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What have we learned from the real estate bubble?

- Asset sorting in the real estate investment market -

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What have we learned from the real estate bubble?[1)]

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1. Introduction

The advent and collapse of real estate bubbles, or the sharp rises and falls in real estate prices, have posed major economic issues in many nations. Real estate prices soared sharply in Japan and Sweden in the 1990s and recently in many Western countries (until the mid-2000s), until plunging in the wake of the financial crisis in the United States.

The rapid rise and fall of real estate prices in Japan from the mid-1980s to the 1990s is said to represent the most significant real estate bubble of the 20th century. Following the collapse of this bubble, Japan experienced a long period of economic stagnation, often cynically described as the "lost decade." What have we learned from these ups and downs in the real estate market? Have recent real estate investment risk management efforts incorporated these lessons?

To answer these questions, the author would like to pay attention to the severalty of each real asset. The lesson learned from last century's economic bubble and from the expansion and shrinkage of the real estate market in the wake of the latest financial crisis is that **"real estate investment risks cannot be dispersed by diversifying investments, and major risks will remain unless assets are carefully selected."**[3)]

In the 1980s bubble, many real assets were the subject of speculative transactions whose purpose was not actual use. The investors in these assets ultimately suffered from devastating losses. Based on this lesson, the latest expansion of the real estate investment market was based on real assets already in use that would provide the investors with certain profits. However, as the market overheated, investments were diversified into various types of property to disperse risk, became smaller in size, and were geographically expanded beyond urban centers into suburban areas, then into regional cities.

As a result of such market expansion, it is likely that market selection will be spurred again by market shrinkage in the wake of the financial crisis.

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1) The original academic research of this paper is Shimizu and Karato (2010).

2) Associate Professor (PhD), The International School of Economics and Business Administration, Reitaku University.

3) Mr. David Bucke, UBS Asset Management, said the lessons learned from the recent financial crisis are that we should be aware that as real estate investment risks, there are appraisal risks as well as liquidity risks and that we have to select real estate very carefully (in his presentation at the IPD/IPF Property Investment Conference 2009 held in Brighton on 26 November, 2009).

Bearing these issues in mind, the author in this paper will look back on the period of adjustment following the collapse of the economic bubble in the 1990s; elucidate how assets were sorted in the Tokyo 23 wards office market, taking macroscopic changes in the real estate market in the Tokyo 23 wards office market into account; and suggest possible major considerations for future investments in office buildings.

2. Collapse of the bubble and development of the office market

2.1 Diversification of the real estate market

In the 1980s bubble, repeated rounds of speculative real estate transactions targeted urban areas in particular, and numerous lots were converted in poor ways. As Tokyo grew as an international financial center, demand for office spaces increased significantly, official forecasts pointed to potential shortages of office floors, and many financial institutions helped finance the construction of office buildings. In urban centers, small office buildings, called “pencil buildings” were built where residences once stood, and many office buildings and commercial facilities were also developed in suburban areas. A large amount of space was introduced to the market in the temporary expectation of strong demand.

However, upon the collapse of the bubble, land of no use became unmarketable, and poorly located office spaces and the pencil buildings built on residential tracts suffered high vacancy rates, with the result that even the 23 wards of Tokyo ended up with a vast store of unused assets. Assets supplied in excess of demand were finally forced off the market and converted into totally different types of property, as occupancy rates failed to improve no matter how far rent fell.

Economically, this constitutes a maldistribution of land resources in urban cities that created strong inefficiencies. Where we find inefficiency in the land use market, **market adjustments cannot be achieved simply by reducing rent or by rising vacancy rates**, but by moving toward a new balance based on changes in land use and redevelopment. In other words, real estate exposed to strong inefficiencies is forced off the market, and those investing in such properties or whose portfolios include such properties would end up with high risks.

What types of real estate were forced out of the market in the 1990s post-bubble period and in which regions? Analysts argue that during the bubble period, many residences were converted into office buildings given the high rent for the latter in urban areas. The author will examine these conversions and their consequences below.

2.2 The microstructure of the office market

To answer this question in terms of data, the author estimated the hedonic function for office and residential house rents[4)] and examined the difference between rents for office spaces in the 23 wards of Tokyo and the rents that would be charged if they were converted to residential use. Office rents are generally higher than residential rents in urban centers, but if the latter is higher, office buildings have the optional value of conversion to residential use. **That is, such assets cannot produce adequate profits as office buildings.**

Examining this phenomenon, Shimizu and Karato (2010) argued office buildings are likely to be converted to another use if the rents gained when used as office buildings is lower than rents that would be earned if used in a different way (e.g., as residences). A series of studies in the United States reached the same conclusion.[5)] **Given large differences between proceeds from the current land use and from possible conversion, the current land use cannot produce sufficient profits, increasing the chances that the owner will be compelled to change the use of the land**. Investors in these assets would end up with high risks given the high possibility that such assets will go unused, a more serious possibility than potential increases in vacancy rates or declines in rent.

