4.100
A_n:	Category13			−0.408	−14.590
A_n:	Category14			−0.444	−13.950
A_n:	Category15			−0.535	−11.300
A_n:	Category16			−0.385	−10.480
A_n:	Category17			−0.449	−10.210
A_n:	Category18			−0.174	−7.600
A_n:	Category19			0.029	1.780
A_n:	Category20			0.020	1.080
A_n:	Category21			0.098	5.270
A_n:	Category22			−0.228	−10.940
A_n:	Category23			−0.441	−15.250
A_n:	Category24			−0.184	−9.740
$\boldsymbol{NE}$: Neiborhood characteristics					
TT:	Distance to Tokyo station	−0.019	−76.62	−0.017	−68.960
Number of observations		36,870		36,870	
Adjusted R square		0.534		0.573	

4 Hedonic Function Estimation Results

4.1 Data

In estimating the hedonic function, data on housing and surrounding environment as well as population concentration was collected. The details are presented below.

Housing Rent Data (P_i), Building Attributes and Market Characteristics (X_l).

For housing, we gathered rent data contracted between January 2010 and December 2010. In terms of the information source, we used condominium rent information published in Recruit's weekly housing listings magazine, *Shukan Jutaku Joho*. This magazine provides information relating to quality and asking price on a weekly basis[*5]. Out of the information published in *Shukan Jutaku Joho*, we used the price information at the point in time when a listing was deleted from the magazine due to the contracted lease.[*6]

In addition, we used building floor space (S) and building age (Age) as quantitative data (X) representing building attributes. The building age is the period from the month the building was constructed until the month the lease was contracted. We took into account whether the building's structure is reinforced concrete (RC) with an RC construction dummy, whether it is a wooden construction with a wooden construction dummy,[*7] whether it faces south with a south-facing dummy ($South$), and, similarly, whether it faces north with a north-facing dummy ($North$).

Furthermore, it is necessary to be careful to use information collected via the property transaction market, since price levels may fluctuate according to market conditions (Genesove and Mayer 2001[9], Goetzmann and Peng 2006[12]). This is because every property's sale price is influenced by the speed of liquidity and market depth. It is known that not just the time until a dwelling is leased but also the agreed price will be influenced based on whether the transaction takes place in an area or time with an active market, or an area or time with few transactions (MK). We employed a "market retention time" (MR) variable to adjust these market feature. The market retention time is the period of time from when the lessor puts a property on the rental market until a tenant is found.

Surrounding Environment Variable (NE)

[*5] Recruit's database includes historical information from the time a dwelling appears in the listings until it is removed due to being leased, etc. In terms of price-related information, three types of data exist: i) the listed price when the dwelling appears on the market (first offer price), ii) the price at the time when it is removed from the listings (first bid price), and iii) the lease (sale) price collected as a sample (transaction price). The first offer price is not the market price but the seller's desired price. On the other hand, the transaction price may be affected by individual circumstances accompanying the property transaction, such as the buyer being in a rush to make a purchase or the seller offloading a property below market value. When selecting data, it is necessary to bear these information characteristics in mind.

[*6] The price at the point in time when a dwelling is removed from the listings is the initial buyer asking price, based on a reverse auction-style process: information on the dwelling's quality and price are published via the listings, and the price decreases until a buyer appears. Therefore, while this is the top price among buyers' offer prices, in comparison to transaction price information, it may be considered a competitive market price that is not influenced by personal circumstances surrounding the transaction.

[*7] In terms of the structure codes, the data was sorted as follows: 01 = reinforced concrete, 02 = steel-reinforced, 03 = precast concrete, 04 = reinforced precast concrete, 05 = wooden construction, 06 = steel frame, 07 = light-gauge steel, 07 = aerated concrete, 09 = block, 99 = other. Most single-family housing is reinforced precast concrete, steel frame, or wood. That being the case, the wooden construction dummy looks at the degree of price difference in the case of wooden construction, taking reinforced precast concrete or steel frame as a base.

To estimate a hedonic function for a broad area, it is necessary to consider not only building characteristics but also spatial differences. In terms of surrounding environment factors relating to spatial differences, the most typical example is the transportation accessibility of each housing location. Specifically, in the Tokyo metropolitan area where there are highly developed train networks, housing rent changes considerably based on the accessibility of the nearest rail station. Therefore the following factors were considered in the hedonic pricing estimation: time to nearest station (TS) and time to the central business district (TT).

