Relationship between Vacancy Duration and Rate of Rent Reduction: Evidence from the Rental Apartment Market in Tokyo's 23 Wards

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Abstract

Owners of rental apartments have an incentive to fill vacant rooms because their returns decrease if vacancies persist for a long time. To improve property's market competitiveness is one of important methods that fill a vacant room for owners. Therefore, owners try various actions such as investing in facilities, improving property management, etc. Rent reductions are a popular option because of ease of implementation and rapid impact. Vacancy duration affects the increasing/decreasing vacancy rate. Many previous studies have identified the existence of an equilibrium vacancy rate that affects increases/decreases in market rent, i.e., the natural vacancy rate (e.g., Tse and MacGregor, 1999; Gabriel and Nothaft, 2001).

On the other hand, vacancy duration may affect the amount of rent reduction, and not just the timing. However, to the best of our knowledge, no prior studies have analyzed this relationship. This study is therefore the first to confirm this effect.

In this paper, the study group used a data set of rental apartments in Tokyo’s 23 Wards contributed by At Home Co., Ltd., which provides real estate market information. Our study group calculated vacancy duration and rates of rent reductions by using them. Next we analyzed the relationship between vacancy duration and rate of rent reduction. As a result, the study group confirmed a negative correlation between these factors from January 2004 to December 2013. Additionally, we confirmed that units with longer vacancy duration are more strongly affected by business trends.

1. Introduction

The duration of periods of vacancy affects the increase or decrease in the vacancy rate. Touching on this, many previous studies have posited the existence of an equilibrium vacancy rate that affects increases and decreases in the market rent, or in other words a natural vacancy rate (e.g., Tse and MacGregor, 1999; Gabriel and Nothaft, 2001). On the other hand, vacancy duration may also affect not only the timing of increases or reductions in rent prices, but also the amount by which rents are reduced. To the best of our knowledge, however, there has not yet been any study of the impact of rent prices on vacancy duration. This study therefore sets out to confirm such an effect.

In this paper, we focus on Metropolitan Tokyo's 23 Wards, Japan, where there is a high risk that market competitiveness decreases as buildings deteriorate with age, as a result of the actively ongoing supply of new housing (e.g., statistics from the Ministry of Land, Infrastructure and Transport indicate that between 40,000 and 70,000 rental properties are supplied annually in Tokyo's 23 Wards). There are additionally many cases where property management is carried out inappropriately, which also contributes to a loss of competitiveness. Typically, under strong economic conditions, vacancy durations remain short even in housing with diminished competitive power, while vacancy durations in such housing lengthen during times of recession. In cases where rent reductions fail to fill vacancies, this serves as an incentive for owners of rental apartments to reduce rents further. Hence, remaining subject to market conditions, it is possible that the length of vacancy durations may also impact the degree of rent reductions.

In this paper, we draw on rental property data from At Home Co., Ltd., One of Japan's largest housing information service provider, to calculate the rate of rent reduction and vacancy duration for individual apartments in Tokyo's 23 Wards. Next, we analyze the relationship between vacancy duration and rate of rent reduction, with a subsequent analysis of the relationship between rent reductions due to vacancy duration and indexes of business conditions.

2. Data

2.1. Rental property dataset

This study was conducted in collaboration with At Home Co., Ltd., a company that provides real estate information media services to consumers and real estate business solutions to companies in the real estate industry. At Home maintains a wealth of real estate-related information, having established a network of more than 51,000 real estate companies. While the property data available through the At Home National Real Estate Information Network includes property advertising data in both print and online media, for the purposes of this study utilize the data in print media only, which constitutes a long accumulation period. It should be noted that our study draws on a sample dataset of only 240,000 tenant contracts from a total useable dataset of 1.67 million items (which include tenant recruitment data) for the period from January 2004 to December 2013. Additionally, as our analysis proceeds to identify trends classified by *madori* (standardized room type used to categorize Japanese residences), we will provide an explanation of *madori* as this classification is used in the context of rental properties in Japan.

2.1.1. Rental property data: *madori*

There are nine different types of *madori* that are considered representative of room type in Japan (1R, 1K, 1DK, 1LDK, 2K, 2DK, 2LDK, 3DK, and 3LDK). Each letter indicates that the room to which it refers exists independently of the other rooms ("K" refers to "kitchen", "D" to "dining room", and "L" to "living room"), with the number indicating the number of bedrooms. A portion of the households in our sample ("single", "compact", "family") exist in multiple *madori* categories. A summary of *madori* is shown in Table 1. Fujii et al. (2012) has pointed out existence of the unique market for each of these *madori* types.

Table 1: Categorized madori data for Tokyo's 23 wards

Madori	Number of Data (offer)	Number of Data (contract)	Description	Area of unit (Average±σ)
1R	303,254	45,959	One room with kitchen area include	14m2 - 30m2
1K	634,797	98,677	1 bedroom and a kitchen	18m2 - 30m2
1DK	115,993	17,602	1 bedroom, a dining room and a kitchen	26m2 - 38m2
1LDK	166,002	22,328	1 bedroom, a living room, a dining room and a kitchen	37m2 - 58m2
2K	49,909	6,207	2 bedrooms and a kitchen	27m2 - 39m2
2DK	144,679	19,988	2 bedrooms, a dining room and a kitchen	37m2 - 48m2
2LDK	138,964	17,500	2 bedrooms, living room and dining room with a kitchen	48m2 - 78m2
3DK	39,342	4,241	3 bedrooms, a dining room and a kitchen	49m2 - 61m2
3LDK	81,196	8,776	3 bedrooms, a living room, a dining room and a kitchen	55m2 - 101m2

2.2. Vacancy duration dataset

2.2.1. Model

Drawing on rental property data from At Home, the following method was used to calculate vacancy duration (*VD*) for rental properties, which was defined as the period from when a given apartment is initially advertised as available to rent and the signing of a rental contract:

Vacancy Duration (*VD*) = Contract Month – Initial Advertisement Month (1)

e.g.,) Initial Advertisement Month: Jan-2013 Contract month: Mar-2013 ⇒ *VD*: **3** months

Initial Advertisement Month: Jan-2013 Contract month: Dec-2013 ⇒ *VD*: **12** months

Out of the information available in the rental property dataset, the items used in the calculation of vacancy duration were as follows: Rental Property Building Number, Room Number, Initial Advertisement Month, Initial Advertised Rent, Contract Rent, Contract Month, *madori*, and Building Age. Additionally, in some cases advertising data was available for a continuous number of months, while in other cases there were gaps lasting a certain number of months. In such cases, advertising data separated by a gap of six months or more were regarded as pertaining to separate advertising data (e.g., where contract information had not been renewed) and excluded from the calculation. Table 1 shows this dataset categorized by *madori*.

2.2.2. Time-series of rent reduction

We took the mean vacancy duration for rooms contracted in a given month, which was calculated as follows:

$$VD_C(t) = \frac{\sum_{i \in I_C(t)} VD_i}{\left|I_C(t)\right|}, \quad I_C(t) : \text{observatio ns contracted in time } t \tag{2}$$

$VD_c(t)$: Vacancy duration (*VD*) of the observation contracted in time *t*

VD_i: Vacancy duration (*VD*) of the *i*-th observation

Note that in order to eliminate seasonal variations, a 12-month moving average was taken. This is used in the analysis shown in Section 3 below.

$$VD_C^*(t) = \frac{\sum_{\tau=t-11}^{t} VD_C(\tau)}{12} \tag{3}$$

VD_c *: 12-months backward moving average of VD_c

Table 2 shows the vacancy duration data for Tokyo's 23 wards used in this study, categorized by *madori*. The same data is plotted in Figure 1.