Figure 1. Spatial distribution of office buildings in 1991

[4)] See Appendex for the details of the estimation.

[5)] See Wheaton (1982), Rosenthal and Helsley (1994), Munneke (1996), and McGrath (2000).

According to surveys of land and building use conducted by the Tokyo metropolitan government in 1991, the 23 wards of Tokyo contained some 52,890 non-wooden office buildings at the peak of the economic bubble. **Figure 1** shows the spatial distribution of these buildings.The author made estimates for each of these buildings, defining excess return as the total sum of the difference between the office rent (*RO*) and the residential rent (*RC*), estimated as models, ($Excess\ Return(ER)_{it} = \sum_{i}(RO_{it} - RC_{it})$ **)**. A higher rent for residential use means an opportunity loss. If this situation persists, the office building is likely to be converted to another use, as discussed above.

Table 1. Percentage of buildings with opportunity losses: by ward and by year

Ward	1991	1995	1999	2000	2001	2002	2003	2004	Number of offices
Chiyoda	0.00%	0.02%	4.62%	10.35%	10.48%	10.75%	9.76%	18.24%	6,365
Chuo	0.00%	0.12%	0.77%	2.68%	2.83%	3.02%	2.37%	8.36%	6,532
Minato	0.00%	0.19%	3.24%	8.41%	8.63%	9.02%	7.72%	16.74%	5,895
Shinjuku	0.00%	0.11%	1.52%	3.95%	3.95%	4.06%	3.52%	8.38%	3,745
Bunkyo	0.00%	3.47%	13.95%	23.45%	23.81%	24.12%	22.53%	36.11%	1,642
Taito	0.00%	0.66%	11.36%	20.44%	20.78%	21.13%	19.59%	31.61%	3,195
Sumida	0.00%	0.20%	13.68%	32.37%	32.89%	34.41%	29.54%	53.16%	1,520
Koto	0.00%	4.51%	28.48%	44.94%	45.40%	46.16%	42.74%	60.42%	2,370
Shinagawa	0.00%	5.07%	22.56%	33.87%	34.30%	35.35%	32.51%	48.33%	1,618
Meguro	0.00%	14.87%	48.82%	60.66%	60.92%	61.45%	59.34%	69.74%	760
Ohta	0.00%	8.03%	26.82%	37.24%	37.84%	38.29%	36.09%	49.65%	2,006
Setagaya	0.00%	5.23%	23.12%	37.63%	38.27%	39.20%	36.02%	51.37%	2,046
Shibuya	0.00%	0.00%	0.34%	1.12%	1.19%	1.22%	1.02%	3.15%	2,949
Nakano	0.00%	1.19%	7.25%	15.80%	16.45%	16.99%	14.94%	29.65%	924
Suginami	0.00%	3.48%	25.85%	37.94%	38.26%	38.81%	36.60%	50.43%	1,265
Toshima	0.00%	1.19%	6.12%	10.69%	10.92%	11.15%	10.24%	18.51%	2,188
Kita	0.00%	1.21%	11.74%	22.83%	23.30%	24.14%	21.34%	37.65%	1,073
Arakawa	0.00%	0.70%	8.70%	18.93%	19.35%	19.92%	17.11%	34.92%	713
Itabashi	0.00%	0.79%	10.36%	22.18%	22.64%	23.42%	20.95%	40.32%	888
Nerima	0.00%	1.96%	15.11%	28.59%	29.08%	29.82%	26.63%	43.87%	1,224
Adachi	0.00%	0.00%	1.21%	4.84%	4.96%	5.25%	4.27%	13.55%	1,734
Katsushika	0.00%	0.00%	3.18%	7.26%	7.49%	7.72%	6.47%	14.76%	881
Edogawa	0.00%	31.02%	53.94%	65.95%	66.47%	66.99%	64.41%	76.93%	1,357
Average	0.00%	2.33%	10.58%	17.89%	18.16%	18.58%	16.98%	27.58%	52,890

Table 1 shows the changes during 1991-2004 in the percentage of office buildings located in each ward associated with opportunity losses. In 1991, for all of the 52,890 buildings, office rents were higher than residential rents. Thereafter, opportunity losses emerged as office rents declined faster than residential rents. In 1995, 1,226 buildings, or 2.33%, were associated with opportunity losses. **By 2004, this figure had risen to 14,577 buildings, or 27.58%.**