First, in terms of the time to the nearest station (TS), travel time by transportation method is available. There are three transportation methods: walking, bus, and car.*8 In the case of walking distances, the walking time (minutes) is recorded, while in the case of bus distances, the walking distance from the property address to the bus stop (minutes) and the time from the bus stop to the nearest train station (minutes) are recorded.*9 In addition, with regard to bus distance, we considered a bus distance dummy (BUS). Furthermore, we distinguished attribute price differences by transportation method (walking, bus) by inserting a cross-term of the bus distance dummy and TS. With regard to the time to the central business district (TT), we used the average daytime travel time by train to Tokyo Station.*10

\The above variables are related to the location and building, but it is expected that geographic differences in price also exist. Accordingly, we decided to reflect differences in public services and the like and differences in the overall area (neighborhood status) by creating an administrative district dummy (LD). In addition, since residential land development in the Tokyo metropolitan area has taken place in tandem with railway line development, the price structure may vary by railway line. We therefore created a railway line dummy (RD).

Population Variable (POP)

It is recognized that a concentration of amenities has a certain relationship with population concentration. However, a variable of total population may have potential to cause collinearity with the hedonic function. Considering areal characteristics, it is recognized that there is a certain relationship between age groups and amenity concentration. To incorporate this issue, we generated two variables. The first is the old-age dependency ratio. The second is the population growth rate from 2005 through 2010. The old-age dependency ratio is an indicator that has theoretically and quantitatively been clearly shown to have a relationship with housing demand and housing prices in a series of research by Nishimura (2011)[17], Nishimura and Takáts (2012)[18], and Takáts (2012)[27]. The old-age dependency ratio is defined as the population of aged 65or more divided by population of the working age (population aged 20 to 64). In other words, with regard to economic activity, this is the ratio between the age group that produces and the age group that does not produce but purely consumes. Previous research (Takáts 2012[27], Saita, Shimizu and Watanabe 2013[21]) has shown that increases in the old-age dependency ratio have the effect of lowering housing prices. Along with this aging rate-related indicator, we also inserted the population rate of change over the previous 5 years ($TPOP(-5)$).

*8 However, only the walking distance and bus distance were present in the analysis data. We therefore decided to control the difference in walking and bus transportation methods using a bus distance dummy variable (BUS).

*9 Therefore, the time to the nearest station (TS) is defined as the "walking time" + "Walking time to the bus stop" + "time spent riding the bus from the bus stop to the nearest station."

*10 Excluding the morning and evening work and school commuting periods, we calculated the average time spent riding the train between 9 a.m. and 3 p.m. The data was supplied by Val Laboratory.

4.2 Hedonic Function Estimation Results

The hedonic function estimation results are reported in Table 6 and Table 7. In Model 1 housing rent increases due to both increases in the diversity of amenities (V) and increases in the number of amenities (AM). This is consistent with the relationship to population concentration that was shown earlier (Table 5). The model also shows that: increases in the old-age dependency ratio (Old) lowers housing rent, while the population growth rate increases housing rent. This result is consistent with the findings of previous research. Moreover, these results were observed when surrounding environment characteristics (NE) and building characteristics (X) were controlled. Specifically, rents decrease as the distance from Tokyo Station at the center of the Tokyo metropolitan area increases, while increases in building age and the distance from the nearest station both lower rents as well. In addition, dwellings whose entrance faces south have a positive effect, while north-facing ones have a negative effect. These results are consistent with findings on housing rent price formation characteristics shown in previous research.

Model 2 looks at the effects by amenity. Housing rent is high in areas where vocational schools, recreational classes, etc., are concentrated (Category 3: Arts Instruction). It is possible that this type of indicator is a proxy showing the area's cultural level. Moreover, housing rents are high in areas where there are concentrations of educational facilities such as elementary/junior high schools, universities, and cram schools (Category 8: Education/Health), a concentration of international-related facilities (Category 9: Foreign Gov't Services), parks (Category 16: Parks and Nature), and a concentration of restaurants and the like (Category 19: Restaurants/Food). Conversely, areas where there are concentrations of cemeteries, parking lots, etc. (Category 14: Other) and movie theaters and video arcades (Category 15: Other Entertainment) lower rents.

In other words, there is a positive relationship between rent and the concentration of educational facilities, facilities for daily life such as restaurants, and amenities that improve the environment such as parks. On the other hand, rents are lowered by concentrations of facilities that cause external diseconomy, such as cemeteries and parking lots, and facilities that are conducive to disruption of the public peace, such as video arcades. These results should be carefully considered because there are two possible causal processes to generate these results: Amenity concentration may happen first and it encourages population concentration and increases housing rent, or alternatively facilities such as parks and the like are first supplied in areas where both population concentration and rent are high, or facilities such as cemeteries are supplied in areas where housing rent is already low.