Table 2: Vacancy duration for Tokyo's 23 wards categorized by *madori*

(Months)

	1R	1K	1DK	1LDK	2K	2DK	2LDK	3DK	3LDK
Jan-06	2.91	2.67	2.86	2.95	2.92	3.06	3.04	3.02	3.18
Feb-06	2.92	2.68	2.92	2.95	2.94	3.07	3.02	3.05	3.21
Mar-06	2.94	2.69	2.91	2.93	2.91	3.07	3.05	3.09	3.2
Apr-06	2.96	2.68	2.92	2.92	2.9	3.07	3.06	3.06	3.22
May-06	2.96	2.7	2.93	2.93	2.85	3.08	3.05	3.12	3.26
Jun-06	2.94	2.7	2.94	2.92	2.83	3.09	3.06	3.15	3.25
Jul-06	2.94	2.7	2.94	2.92	2.83	3.08	3.02	3.15	3.27
Aug-06	2.96	2.72	2.92	2.97	2.84	3.07	3.04	3.18	3.32
Sep-06	2.94	2.71	2.95	3.01	2.88	3.03	3.03	3.33	3.27
Oct-06	2.92	2.7	2.95	3	2.9	3.03	3.04	3.32	3.21
Nov-06	2.91	2.7	2.9	3	2.97	3.03	2.98	3.29	3.25
Dec-06	2.91	2.67	2.86	3.06	2.97	2.98	2.98	3.32	3.24
Jan-07	2.89	2.63	2.78	3	2.82	2.93	2.96	3.24	3.15
Feb-07	2.87	2.6	2.69	3.01	2.83	2.93	2.96	3.19	3.09
Mar-07	2.86	2.58	2.67	3	2.85	2.92	2.92	3.15	3.11
Apr-07	2.84	2.58	2.64	3	2.85	2.89	2.86	3.16	3.08
May-07	2.86	2.57	2.65	3.02	2.82	2.87	2.86	3.17	3.05
Jun-07	2.87	2.59	2.62	3.02	2.83	2.87	2.82	3.22	3.06
Jul-07	2.87	2.58	2.63	3.06	2.85	2.86	2.81	3.14	3.01
Aug-07	2.86	2.56	2.64	3.02	2.83	2.85	2.77	3.08	2.97
Sep-07	2.87	2.58	2.63	3	2.85	2.9	2.78	2.95	3
Oct-07	2.88	2.58	2.63	2.97	2.82	2.87	2.78	2.92	3.05
Nov-07	2.89	2.58	2.7	3.03	2.78	2.86	2.81	2.92	2.97
Dec-07	2.9	2.59	2.71	3.02	2.81	2.86	2.81	2.96	2.97
Jan-08	2.95	2.65	2.75	3.06	3.03	2.88	2.74	3.01	3.01
Feb-08	2.94	2.68	2.79	3.05	2.98	2.89	2.76	3.06	3.03
Mar-08	2.95	2.72	2.81	3.08	3.06	2.89	2.8	3.04	2.97
Apr-08	2.94	2.73	2.83	3.07	3.08	2.87	2.86	3.09	2.96
May-08	2.91	2.75	2.83	3.07	3.11	2.86	2.85	3	2.94
Jun-08	2.9	2.74	2.88	3.07	3.13	2.84	2.88	2.94	2.91
Jul-08	2.9	2.77	2.88	3.09	3.11	2.84	2.93	2.94	2.92
Aug-08	2.88	2.79	2.91	3.15	3.12	2.84	2.96	2.99	2.91
Sep-08	2.87	2.8	2.9	3.15	3.09	2.83	2.97	2.91	2.86
Oct-08	2.89	2.81	2.91	3.17	3.07	2.83	2.93	2.86	2.74
Nov-08	2.89	2.82	2.89	3.17	3.05	2.83	2.91	3.01	2.75
Dec-08	2.86	2.82	2.93	3.17	3.06	2.82	2.89	3.01	2.7
Jan-09	2.81	2.81	2.9	3.19	2.9	2.82	2.9	3.03	2.7
Feb-09	2.83	2.81	2.94	3.25	2.95	2.79	2.92	3.01	2.7
Mar-09	2.84	2.81	2.99	3.27	2.92	2.89	2.95	3.12	2.75
Apr-09	2.86	2.8	3.01	3.31	2.92	2.9	2.99	3.05	2.81
May-09	2.92	2.83	3.04	3.35	2.91	2.93	3	3.22	2.87
Jun-09	2.94	2.84	3.01	3.39	2.86	2.94	3.02	3.23	2.95
Jul-09	2.94	2.84	2.99	3.37	2.84	2.97	3.01	3.29	3.05
Aug-09	2.98	2.86	2.93	3.4	2.8	2.99	3.09	3.2	3.19
Sep-09	3.08	2.92	2.97	3.44	2.79	2.97	3.13	3.24	3.27
Oct-09	3.09	2.95	2.94	3.46	2.78	3.02	3.17	3.28	3.47
Nov-09	3.12	2.99	2.97	3.47	2.94	3.09	3.25	3.18	3.57
Dec-09	3.16	3.02	2.93	3.48	2.97	3.14	3.3	3.23	3.66
Jan-10	3.22	3.04	2.96	3.46	2.97	3.15	3.38	3.26	3.73
Feb-10	3.23	3.07	2.99	3.43	3.02	3.2	3.43	3.28	3.82
Mar-10	3.26	3.09	2.94	3.43	2.96	3.13	3.44	3.23	3.89
Apr-10	3.34	3.19	2.97	3.46	3.07	3.25	3.44	3.41	3.92
May-10	3.33	3.19	2.98	3.43	3.07	3.28	3.5	3.26	3.9
Jun-10	3.33	3.22	3	3.44	3.12	3.33	3.55	3.32	3.88
Jul-10	3.37	3.21	3.06	3.42	3.17	3.31	3.54	3.37	3.85
Aug-10	3.44	3.21	3.13	3.38	3.18	3.31	3.47	3.46	3.9
Sep-10	3.34	3.17	3.14	3.37	3.18	3.32	3.44	3.6	3.91
Oct-10	3.38	3.21	3.22	3.43	3.32	3.34	3.45	3.55	3.8
Nov-10	3.34	3.16	3.19	3.43	3.17	3.29	3.4	3.62	3.81
Dec-10	3.36	3.18	3.17	3.44	3.1	3.29	3.38	3.85	3.76
Jan-11	3.33	3.19	3.2	3.39	3.22	3.31	3.32	3.87	3.73
Feb-11	3.33	3.16	3.18	3.38	3.21	3.31	3.24	4.01	3.64
Mar-11	3.32	3.17	3.22	3.36	3.27	3.3	3.25	4.08	3.59
Apr-11	3.28	3.09	3.2	3.34	3.18	3.28	3.24	4.09	3.56
May-11	3.3	3.08	3.19	3.35	3.2	3.28	3.17	4.46	3.6
Jun-11	3.33	3.08	3.22	3.32	3.23	3.3	3.11	4.51	3.55
Jul-11	3.31	3.07	3.15	3.34	3.24	3.39	3.17	4.51	3.52
Aug-11	3.26	3.07	3.13	3.34	3.31	3.46	3.21	4.68	3.39
Sep-11	3.27	3.04	3.14	3.31	3.33	3.46	3.17	4.52	3.35
Oct-11	3.2	2.98	3.1	3.2	3.29	3.46	3.12	4.72	3.35
Nov-11	3.26	3.01	3.19	3.12	3.41	3.44	3.11	4.63	3.32
Dec-11	3.23	2.98	3.2	3.1	3.49	3.44	3.09	4.32	3.36
Jan-12	3.22	3	3.18	3.07	3.45	3.45	3.11	4.24	3.33
Feb-12	3.21	3.03	3.13	3.05	3.46	3.46	3.12	4.06	3.39
Mar-12	3.27	3.06	3.12	3.05	3.46	3.43	3.04	4.13	3.37
Apr-12	3.26	3.07	3.19	2.99	3.53	3.45	3.11	4.02	3.36
May-12	3.22	3.02	3.15	2.97	3.46	3.41	3.14	3.92	3.27
Jun-12	3.18	2.97	3.14	2.93	3.47	3.43	3.12	3.91	3.35
Jul-12	3.17	2.95	3.11	2.87	3.43	3.37	3.04	3.85	3.43
Aug-12	3.13	2.97	3.05	2.83	3.41	3.42	2.99	3.73	3.41
Sep-12	3.15	2.97	3.04	2.8	3.43	3.51	2.95	3.79	3.42
Oct-12	3.17	2.92	3.07	2.8	3.36	3.48	2.97	3.74	3.42
Nov-12	3.12	2.88	2.98	2.8	3.27	3.48	2.95	3.93	3.36
Dec-12	3.11	2.88	3.01	2.79	3.25	3.57	2.95	4.06	3.36
Jan-13	3.08	2.85	3.02	2.81	3.21	3.52	3.04	4.14	3.44
Feb-13	3.09	2.85	3.08	2.84	3.07	3.55	3.07	4.36	3.37
Mar-13	3.04	2.8	3.11	2.84	3.08	3.61	3.14	4.2	3.37
Apr-13	3.03	2.79	3.02	2.85	2.97	3.57	3.08	4.28	3.37
May-13	3.04	2.83	3.09	2.82	3.01	3.69	3.1	4.17	3.38
Jun-13	3.02	2.84	3.06	2.86	3.06	3.7	3.09	4.1	3.32
Jul-13	3.02	2.85	3.12	2.9	3.1	3.72	3.14	4.05	3.23
Aug-13	2.99	2.8	3.18	2.89	3.13	3.61	3.13	3.92	3.3
Sep-13	3.02	2.82	3.17	2.9	3.18	3.54	3.2	4.05	3.25
Oct-13	3.05	2.87	3.13	2.91	3.15	3.61	3.19	3.92	3.24
Nov-13	3.02	2.85	3.12	2.91	3.14	3.63	3.16	3.78	3.16
Dec-13	3	2.8	3.16	2.9	3.33	3.58	3.29	3.66	3.14