Figure 2. Spatial distribution of office spaces for which residential rents exceed office rents in the 23 wards of Tokyo in 1995 (residential rents > office rents)

Figure 3. Spatial distribution of office spaces for which residential rents exceed office rents in the 23 wards of Tokyo in 2000 (residential rents > office rents)

Figure 4. Spatial distribution of office spaces for which residential rents exceed office rents in the 23 wards of Tokyo in 2005 (residential rents > office rents)

In 2004, from a regional aspect, the percentage of buildings associated with opportunity losses exceeded 50% in Sumida, Koto, Meguro, Setagaya, Suginami, and Edogawa. These wards had many lots that were proactively converted from residential to office use during the economic bubble beginning in the early 1980s.[6)] **Figures 2** to **4** show the changes in the spatial distribution of buildings associated with opportunity losses in selected years. These office buildings were first observed in suburban areas, then expanded to urban centers.

The author examined the relationship between excess returns in 2005 and three conditions, of which the first two are locational conditions: (a) distance to the nearest railway station; (b) time distance to the urban center; (c) building size (total floorage).

The results of the estimates are shown below.

$$ER_{it} = 846.380 - 915.559 \cdot \ln WK_{it} - 188.483 \cdot \ln ACC_{it} + 335.767 \cdot \ln TA_{it}$$

(23.578) (-130.749) (-23.614) (87.103)

Adjusted R-square=0.387 Number of observation=52,890

6) Chapter 14 of Shimizu (2004) includes an analysis of land use changes from 1991 to 1996 by purpose of use and ward, based on the surveys of land and building use conducted by the Tokyo metropolitan government.

Excess returns tend to fall (meaning opportunity losses are more likely to occur) as the distance from the nearest railway station (*WK*) or from the urban center (*ACC*) increases, tending to increase in proportion to building size (*TA*). Thus, most opportunity losses are found in small, less conveniently located buildings.

2.3 Withdrawal from the office building market

Next, let's examine how these office buildings associated with opportunity losses were converted during the post-bubble period.

Table 2 shows the percentage of all of the 52,890 buildings in the 23 wards intended for office use as of 1991 that suffered opportunity losses in later years leading up to 2004 by pattern of change in building use. The author examined building conversions occurring in three points at quinquennial intervals (i.e., 1991, 1996, and 2001) to identify land use changes in the office market in these wards, classifying building use as O (office), R (condominium), or S (other than office or condominium) and observed the subsequent conversion of the buildings intended for office use in 1991. For example, if a building intended for office use (O) in 1991 was still used as offices (O) in 1996 but was converted into a condominium (R) by 2001, the change pattern is O-O-R. This gives us five possible patterns of change over the 1991-1996-2001 period: O-O-O, O-O-S, O-O-R, O-R-R, and O-S-S.

Of all 52,890 buildings, 38,974 buildings, or 74%, were used for office purposes at all three observed points in time, 1991, 1996, and 2001. This means 26% of the properties were eventually forced off the market and converted to a different use: 1,091 buildings, or 2%, had been converted into residences by 2001, while 2,808 buildings, or 5%, had been converted to residential use by 1996.

Table 2. Distribution of office buildings associated with opportunity losses
by land use change pattern: 1991 to 2001

Change pattern	1991	1995	1999	2000	2001	2002	2003	2004	Number of offices
O-O-O	0.00%	1.93%	9.41%	16.24%	16.51%	16.93%	15.37%	25.52%	38,974
O-O-S	0.00%	2.24%	10.18%	17.68%	17.99%	18.30%	16.67%	26.42%	2,279
O-O-R	0.00%	3.48%	15.31%	25.76%	26.03%	26.76%	24.75%	38.22%	1,091
O-R-R	0.00%	5.09%	20.48%	30.41%	30.84%	31.27%	29.42%	43.13%	2,808
O-S-S	0.00%	3.11%	12.37%	20.63%	20.87%	21.26%	19.59%	31.04%	7,738
Total	0.00%	2.33%	10.58%	17.89%	18.16%	18.58%	16.98%	27.58%	52,890

Note: "O" stands for offices, "R" for condominiums, and "S" for other uses.

This data shows that office buildings representing the glut created during the bubble period were forced off the market in the post-bubble market adjustment process. **In the post-bubble office market, we see only declines in contract rents if we look only at the macroscopic changes; but when we analyze the microstructure in terms of buildings, we find that market sorting has occurred in the form of conversions.**

3. What happens in the office market?

What are the current levels of returns in the office and residential markets? How will the real estate investment market change in the future?