In Models 3 and 4, which used variables of normalized amenity indicators, the results were consistent with Models 1 and 2. In other words, the models estimated here may be considered to have a certain robustness.

Table. 6 Housing values and amenity concentration 1

		Model.1		Model.2	
		coefficient	t value	coefficient	t value
Constant term		10.819	503.390	10.815	504.350
$\boldsymbol{A}$: Effect of amenities					
A_{ct}:	Number of amenity types	0.001	2.890	−0.001	−1.680
A_{all}:	Total N of amenities	0.003	2.830	-	-
A_n:	Category01	-	-	−0.014	−3.500
A_n:	Category02	-	-	0.005	1.720
A_n:	Category03	-	-	0.011	6.870
A_n:	Category04	-	-	0.003	1.700
A_n:	Category05	-	-	−0.002	−1.400
A_n:	Category06	-	-	0.006	4.390
A_n:	Category07	-	-	−0.002	−1.260
A_n:	Category08	-	-	0.004	2.820
A_n:	Category09	-	-	0.032	4.260
A_n:	Category10	-	-	−0.001	−0.420
A_n:	Category11	-	-	0.010	6.750
A_n:	Category12	-	-	0.028	3.460
A_n:	Category13	-	-	0.001	0.560
A_n:	Category14	-	-	−0.006	−2.920
A_n:	Category15	-	-	−0.010	−3.400
A_n:	Category16	-	-	0.017	7.450
A_n:	Category17	-	-	0.001	0.470
A_n:	Category18	-	-	−0.010	−6.170
A_n:	Category19	-	-	0.010	6.880
A_n:	Category20	-	-	−0.002	−1.100
A_n:	Category21	-	-	0.002	1.610
A_n:	Category22	-	-	−0.007	−34.900
A_n:	Category23	-	-	0.017	378.960
A_n:	Category24	-	-	−0.009	−139.660
$\boldsymbol{POP}$: Population factors					
Old:	Old age dependency ratio	−0.011	−2.770	−0.012	−3.030
$TPOP$:	Relative change in population(−5)	0.005	1.600	0.005	1.550
$\boldsymbol{NE}$: Neighborhood characteristics					
TT:	Distance to Tokyo station	−0.007	−36.130	−0.009	−74.930

		Model.1		Model.2	
		coefficient	t value	coefficient	t value
$\boldsymbol{X}$: Building characteristics					
S:	Exclusive area	0.017	379.080	-0.159	-21.370
Age:	Building age	-0.009	-139.220	0.003	6.650
TS:	Distance to closest rail station	-0.009	-75.640	-0.053	-33.540
Bus:	Bus Dummy	-0.162	-21.580	0.013	5.050
$TS \times Bus$		0.003	6.820	0.004	3.190
WD:	Wooden dummy	-0.054	-33.810	-0.025	-5.180
RC:	Reinforced concrete dummy	0.014	5.390	0.000	9.750
$South$:	South-facing dummy	0.003	2.950	-0.012	-3.030
$North$:	North-facing dummy	-0.025	-5.150	0.000	1.550
MT:	Market reservation time	0.00008	9.570	0.01298	3.130
Others, dummy variables					
Ward dummy		Yes		Yes	
Railway line dummy		Yes		Yes	
Number of observations		50,272		50,272	
Adjusted R square		0.891		0.892	

Table. 7 Housing value and amenity concentration 2

		Model.3		Model.4	
		coefficient	t value	coefficient	t value
Constant term		10.822	503.070	10.815	504.350
$\boldsymbol{A}$: Effect of amenities					
A_{ct}:	Number of amenity types	0.001	5.670	0.001	5.420
A_{all}:	Total N of amenities	0.004	4.260	-	-
A_n:	Category01	-	-	-0.005	-6.600
A_n:	Category02	-	-	0.002	2.010
A_n:	Category03	-	-	0.006	5.270
A_n:	Category04	-	-	0.009	5.070
A_n:	Category05	-	-	0.004	3.240
A_n:	Category06	-	-	0.009	7.030
A_n:	Category07	-	-	-0.001	-2.090
A_n:	Category08	-	-	-0.001	-0.810
A_n:	Category09	-	-	0.006	5.480
A_n:	Category10	-	-	0.000	-0.160
A_n:	Category11	-	-	0.008	3.290
A_n:	Category12	-	-	0.002	2.930
A_n:	Category13	-	-	-0.003	-2.930
A_n:	Category14	-	-	-0.001	-1.110
A_n:	Category15	-	-	-0.002	-2.560
A_n:	Category16	-	-	0.005	6.820
A_n:	Category17	-	-	-0.002	-1.550
A_n:	Category18	-	-	-0.009	-6.430
A_n:	Category19	-	-	0.006	4.190
A_n:	Category20	-	-	-0.006	-3.480
A_n:	Category21	-	-	-0.001	-0.350
A_n:	Category22	-	-	-0.007	-34.790
A_n:	Category23	-	-	0.017	379.950
A_n:	Category24	-	-	-0.009	-140.060
$\boldsymbol{POP}$: Population factors					
Old:	Old age dependency ratio	-0.012	-2.930	-0.014	-3.590
$TPOP$:	Relative change in population(-5)	0.005	1.510	0.004	1.110
$\boldsymbol{NE}$: Neighborhood characteristics					
TT:	Distance to Tokyo station	-0.007	-35.960	-0.009	-74.760