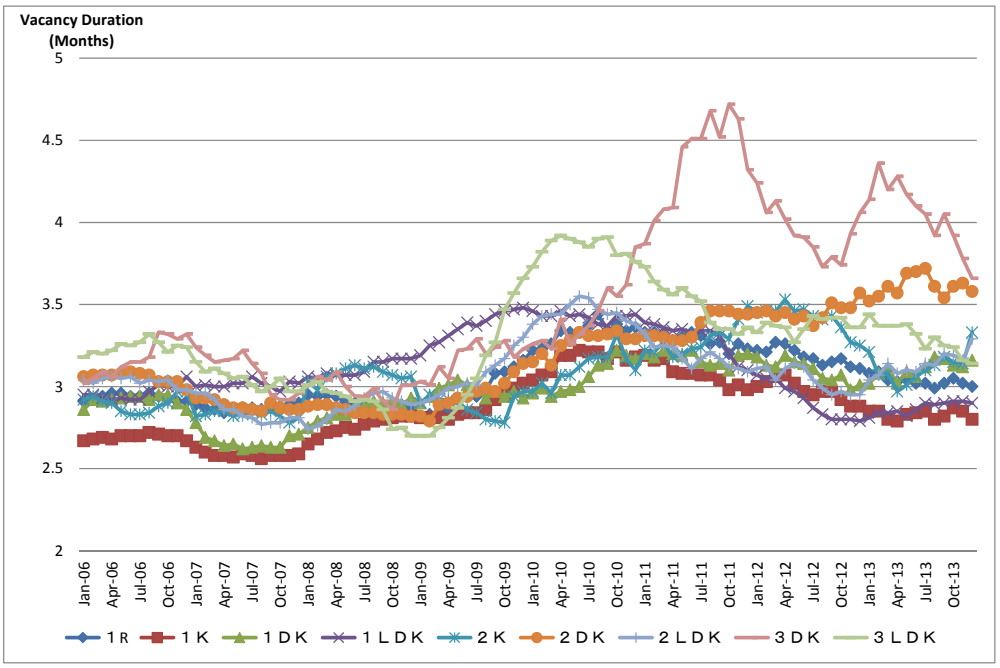


Figure 1 Change in vacancy duration for Tokyo's 23 wards categorized by *madori*

2.3. Dataset for rent reduction with vacancy duration

2.3.1. Model

The rate of rent reduction from the initial advertisement of rental units until a contract is signed was calculated as follows:

$$RR_i = \frac{CR_i - IAR_i}{IAR_i} \times 100 \qquad (4)$$

RR: Rate of rent reduction (with vacancy duration)

CR: Contract Rent

IAR: Initially Advertised Rent

e.g.) ((*CR*: 90, 000 JPY – *IAR*: 100,000) / 100,000) × 100 = *RR*: –10%

2.3.2. Rate of rent reduction in response to vacancy duration

In order to confirm the impact of vacancy duration on reductions in rent, the rate of rent reduction was calculated for each single month of vacancy duration.

$$RR_{VD}(vt) = \frac{\sum_{i \in I_{VD}(vt)} RR_i}{\left| I_{VD}(vt) \right|}, \quad I_{VD}(vt) : \text{observations with vacancy duration } VD = vt \qquad (5)$$

RR_{VD}: *RR* with Vacancy Duration *VD*

RR_i: *RR* of the *i*-th observation

Table 3 shows rates of rent reduction for the 23 Tokyo wards used in this study, categorized by advertisement period.

Table 3: Rate of rent reduction by vacancy duration

Vacancy duration	Number of Data	Rate of rent reduction (with vacancy duration)
1	52298	−0.03
2	105242	−0.18
3	30934	−1.4
4	18399	−2.27
5	12106	−2.89
6	8153	−3.57
7	5305	−3.98
8	3395	−4.49
9	2471	−4.98
10	1727	−5.12
11	1152	−4.82
12	898	−5.63
13	656	−5.66
14	437	−5.52
15	292	−5.72
16	213	−6.15
17	178	−5.55
18	146	−6.07
19	122	−7.08
20	94	−7.86

2.3.3. Time-series of rate of rent reduction

In order to confirm the change in the rate of rent reduction due to vacancy duration, the rate of rent reduction was calculated for each month that a contract was signed.

$$RR_C(t) = \frac{\sum_{i \in I_C(t)} RR_i}{\left| I_C(t) \right|}, \quad I_C(t) : \text{observations contracted in time} = t \tag{6}$$

$RR_c(t)$: RR of the observation contracted in time t

Note that in order to eliminate seasonal variations, a 12-month moving average was taken. This is used in the analysis shown in Section 4 below.

$$RR_C{}^*(t) = \frac{\sum_{\tau=t-11}^{t} RR_C(\tau)}{12} \tag{7}$$

RR_c*: 12-months backward moving average of RR_c

Table 4 shows the rates of rent reduction for vacancy duration for the Tokyo's 23 Wards used in this study, categorized by *madori*. This data is plotted in Figure 2.

Table 4: Rate of rent reduction for vacancy durations in Tokyo's 23 wards categorized by *madori*

(%)