3.1 Deterioration of fundamentals in the office market

The financial crisis was not just a headache for property markets, but had considerable impact on the real economy. The economic bubbles that began and ended in Japan and Sweden in the 1990s were confined to those countries. However, the latest real estate bubble and its collapse took place simultaneously around the world, changing its economic landscape entirely. The collapse of this particular bubble led to lower results for Japanese enterprises and forced them to change their global management strategies.

The resulting recession and revisions of management strategies have had a major impact on the real estate market. First, the recession implies a considerable decline in quantitative demand for office spaces. Long before this problem took shape, observers had already pointed out that the office market would experience a significant drop in demand when the retirement of the baby-boom generation began on a large scale. However, others opined that given a period of economic expansion, extending the term of employment and creating new jobs would maintain quantitative demand for office spaces. The recession that emerged instead caused enterprises to forgo employment extensions, discontinue the employment of non-regular workers, and even curb new hires. This indicates a decline in demand for office spaces as a macroscopic sum. Lower business results imply lower per capita productivity. Corporate productivity affects employee income and per unit office payment. In other words, a fall in corporate productivity after the financial crisis not only led to declining employee income, but pushed down rents paid per unit of space. Even a company located in one of the highest-grade office buildings at a prime location in the urban center will reduce the leased area it holds and seek to cut rent payments per unit if productivity declines.

We would expect changes in a company’s management strategy to trigger a restructuring of the properties it currently uses. Rather than carrying out temporary measures like consolidating or reorganizing its business sites, it would review management resources to change its production systems or product lineup, affecting the allocation of real estate resources.

In particular, the fundamentals of the office market will undergo major changes.

3.2 Adjustment of income return on office investment

This change in the fundamentals of the office market will result in higher vacancy rates and lower rent per unit.

Shown below (Figure 5) are long-term trends in office and house rents in the Tokyo 23 wards, indicated by a rent index based on contracted rents as estimated above.[7)] The reader may expect to see clear trends in the real estate market, but **no statistical data currently available shows by how much real estate prices and rents rose during the bubble period, when the bubble reached its peak, or how far adjustments progressed after the bursting of the bubble.**[8)]

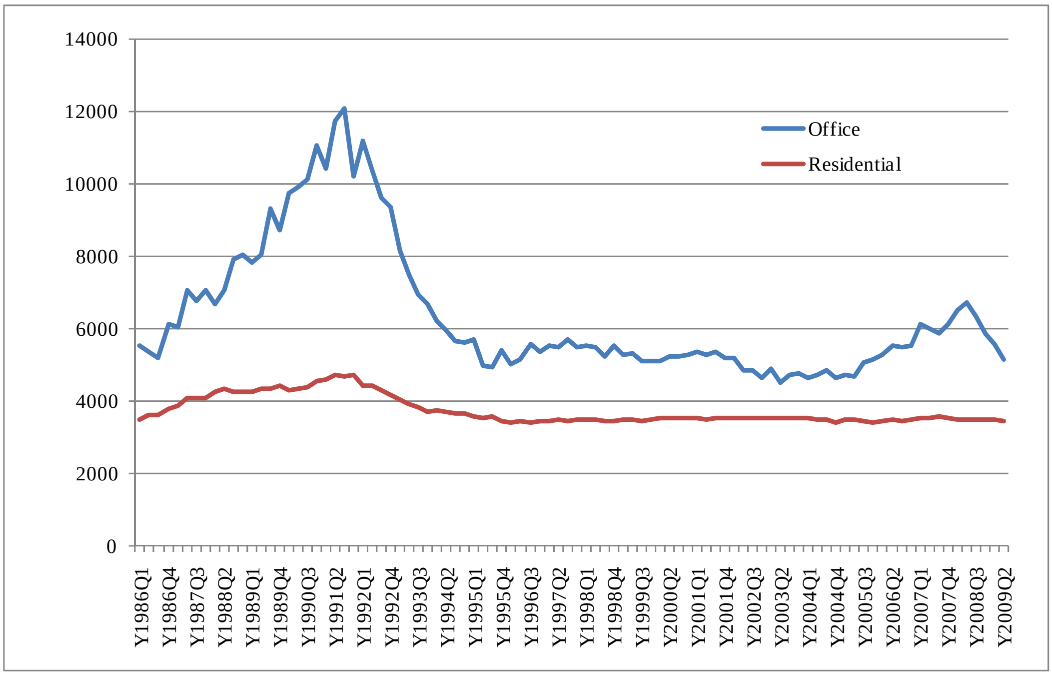

Figure 5. Macro-trends in office and residential rents

Office rents were ¥5,500/m^2 in the first quarter of 1986, reaching a peak of ¥12,000/m^2 in the third quarter of 1991, a 2.4-fold increase.[9)] However, after the bursting of the bubble, rent adjustments proceeded for five years, reducing rents to ¥5,000/m^2 by 1996, 60% down from 1991 levels. Thereafter, office rents continued to decline until 2004; began to rise in 2005,

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[7)] The rent index was estimated by the hedonic approach. Data on contracted rents for residential spaces and office spaces were provided by Recruit Co., Ltd. and by the member companies of Zentakuren, respectively.