		Model.3		Model.4	
		coefficient	t value	coefficient	t value
$\boldsymbol{X}$: Building characteristics					
S:	Exclusive area	0.017	379.020	−0.160	−21.410
Age:	Building age	−0.009	−139.220	0.003	6.720
TS:	Distance to closest rail station	−0.009	−75.610	−0.054	−33.770
Bus:	Bus Dummy	−0.162	−21.600	0.013	5.080
$TS \times Bus$		0.003	6.820	0.004	3.240
WD:	Wooden dummy	−0.054	−33.810	−0.025	−5.230
RC:	Reinforced concrete dummy	0.014	5.400	0.000	9.730
$South$:	South-facing dummy	0.003	2.910	−0.014	−3.590
$North$:	North-facing dummy	−0.025	−5.190	0.000	1.110
MT:	Market reservation time	0.00008	9.630	0.01052	2.430
Others, dummy variables					
Ward dummy		Yes		Yes	
Railway line dummy		Yes		Yes	
Number of observations		50,272		50,272	
Adjusted R square		0.891		0.892	

5 Conclusion: Do Amenities Impact Housing Concentration and Housing Service Prices?

What kinds of drivers encourage urban growth? Focusing on the Tokyo metropolitan area, which is one of the world's largest urban areas, this paper analyzed the relationship between amenity concentration and housing rent. The reason we focused on the relationship with rent here is that rent has a clear causal relationship with housing location behavior. If we assume that land supply is fixed, increases in location pressure for areas with a high level of amenities are reflected in the market as an increase in housing rent. Conversely, the concentration of amenities with negative externality decreases location pressure, which may be reflected in the market via a decrease in housing rent. Furthermore, regardless of the country, rent is the biggest household expenditure item, representing around 25% of household expenditures. Given this, we believed there was considerable sense in focusing on housing rent.

First, let us summarize the obtained results.

When we examined the spatial distribution of amenity concentration, we found that some amenities were concentrated only in specific areas, depending on their type, and their spatial variation differed considerably. That being the case, it is recognized that it will be difficult to clearly measure the relationship with household utility level by using only the number of amenities as an indicator. Based on this analysis, we decided to focus not just on the number of amenities but also their diversity.

When we looked at the relationship of amenity diversity and concentration to population and housing rent, we found that amenity concentration generates population concentration and also drives up housing rent. In particular, we found that it was not the simple number of amenities but the diversity of amenities that was important. Concentration of diverse amenities enhances the appeal of an area and, as a result, households will seek to reside there, even if it means paying higher rent. Among the various types of amenities, facilities such as educational institutions, recreational classes and convenient facilities such as restaurants and the like were observed to have positive externality. However, it was made clear that there is a well-defined negative relationship between housing rent and amenities such as cemeteries and video arcades with negative externality.

An important implication is understanding the effect of amenity diversity. The types of amenities counted here included some with simple negative externality, some that do not have a clear relationship, and so on. In that case, it is necessary to carefully elucidate the significance of diversity. In estimating the hedonic function, there is a possibility that the effect of diverse amenities on rent may be biased by diversity level of amenities in surrounding areas. Addressing this issue could provide an important view point for future works.

In addition, in sorting amenities into 24 groups, we grouped together amenities thought to have similar characteristics in terms of their function into the same category, but the criteria did not involve any objective indicators; categorization was performed based on the subjective judgment by one of the authors specializing in urban sociology. Therefore, some alternative criteria to categories of amenities can be suggested, for example, the correlation between various indicators showing urban growth, including rent, by categorizing amenities according to criteria for the 15 groups suggested by the "entertainment machine" theory that demonstrate amenities drive urban growth (Navarro et al. 2012[16]).

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