	1R	1K	1DK	1LDK	2K	2DK	2LDK	3DK	3LDK
Jan-06	−1.22	−0.87	−0.97	−0.99	−1.06	−1.26	−1.18	−1.18	−1.61
Feb-06	−1.24	−0.89	−0.99	−1	−1.06	−1.31	−1.15	−1.23	−1.62
Mar-06	−1.23	−0.9	−0.94	−0.97	−1.1	−1.29	−1.14	−1.23	−1.62
Apr-06	−1.21	−0.9	−0.97	−0.97	−1.11	−1.25	−1.13	−1.19	−1.58
May-06	−1.19	−0.94	−0.98	−0.93	−1.06	−1.23	−1.08	−1.13	−1.58
Jun-06	−1.11	−0.91	−0.94	−0.9	−1.05	−1.19	−1	−1.15	−1.54
Jul-06	−1.08	−0.84	−0.9	−0.89	−1.08	−1.18	−1	−1.16	−1.45
Aug-06	−1.06	−0.83	−0.89	−0.89	−1.07	−1.13	−0.96	−1.12	−1.49
Sep-06	−1	−0.81	−0.85	−0.91	−1.06	−1.11	−0.92	−1.15	−1.4
Oct-06	−0.96	−0.77	−0.88	−0.91	−1.07	−1.11	−0.94	−1.15	−1.43
Nov-06	−0.92	−0.74	−0.84	−0.91	−1.17	−1.1	−0.89	−1.1	−1.37
Dec-06	−0.88	−0.71	−0.88	−0.92	−1.15	−1.07	−0.81	−1.13	−1.4
Jan-07	−0.86	−0.68	−0.86	−0.92	−1.13	−1.04	−0.83	−1.15	−1.31
Feb-07	−0.82	−0.64	−0.82	−0.9	−1.11	−1	−0.83	−1.1	−1.25
Mar-07	−0.8	−0.61	−0.82	−0.86	−1.06	−0.98	−0.8	−1.09	−1.27
Apr-07	−0.77	−0.58	−0.77	−0.83	−1.07	−0.9	−0.76	−1.13	−1.32
May-07	−0.77	−0.56	−0.74	−0.85	−1.04	−0.87	−0.74	−1.19	−1.24
Jun-07	−0.78	−0.55	−0.7	−0.83	−1.03	−0.88	−0.73	−1.14	−1.19
Jul-07	−0.78	−0.55	−0.74	−0.88	−0.98	−0.83	−0.73	−1.11	−1.26
Aug-07	−0.78	−0.52	−0.7	−0.89	−0.91	−0.79	−0.77	−1.08	−1.23
Sep-07	−0.8	−0.53	−0.69	−0.89	−0.86	−0.77	−0.77	−1.07	−1.26
Oct-07	−0.81	−0.53	−0.7	−0.89	−0.75	−0.71	−0.81	−0.99	−1.29
Nov-07	−0.8	−0.54	−0.69	−0.87	−0.66	−0.66	−0.86	−0.88	−1.25
Dec-07	−0.82	−0.54	−0.64	−0.83	−0.68	−0.64	−0.82	−0.85	−1.2
Jan-08	−0.83	−0.56	−0.67	−0.95	−0.65	−0.65	−0.76	−0.82	−1.14
Feb-08	−0.82	−0.58	−0.68	−0.94	−0.7	−0.64	−0.76	−0.83	−1.13
Mar-08	−0.82	−0.59	−0.67	−0.97	−0.71	−0.64	−0.77	−0.83	−1.06
Apr-08	−0.82	−0.59	−0.64	−1	−0.7	−0.63	−0.78	−0.79	−0.99
May-08	−0.8	−0.58	−0.63	−1.05	−0.72	−0.61	−0.84	−0.65	−0.99
Jun-08	−0.79	−0.58	−0.66	−1.15	−0.76	−0.56	−0.86	−0.62	−1.04
Jul-08	−0.8	−0.6	−0.64	−1.12	−0.76	−0.57	−0.89	−0.61	−0.99
Aug-08	−0.8	−0.65	−0.65	−1.19	−0.86	−0.56	−0.9	−0.55	−1.03
Sep-08	−0.8	−0.63	−0.64	−1.17	−0.82	−0.56	−0.9	−0.48	−1.03
Oct-08	−0.82	−0.66	−0.6	−1.24	−0.78	−0.58	−0.95	−0.52	−0.99
Nov-08	−0.85	−0.67	−0.67	−1.34	−0.8	−0.57	−0.97	−0.71	−1.04
Dec-08	−0.87	−0.67	−0.71	−1.42	−0.85	−0.54	−1.06	−0.67	−1
Jan-09	−0.9	−0.67	−0.7	−1.34	−0.85	−0.58	−1.11	−0.76	−1.14
Feb-09	−0.93	−0.68	−0.74	−1.47	−0.89	−0.58	−1.15	−0.86	−1.23
Mar-09	−0.98	−0.72	−0.78	−1.56	−0.93	−0.56	−1.25	−0.85	−1.29
Apr-09	−1.04	−0.73	−0.87	−1.67	−0.92	−0.58	−1.34	−0.89	−1.46
May-09	−1.09	−0.77	−0.93	−1.69	−0.91	−0.58	−1.33	−1.08	−1.6
Jun-09	−1.13	−0.83	−0.93	−1.73	−0.84	−0.62	−1.44	−1.14	−1.84
Jul-09	−1.2	−0.86	−1	−1.84	−0.85	−0.7	−1.54	−1.21	−2.08
Aug-09	−1.28	−0.88	−1.01	−1.94	−0.76	−0.76	−1.64	−1.22	−2.23
Sep-09	−1.36	−0.93	−1.07	−2.05	−0.79	−0.76	−1.77	−1.29	−2.37
Oct-09	−1.38	−0.96	−1.1	−2.11	−0.84	−0.82	−1.83	−1.26	−2.62
Nov-09	−1.45	−1.01	−1.15	−2.23	−0.87	−0.88	−1.96	−1.16	−2.79
Dec-09	−1.5	−1.06	−1.12	−2.31	−0.87	−0.98	−1.97	−1.15	−2.79
Jan-10	−1.5	−1.11	−1.14	−2.37	−0.86	−0.98	−2.03	−1.15	−2.94
Feb-10	−1.55	−1.14	−1.17	−2.33	−0.81	−1.03	−2.13	−1.07	−2.99
Mar-10	−1.55	−1.16	−1.19	−2.38	−0.73	−1.06	−2.16	−1.21	−3.04
Apr-10	−1.59	−1.19	−1.2	−2.41	−0.8	−1.12	−2.15	−1.28	−2.99
May-10	−1.67	−1.22	−1.28	−2.39	−0.84	−1.16	−2.22	−1.15	−2.97
Jun-10	−1.73	−1.21	−1.28	−2.4	−0.97	−1.23	−2.2	−1.12	−2.83
Jul-10	−1.73	−1.23	−1.31	−2.39	−1.02	−1.24	−2.13	−1.11	−2.68
Aug-10	−1.71	−1.24	−1.32	−2.32	−1.15	−1.23	−2.02	−1.13	−2.62
Sep-10	−1.72	−1.26	−1.36	−2.27	−1.19	−1.28	−1.97	−1.17	−2.64
Oct-10	−1.73	−1.26	−1.4	−2.25	−1.2	−1.27	−1.87	−1.18	−2.4
Nov-10	−1.69	−1.25	−1.37	−2.17	−1.28	−1.26	−1.84	−1.16	−2.32
Dec-10	−1.66	−1.22	−1.37	−2.11	−1.21	−1.23	−1.88	−1.13	−2.38
Jan-11	−1.68	−1.22	−1.39	−2.03	−1.31	−1.22	−1.83	−1.18	−2.24
Feb-11	−1.68	−1.21	−1.38	−2	−1.41	−1.24	−1.71	−1.28	−2.12
Mar-11	−1.69	−1.21	−1.38	−1.92	−1.5	−1.28	−1.64	−1.16	−2.12
Apr-11	−1.67	−1.17	−1.33	−1.84	−1.47	−1.31	−1.57	−1.22	−2.2
May-11	−1.7	−1.16	−1.26	−1.81	−1.46	−1.31	−1.48	−1.29	−2.24
Jun-11	−1.66	−1.13	−1.3	−1.82	−1.38	−1.34	−1.44	−1.34	−2.1
Jul-11	−1.62	−1.13	−1.25	−1.85	−1.36	−1.28	−1.45	−1.6	−2.09
Aug-11	−1.67	−1.13	−1.28	−1.79	−1.32	−1.25	−1.55	−1.98	−2.08
Sep-11	−1.65	−1.1	−1.29	−1.78	−1.46	−1.28	−1.52	−1.95	−1.95
Oct-11	−1.6	−1.11	−1.34	−1.73	−1.54	−1.37	−1.51	−2.18	−2.01
Nov-11	−1.71	−1.15	−1.38	−1.65	−1.49	−1.41	−1.48	−2.16	−1.95
Dec-11	−1.7	−1.2	−1.42	−1.62	−1.59	−1.48	−1.43	−2.28	−1.94
Jan-12	−1.66	−1.21	−1.41	−1.58	−1.73	−1.55	−1.47	−2.24	−2
Feb-12	−1.64	−1.21	−1.38	−1.61	−1.7	−1.53	−1.45	−2.09	−2.01
Mar-12	−1.65	−1.22	−1.36	−1.59	−1.68	−1.5	−1.43	−2.24	−2
Apr-12	−1.66	−1.28	−1.37	−1.52	−1.84	−1.52	−1.51	−2.28	−1.83
May-12	−1.58	−1.22	−1.38	−1.48	−1.8	−1.53	−1.61	−2.22	−1.7
Jun-12	−1.57	−1.2	−1.37	−1.34	−1.82	−1.5	−1.58	−2.25	−1.8
Jul-12	−1.56	−1.18	−1.33	−1.2	−1.83	−1.52	−1.57	−2.01	−1.76
Aug-12	−1.49	−1.19	−1.25	−1.13	−1.79	−1.61	−1.5	−1.66	−1.71
Sep-12	−1.52	−1.18	−1.22	−1.07	−1.6	−1.56	−1.47	−1.68	−1.83
Oct-12	−1.56	−1.15	−1.12	−1.04	−1.68	−1.52	−1.53	−1.51	−1.85
Nov-12	−1.43	−1.08	−1.09	−1.05	−1.71	−1.46	−1.46	−1.67	−2.02
Dec-12	−1.42	−1.05	−1.12	−1.02	−1.79	−1.36	−1.43	−1.59	−2.07
Jan-13	−1.41	−1.01	−1.1	−1.01	−1.62	−1.33	−1.44	−1.55	−2.1
Feb-13	−1.39	−0.98	−1.13	−0.99	−1.52	−1.35	−1.41	−1.61	−2.05
Mar-13	−1.33	−0.95	−1.11	−0.99	−1.44	−1.37	−1.44	−1.45	−1.99
Apr-13	−1.29	−0.9	−1.07	−0.99	−1.29	−1.34	−1.39	−1.51	−1.95
May-13	−1.24	−0.92	−1.07	−0.94	−1.49	−1.31	−1.32	−1.8	−1.96
Jun-13	−1.24	−0.92	−1.06	−0.98	−1.63	−1.36	−1.29	−1.79	−1.85
Jul-13	−1.25	−0.89	−1.07	−0.98	−1.57	−1.4	−1.27	−1.66	−1.8
Aug-13	−1.16	−0.87	−1.18	−0.97	−1.6	−1.38	−1.3	−1.6	−1.76
Sep-13	−1.13	−0.87	−1.21	−0.98	−1.7	−1.33	−1.31	−1.53	−1.63
Oct-13	−1.14	−0.86	−1.24	−0.99	−1.59	−1.3	−1.21	−1.56	−1.53
Nov-13	−1.09	−0.85	−1.2	−0.93	−1.59	−1.33	−1.15	−1.31	−1.25
Dec-13	−1.09	−0.82	−1.23	−0.91	−1.53	−1.4	−1.17	−1.4	−1.13