[8)] See Nishimura and Shimizu (2002) for this issue.

[9)] This theoretical value is the average level including small buildings. Since small buildings are far greater in number in terms of the stock level, the observation looks lower in terms of the absolute level.

returning to ¥6,100/m^2 by the second quarter of 2008; but took a sharp downturn with the Lehman Shock in 2008, being adjusted to ¥5,000/m^2 by the second quarter of 2009. **The recent rent fluctuations in the wake of the financial crisis are approximately 25%—about half those of the bubble period, in which fluctuations exceeding 40% were experienced.**

Residential rents, on the other hand, have not fluctuated as sharply as office rents. Residential rents were ¥3,400/m^2 in the first quarter of 1986, reaching a peak in the second quarter of 1991, almost at the same moment as office rents, for a 1.35-fold increase, or over ¥4,700/m^2. Given the 2.4-fold increase in office rents, the rise in residential rents was relatively less pronounced, even during the bubble period. Residential rents bottomed out in the first quarter of 1996, at the same time as office rents, and were adjusted to ¥3,400/m^2, nearly equal to the first quarter of 1986. Thereafter, residential rents have remained between around ¥3,400/m^2 and ¥3,500/m^2. **Office rents rose from 2005 until they began declining once again in 2008 through 2009, but residential rents remained proof to these fluctuations. In short, residential rents have proved quite stable even in the wake of the financial crisis.**

The recent drop in office rents in the Tokyo 23 wards is not an immediate aggravating factor in the performance of office investments. As discussed by Shimizu (2009), we know that income returns from real estate investment have a tendency to resist movement, and rapid and sweeping adjustments do not occur in response to market changes. Income returns from real estate already in use do not change unless contractual rent figures are renewed; that is, they vary according to the probability of contract renewal and the amount by which rent rises or falls.

Given the ordinary practice in Japan of renewing lease contracts every other year, 2010 will mark a year of contract renewal for tenants who signed contracts when rents were highest in 2008. Negotiations for such contract renewals are expected to be based on and reflect the recent drops in rents. In other words, income returns will likely decline considerably due to possible downward rent revisions following contract renewals and the increases in macroscopic vacancies resulting from lower demand.

However, it would appear that this period of market adjustments is now almost at a close. Office rents cannot go lower than now, given the close proximity to the record lows of the past 25 years, including the post-bubble period, although we should not forget lagging effects. The impact of market adjustments will be limited compared with the post-bubble period in terms of the extent of market change.

3.3 Sorting office buildings

Income returns will decline temporarily, while the deterioration in fundamentals depends on economic recovery. However, it is important to note that not all office buildings will undergo average, similar fundamental changes. As the analysis in the preceding section suggests, many office buildings maintained certain performance levels and survived the post-bubble period. The line between such office buildings and those that will be forced off the market will grow clearer.

In this context, how will office buildings be sorted? The major differences from the 1990s bubble period are higher office stock levels and larger office spaces.

Many large buildings were constructed in the Tokyo 23 wards after 2000 in a phenomenon called the “year 2003 problem.” Given a sharp increase in office floorage and a decline in absolute demand for office spaces, it is easy to predict the market adjustment that occurred upon the collapse of the economic bubble. In such cases, adjustments will affect not just pencil buildings and peripherals, as with the post-bubble period. Rather, the sorting criteria will grow even more diverse.

The criteria used to be building location, size, and specifications. Now, there will be a growing tendency to differentiate office buildings by management skill. Such differentiation cannot be derived from the present analysis. It should be noted that even similar buildings located in similar areas will demonstrate significantly varying performances due to differences in the skill of their management.

No matter how large and conveniently located, office buildings may face rising vacancy rates and declining rents if they are poorly managed. Attention should be paid to the fact that more than ever before, mid-/small-sized buildings are likely to be sorted out as unused assets by the market.

3.4 Declines in capital return

If the office market changes as depicted above, capital returns will inevitably drop. Since this is determined as the discounted present value of a future return, if the return declines, there will be greater pressure to reduce prices. In addition, the discount rate has been raised due to growing liquidity risks. All this points to a further decline in capital returns.

4. What have we learned from the real estate bubble and the financial crisis?

What have the players in Japan’s real estate market learned from the advent and collapse of the real estate bubble? Have they incorporated these lessons when managing risks related to real estate investments?

When the economic bubble collapsed in the 1990s, as discussed in this paper, many assets were forced off the market. This implies the severalty of each real property; individual assets may have undergone various phenomena that cannot be estimated based on macroscopic changes alone, such as rising vacancy rates and declining rents.

The lesson learned by those who witnessed the generation and collapse of the bubble is that we can diversify our investments in periods of market expansion in terms of property type, size (asset class), and region, but we should select our assets carefully. Some have argued dispersing effects would arise from the increasing diversity of the market. In fact, these effects did not materialize, and we were required to select individual assets carefully. The recent fund bubble began with major office buildings in urban centers and expanded to encompass mid- and small-sized ones. Property types included not just office buildings, but residences, commercial facilities, logistics facilities, hotels, and the industrial infrastructure. The geographical scope of investment extended beyond Tokyo and other large cities to reach core and smaller cities in other regions.

In essence, real estate investments should be made from a long-range perspective. In particular, if long-term funds are to be used, it is important to carefully select real estate that is highly resistant to change over time, rather than investing in a wide variety of assets for the sake of reducing the related risk.

Differentiation will be spurred not merely by changes in fundamentals, but by building characteristics such as earthquake protection and the ability to conform to global environmental policies and regulations, as well as tightening of financial restrictions. Failure to properly control these risks will result in a higher cap rate, hence lower capital returns. In short, it will grow increasingly more important to identify and to invest with care in certain types of real estate.

The past real estate bubble and the recent financial crisis have demonstrated the diversity and severalty of real estate properties and the conditions investment properties must meet to be highly resistant to change over time.

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Appendix

Data

Land uses and use conversions

This study uses the building-based GIS (geographical information system) polygon data from a land and building use survey by the Bureau of Planning of the Tokyo Metropolitan Government to observe how buildings that existed in 1991 were redeveloped and converted by 1996 and 2001. The number of office buildings in 1991 stood at 40,516, excluding those used for both stores and housing.

Of the 40,516 office buildings that existed in 1991, 2,607 were redeveloped or converted into housing by 1996, with the remaining 37,909 buildings used still for offices. Of office buildings that existed in 1996, 3,576 were redeveloped or converted into housing by 2001. The remaining 36,940 office buildings remained as offices.

Office and housing rents

Office rent R^R and housing rent R^C must be specified to estimate the model in the previous section. We used rent data provided by the National Federation of Real Estate Transaction Associations, known as Zentakuren, for the period between January 1991 and December 2004. The data covered 13,147 rent contracts during the period.

Meanwhile, we used "*Weekly residential listing magazine—Rental Homes*" from Recruit Co. to collect housing rent data[10]. From the data in the magazine, we selected data that were deleted because contracts had been concluded. Rent prices upon their deletion from magazines represent first offers in the reverse auction process where landlords send house quality and rent information through magazines and continue to cut rents until they find tenants. These figures can be characterized as the highest prices for tenants, but may be taken as market prices because few tenants successfully negotiate reductions in rents from offered levels[11]. Between 1991 and December 2004, there were data on 488,348 rents. Office and housing rent databases are shown in Table 1 and a statistical summary in Table 2.

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[10] Steel apartments account for most rental housing stock. Because our study was designed to compare housing with office buildings, however, we limited data for our analysis to RC (reinforced concrete) and SRC (steel reinforced concrete) buildings.

[11] On a weekly basis, Recruit monitors whether contracts are concluded on advertised rents and how rents failing to meet tenant requests are lowered. As a result of monitoring, it has been found that final rent levels offered just before their deletion from the magazine are equal to contract levels (as confirmed with data from the period 1996 to 2001).

Table 1. Rent Data Outline

Symbols	Variables	Contents	Unit
WK	Distance to nearest station	Time to the nearest station (walking and bus).	minutes
ACC	Accessibility to central business district	Average of railway travel time in daytime to the most crowded 40 stations in 1988 weighted by the number of passengers at the stations*.	minutes
FS	Floor space/ square metres	Floor space	m^2
TA	Total floor space/ square metres	Total floor space	m^2
BY	Number of years after construction	Period between the date when the data are deleted from the magazine and the date of construction of the building.	year
BS	Balcony space/ square metres	Balcony space (as shown in *Jutaku Joho* magazine).	m^2
NU	Number of units	Total number of units in the condominium.	unit
RT	Market reservation time	Period between the date when the data appear in the magazine** for the first time and the date when the data are deleted	date
MC	Management cost	Management fee.	YEN/ month
WD	Walk dummy	Whether the travel time includes time on bus 1, not including time on bus 1 but including time on bus 0.	(0,1)
FF	First-floor dummy	The property is on the ground floor 1, on other floors 0.	(0,1)
HF	Highest floor dummy	The property is on the top floor 1, on the other floors 0.	(0,1)
SD	South-facing dummy	Windows facing south 1, other directions 0.	(0,1)
SD2	South-facing dummy2	Fenestrae facing south, south west or south east 1, other directions 0.	(0,1)
TK	Ferroconcrete dummy	Steel reinforced concrete frame structure 1, other structure 0.	(0,1)
KD	Housing Loan Corporation dummy	Eligible for Housing Loan Corporation loan 1, not eligible 0.	(0,1)
LDj (*j=0,…,J*)	Location (Ward) dummy	*j th administrative district 1,* other district 0.	(0,1)
RDk (*k=0,…,K*)	Railway line dummy	*i th railway line 1, other railway line 0.* (10 railway lines appeared in the magazine)	(0,1)