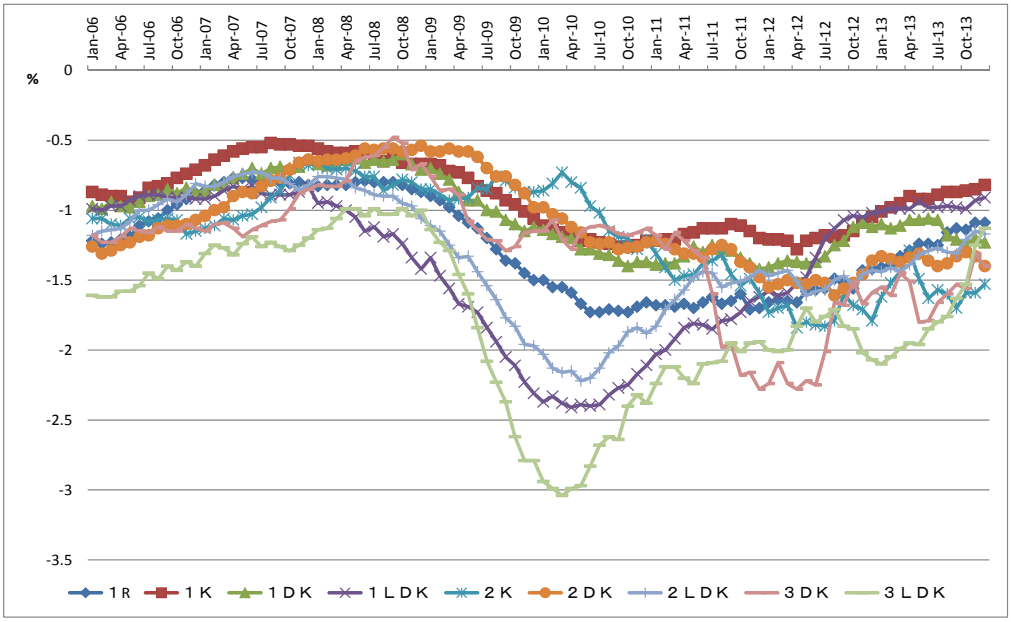


Figure 2: Change in rate of rent reduction with vacancy duration and *madori*

2.4. Economic trend data

As our analysis concerns the relationship between reductions in rent due to vacancy duration and economic trends, we adopted indexes of business conditions (hereinafter called IBC) published by the Cabinet Office. In addition, from the available IBC, we selected Composite Index (hereinafter called CI) of Lagging Indicators. Here, our attempt at an analysis using a CI of Lagging Indicators follows Fujii et al. (2014), who stated that "While there are CI of Leading Indicators, Coincident Indicators, and Lagging Indicators, we use Lagging Indicators in order to take into account the impact of economic trends that to some extent accompany actual conditions."

3. Vacancy duration

How long a period is required between the initial listing of a rental unit and the signing of a contract? We attempted to calculate this value using sampling data in the contract information included in the rental unit data. Figure 3 plots vacancy duration data for rental units in Tokyo's 23 wards. First of all, it can be seen that contracts are signed for almost all rental units within 12 months of initial advertisement. Approximately 20% of rental units are contracted within 1 month of initial advertisement, 65% at 2 months, 80% at 3 months, and 99% of units are contracted within 1 year. Few rental units remain vacant for periods of longer than a year, and those that are may be said to have especially diminished market competitiveness. The following sections will investigate the characteristic features that distinguish units with brief vacancy durations from units with prolonged vacancy durations.

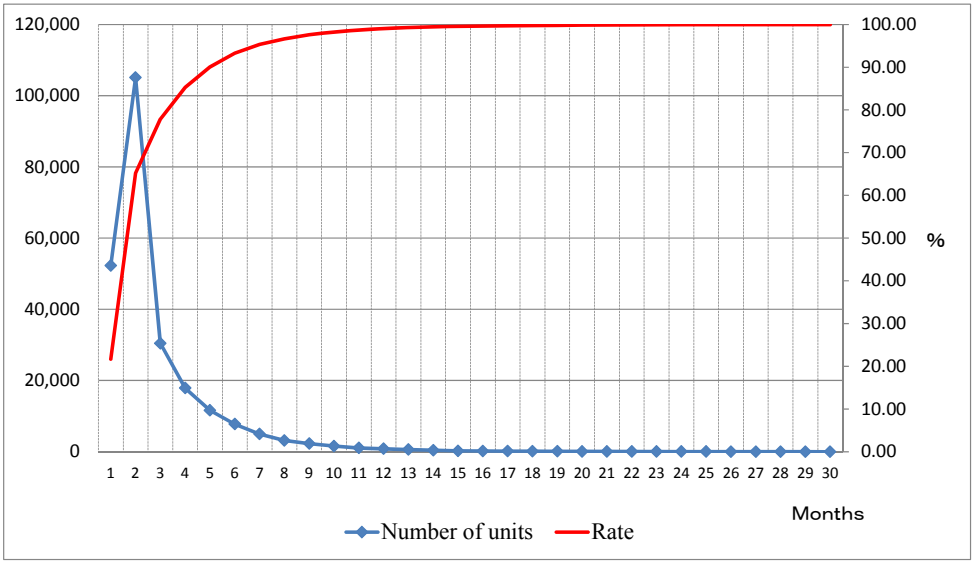


Figure 3: Change in number of vacant units with vacancy duration

3.1. Vacancy duration categorized by *madori*

Using the rental property data for which contract information exists, the data from which we calculated vacancy duration for our sample is shown as a ratio in Figure 4, categorized by *madori*. It can be seen that the *madori* categories of 1R and 1K (both single accommodations) account for approximately 60% of our data.

Figure 5 shows the change in the *madori* ratio with vacancy duration. Here we can see that as vacancy duration grows longer, the ratio of single-oriented 1R and 1K apartments decreases somewhat, while the ratio of family-oriented apartments such as 2DK and 3LDK grows. Note that the considerable variability visible towards the right of the graph is a result of the relative scarcity of units that remain vacant for 20 months or more.

Next, Figure 6 breaks down units by building age, showing these as ratios categorized by *madori*. We can see that there are many units in the 1R, 1K, 1DK, 1LDK, and 2LDK categories that are only 10 years old or newer, indicating an actively ongoing supply of new units. Conversely, there seems to be little new development for 2K, 2DK, or 3DK units, and many buildings in these categories are quite old. These observations allow us to confirm that supply trends vary according to *madori*, with considerable changes in the ratio for building age.

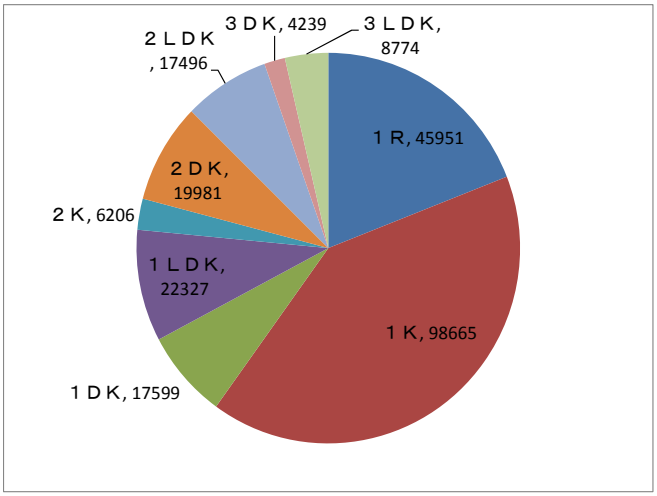


Figure 4: Ratio of vacancy duration data categorized by *madori*

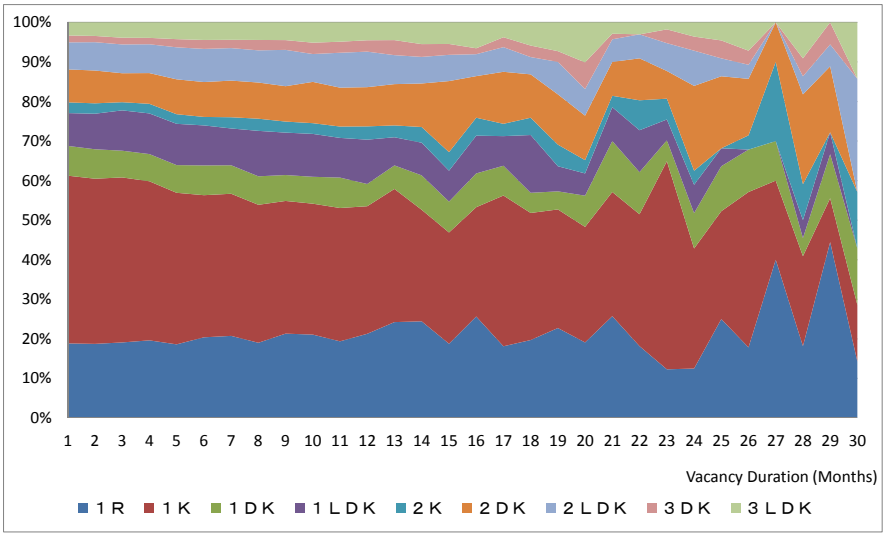


Figure 5: Change in *madori* ratio with vacancy duration

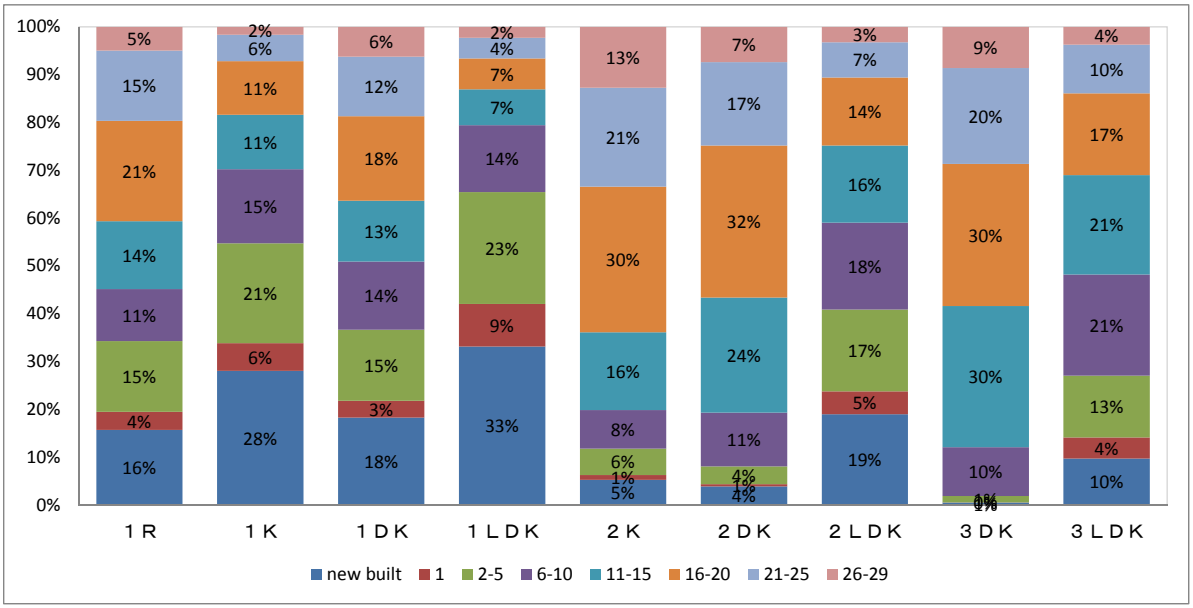


Figure 6: Building age ratios for vacancy duration data, categorized by *madori*

3.2. Vacancy duration by building age

Figure 7 shows the change in the building age ratio with vacancy duration. It can be seen that the ratio of older units increases as vacancy durations grow longer. The number of more recently constructed units decreases as vacancy durations grow longer, which suggests that such units are able to find contracts comparatively earlier. In addition, newly constructed units have the highest contracting ratio at 3 months, after which this ratio decreases as vacancy durations grow longer. Moreover, newly constructed units do not exist that have vacancy durations in excess of 26 months.

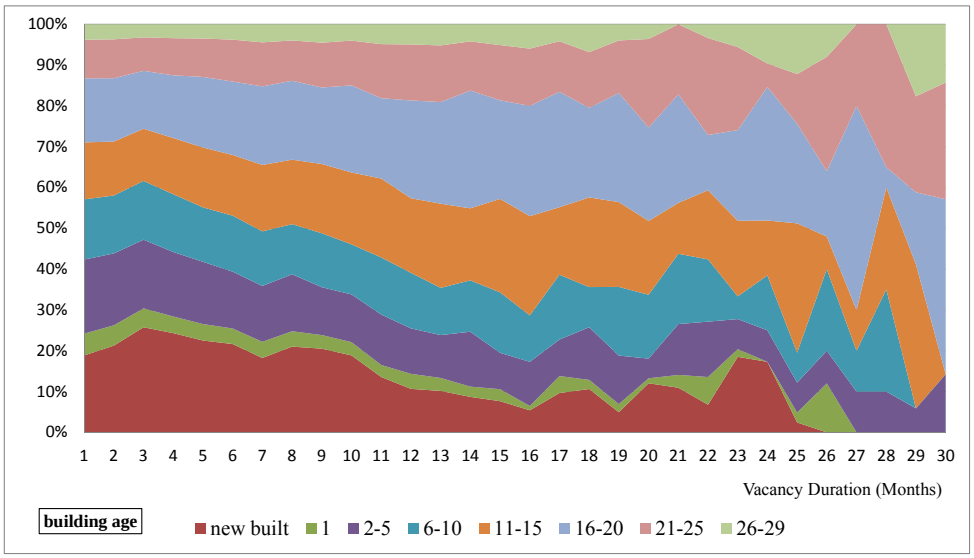


Figure 7: Change in building age ratio with advertising period (vacancy duration)

3.3. Results of trend analysis for vacancy duration

We confirmed that the ratio of single-oriented 1R and 1K apartments decreases somewhat as vacancy duration increases, while the ratio of family-oriented apartments such as 2DK and 3LDK grows over the same period. In addition, we identified a trend whereby newly constructed units are contracted within a comparatively short time of their initial advertisement, while older units have longer vacancy durations. Furthermore, we also observed that because trends for each *madori* category vary considerably depending on when the unit was built, the length of vacancy duration for each *madori* category is also influenced by the age of the building.