TDl (k=0,…,L)	Time dummy (monthly)	*k th month* *1,* other month 0.	(0,1)

* Shinjuku station is the busiest station. The busiest 40 stations include main terminal stations of the Yamanote Line such as Shinagawa, Ikebukuro and Shibuya as well as Yokohama, Kawasaki, Chiba, Omiya and Kashiwa stations. We have established a 73,920 railway line network database, which is worked out of 1,848 stations that appeared in the magazine for the 40 stations. This database is updated every six months.

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Table 2. Descriptive Statistics of Office and Housing Rent Data

	Office		Housing	
	Average	Standard deviation	Average	Standard deviation
Rent (yen/m^2)	4,851.48	1,925.12	3,248.26	824.90
Contractual space (m^2)	264.02	309.87	41.03	20.63
Distance to Tokyo centre (minutes)	12.46	6.25	10.53	7.17
Number of years after construction (years)	16.19	10.29	9.26	7.28
Distance to station (minutes)	4.13	2.91	6.76	3.89
Total floor space (m^2)	3,426.36	4,520.41	–	–
Number of observations=	13,147		488,348	

Each database covers a 14-year period in which bubbles formed and burst, including volatile rent data. The average office rent was 4,851 yen per square metre with a standard deviation of 1,925 indicating strong volatility. The average housing rent was 3,248 yen per square metre with a standard deviation of 824[12].

We use the above data to estimate floor rents. Office rents are determined through business location, based on the convenience of business communications and employees' commutation as well as workplace conditions such as space. Because the data for this study cover 14 years from 1991 to 2004, we make next pooling regression model as follows:

$$\log R_{it}^{O} = x_i^{O}{}'\theta^{O} + d_i^{O}{}'\delta^{O} + v_{it}^{O} \qquad (6)$$

where R_{it}^{O} stands for office rent per unit of floor area for property *i* at time *t*, x_i for the vector of property *i* characteristics (including floor space, distance to the nearest station, age, proximity

[12] Office rents ranged from the minimum at 1,815 yen to the maximum at 13,310 yen and housing rents from 600 yen to 13,300 yen. Both rents were distributed in the same area.

to an urban centre, and a regional dummy variable), θ^O for the relevant implicit price vector, d_i^O for a time dummy variable vector that takes the value of 1 at time *t* and 0 at any other time, δ^O for the time effect vector, and v_{it}^O is the disturbance term.

Housing rents are assumed to be based on commutation convenience, indicated by proximity to the urban centre, the distance to the nearest station, building age, structure and other characteristics such as window and door aspects. Prices of one-room apartments mainly for singles, compact houses for DINKS (double income no kids) and other small families, and family-type houses for large households are structurally different. Housing preferences for small households including singles and DINKS are different from those for large households including parents and their children. Therefore, their bid prices are structurally different (Shimizu et al., 2004). The model is given in next equation:

$$\log R_{it}^H = x_i^{H}{}'\theta^H + d_i^{H}{}'\delta^H + v_{it}^H \qquad (7)$$

where R_{it}^H stands for the housing rent per unit area for property *i* at times *t* and x_i for the vector of property *i* characteristics (including space occupancy, age, distance to the nearest station, time to the urban centre and a regional dummy variable).

Estimation Results

Rent functions for office and housing uses

Table 5 indicates estimation results for office and housing rent functions. Regarding the office rent function, age, or number of years since construction, was estimated at –0.093 and the distance to the nearest station at –0.219. As for age, the rent per square metre was estimated to decline by 9.3% every year. Although the decline appears too fast, the age variable apparently accounts for fast economic and technological deterioration of old office buildings amid the advancement of office buildings (for adaptations to office automation equipment, higher ceilings and earthquake resistance) and building methods (for features such as columns). Given the average age of 16 years for buildings in our analysis, we believe that the tendency may be strong.

Distance to the nearest station indicates how business communication and workers' commutation is convenient.