4. Rent reduction during vacancy periods

Because the returns that can be generated by units will be diminished if vacancies persist for a long time, owners have an incentive to fill existing vacancies. In order to achieve this, it is vital to improve the market competiveness of the units. To this end, owners may implement a variety of measures, including investing in facilities and improving their style of unit management. Alternatively, many owners opt for rent reductions, since these are easily implemented and their efficacy can be seen almost immediately. This implies that where rent levels are high, this has an effect on the amount of time it will take for a tenant to commit (i.e., vacancy duration). And because vacancy durations affect vacancy rates, this will ultimately also influence increases or decreases in rent.

In addition, as indicated by Fujii et al. (2013), a positive correlation exists between rent fluctuations and economic conditions. Although there will be pressure to lower rents in a faltering economy, contracts at such times will be signed first on rental units with strong market competitiveness, so owners will face pressure to reduce rent to the extent that the market competitiveness of these units is diminished. In other words, the pressure to reduce rent will become stronger the longer a rental unit lies vacant. Additionally, owners will attempt to strike a profitable balance between discounting rents and eliminating vacancies. Therefore, even when market conditions grow worse, there would seem to be a certain period during which owners remain bullish when setting rents, and try to maintain their existing levels of presumed profitability. Furthermore, there is also a possibility that owners will continue to do their best to avoid reducing the asking rent out of concerns that they will become embroiled in rent reduction discounts with existing tenants as a result of making discounts to the asking rent on vacant units. As a result of such factors, it is possible that the rate of rent reduction due to vacancy duration will lag behind economic fluctuations.

From the above, we may posit the following three hypotheses: (i) the extent of rent reductions will increase as vacancy durations grow longer, (ii) fluctuations in economic trends will precede change in rent reduction due to vacancy duration, and (iii) the rental apartment market in Tokyo's 23 wards will be unique for each category of *madori*. Based on these three hypotheses, we performed an analysis by calculating vacancy durations and rates of rent reduction due to vacancy duration drawn from rental unit data from Tokyo's 23 wards.

4.1. Percentage change in rent due to vacancy duration

Figure 8 shows the proportionate extent to which rent units prices change according to vacancy duration. Most rental units do not show any change until the second month following initial advertisement. However, changes in rent prices begin to appear from around three months after initial advertisement. By the third month after initial advertisement, more than 20% of rental units start to be discounted. Additionally, while few in number, there are also some rental units for which rent prices are increased. The proportion of rental units with discounted rent continues to increase until around 12 months after initial advertisement, at which point it stabilizes at slightly more than 60%.

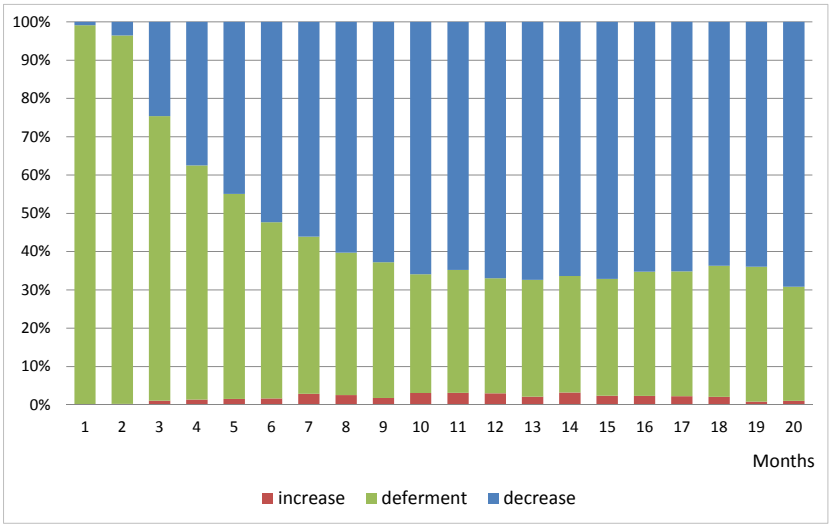


Figure 8: Unit ratios for rent changes due to vacancy duration (increase / deferment / decrease)

4.2. Change in rate of rent reduction with vacancy duration

To what extent do rent prices fluctuate with increases in vacancy duration? We have attempted to answer this question by taking average rates of rent reduction for each vacancy duration. Figure 9 plots the rate of rent reduction due to vacancy duration for Tokyo's 23 wards. It will be noted that the presence or absence of rent reductions, and their degree, vary considerably for each unit, and while a large dispersion is evident in the rates of rent reduction as shown in the error bars in Figure 9, an average downward trend can be observed. Confirming the dependence on vacancy duration, we can see that there is hardly any change in rent during the two months that follow initial advertisement, and the initial asking rent is more or less maintained. It can be seen that price reductions become available from the third month when rent changes begin to escalate, with discount rates increasing as vacancy durations grow longer. At one year after initial advertisement, an average discount of approximately 5.5% is being offered. From that point, rent prices are maintained for a further six months, and then broadly discounted from 18 months after initial advertisement. There is also the conceivable possibility that this is the result of offerings that were slash price (*tataki-uri*).

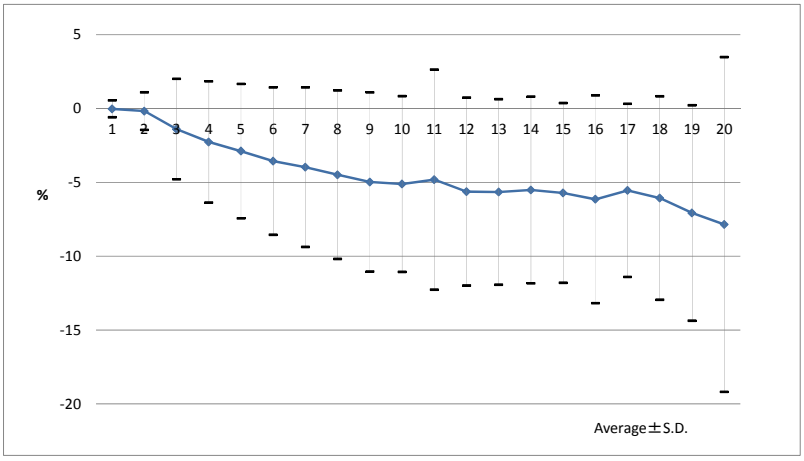


Figure 9: Change in rate of rent reduction with vacancy duration

4.2.1. Change in rate of rent reduction with vacancy duration categorized by *madori*

Figure 10 plots the change in rate of rent reduction for Tokyo's 23 wards with vacancy duration and *madori*. While there does not appear to be any disparity between types of *madori* for a short period after initial advertisement, there begin to be large discounts on LDK-type apartments from around the 10th month. This is conceivably due to the fact that LDK-type apartment units often have higher rents, since they both have a larger floor area than competing *madori* categories and are in many cases located in relatively young buildings. It should be noted that, as described above, there are very few units that go for more than 12 months between initial advertisement and the signing of a contract, and in fact in some cases, depending on the category of *madori*, there were less than 10 units in our sample per vacancy duration when tallied by *madori*. Accordingly, considerable variability can be seen with respect to *madori* categories that are less well represented in our sample, particularly for vacancy durations exceeding 12 months.