Regarding the housing rent function for the standard compact type, age is estimated at

–0.070, distance to the nearest station at –0.034, the First-floor dummy(Table.1) at –0.042 and proximity to the urban centre at –0.066. All of these variables are negative, consistent with the general tendency, but space occupancy is given as –0.197 in contrast to a positive figure for the office rent model. We must pay attention to the sign difference. Here, the constant term dummy and the cross term are also observed.

Among constant term dummies, the one-room dummy is estimated at +0.706 and the family-type dummy at –1.581. Regarding cross terms between the one-room dummy and the variables, space occupancy is estimated at –0.263, distance to the nearest station at –0.011, age at +0.025 and time to the urban centre at –0.040. The estimation results indicate that the tendency to avoid age for the one-room type is weaker than for the compact type. One-room apartment residents may give priority to convenience rather than environment, demonstrating strong preferences for shorter distance to the nearest station and a shorter time to the urban centre.

For the family-house type, space occupancy is estimated at +0.043, distance to the nearest station at +0.004, age at –0.002 and time to the urban centre at –0.035. Family-type house residents have stronger preferences than compact or one-room house residents for newer and wider buildings. If +0.004 of the cross term is taken into account, the distance to the nearest station is then –0.030. This tendency indicates that residents in relatively wide rental condominiums give less priority to traffic convenience than do one-room and compact house residents. This suggests that better residential environments for houses are associated with longer distances to the nearest station. In Tokyo’s special wards, railway stations and their vicinities feature greater convenience and commercial concentration while lacking greenery, playgrounds or security. At locations that are more distant from railway stations, the natural environment, park development and security may be better. This may be interpreted to mean that households in larger houses might have given priority to natural environmental quality rather than convenience associated with shorter distances to railway stations.

Therefore, family-type house residents who demonstrate stronger preferences for better residential environments are expected to be less sensitive to distances to railway stations than one-room or compact house residents.

Table 5. Office and Housing Rent Function Estimation Results

Method of Estimation	OLS			
Dependent Variable	*OR*: Rent of Office (in log)		*RC*: Rent of Condominium (in log)	
Property Characteristics (in log)	Coefficient	t-value	Coefficient	t-value
Constant	8.374	181.483	0.253	–24.999
FS: Contractual space	0.190	59.102	–0.197	–141.297
BY: Number of years after construction	–0.093	–24.174	–0.070	–259.324
WK: Distance to nearest station	–0.219	–46.556	–0.034	–70.827
ACC: Time distance to Tokyo centre	–0.112	–25.362	–0.066	–117.539
TA: Total floor space	0.051	16.932	–	–
SRC: SRC building dummy	0.199	34.020	0.013	29.494
D1F: First-floor dummy	–	–	–0.042	–76.386
DR1: One-room dummy	–	–	0.706	94.008
DRF: Family-type dummy	–	–	–1.581	–125.536
Cross-Term Effect by Property Characteristics				
DR1×FS	–	–	–0.263	–123.852
DR1×WK	–	–	–0.011	–14.917
DR1×BY	–	–	0.025	63.409
DR1×ACC	–	–	–0.040	–74.509
DRF×FS	–	–	0.403	137.089
DRF×WK	–	–	0.004	4.966
DRF×BY	–	–	–0.002	–3.705
DRF×ACC	–	–	–0.035	–46.599
Ward (city) Dummy	Yes		Yes	
Railway/Subway Line Dummy	Yes		Yes	
Time Dummy	Yes		Yes	
Adjusted R square=	0.608		0.758	
Number of observations=	13,147		488,348	

Condition for profit gaps

The above office and housing rent function parameters are used to measure theoretical rents for buildings in our analysis. Building data identified through the GIS polygon include use, floor-space ratio, area, number of floors, building shape and geographic coordinates. Including time effects, these data are included to compute theoretical (predicted) office and housing rents for each building in 1996 and 2001.

First, we computed theoretical rents, compared theoretical office and housing rents and confirmed the distribution of buildings that should be converted into housing for higher rents. The distribution of buildings for which housing rents would be higher than office rents is given for 1991, 1996 and 2001 (Figures 2, 3 and 4). In 1991, there are few buildings for which housing rents were higher than office rents, but such buildings proliferated year by year as bubbles burst. Particularly, clear distribution biases were confirmed. Such rent or profit gaps do not lead immediately to building use conversions because these are accompanied by demolition and reconstruction costs. If land-use conversions are expected to improve profit even with these costs taken into account, incentives for conversions may be effective. If land-use conversions are temporarily projected to improve profit at a certain point, however, they may not necessarily be implemented. Because real estate properties are durable investment goods, land-use conversions may not be implemented unless net profit is expected to improve even with costs taken into account for a certain period of time.