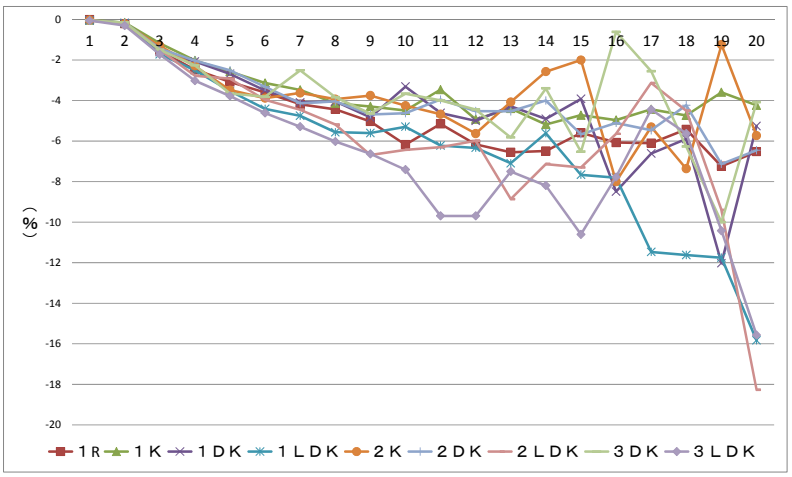


Figure 10: Change in rate of rent reduction with *madori* and vacancy duration

4.2.2. Change in rate of rent reduction with vacancy duration (by building age)

Figure 11 plots the change in the rate of rent reduction for Tokyo's 23 wards with vacancy duration and building age. This figure can be read to indicate that there are higher discount rates for units in buildings that are 26 years old or older. On the other hand, since relatively younger units have shorter vacancy durations, there may be a bias towards units that attracted tenants at an earlier period. In order to eliminate this bias, we calculate rates of rent reduction using only discounted units, which confirms that high rates of rent reductions do exist in buildings that are either new or only two years old (Figure 12). From these data, we are able to observe the existence of a certain proportion of newly built rental apartments with diminished market competitiveness (such as might result from rents being set significantly higher than the market rate) and which have been forced into rent reductions immediately after market investment.

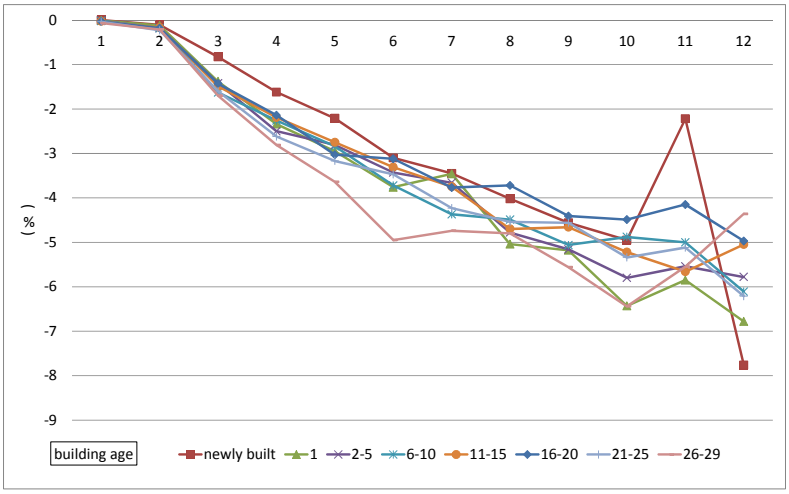


Figure 11: Change in rate of rent reduction with building age and vacancy duration

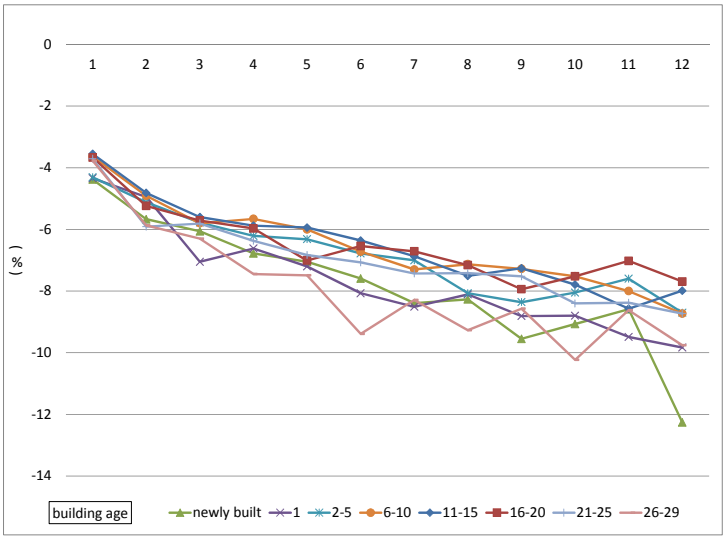


Figure 12: Change in rate of rent reduction with building age and vacancy duration (discounted units only)

4.3. Change in rate of rent reduction and vacancy duration with date of contract conclusion

Figure 13 plots the change in vacancy duration and rate of rent reduction with contract month. As can be seen, the two are negatively correlated, with a correlation coefficient of –0.96. In addition, a negative correlation also exists between vacancy duration and the rate of rent reduction categorized by *madori*. The correlation coefficients for the change in vacancy duration and rate of rent reduction with contract month and *madori* category are shown in Table 5 and in Figure 14. Although the correlation coefficients are in some cases inconsequential, this has been done as a simple way of measuring the linked relationship between the two variables. In future research, we plan to generate estimates that have more appropriateness statistically.

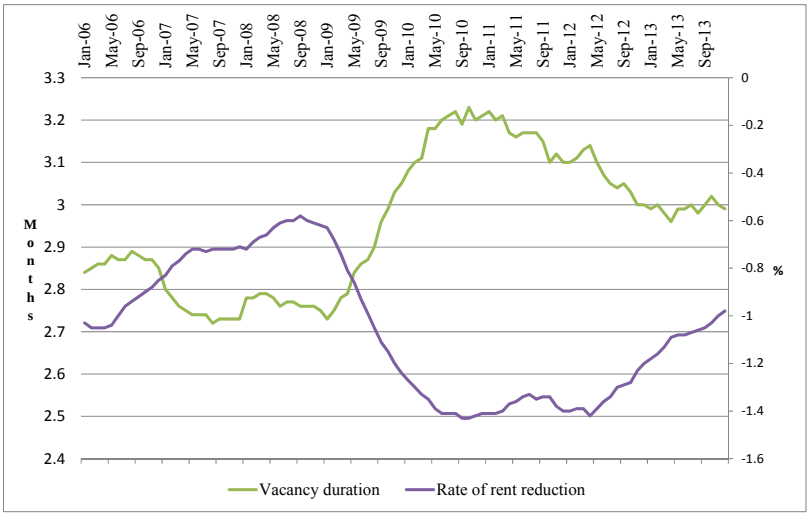
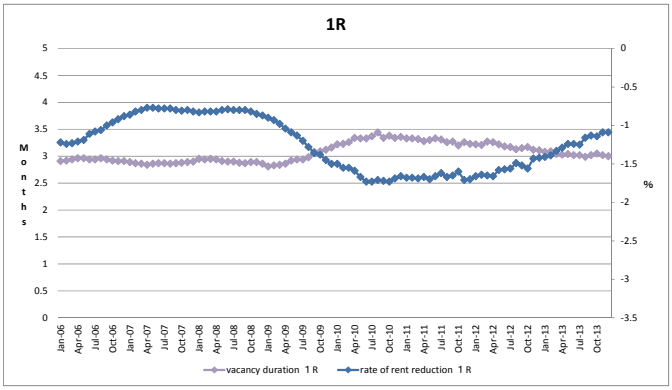
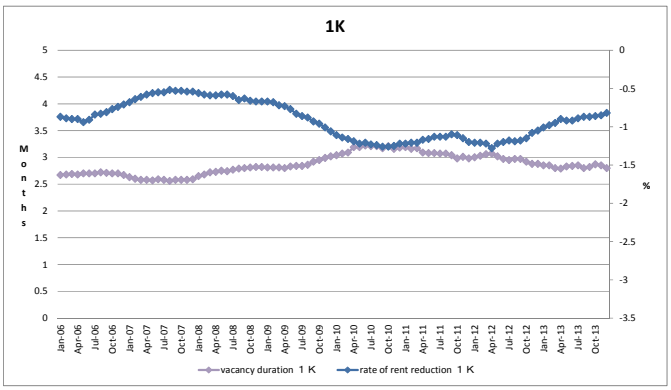


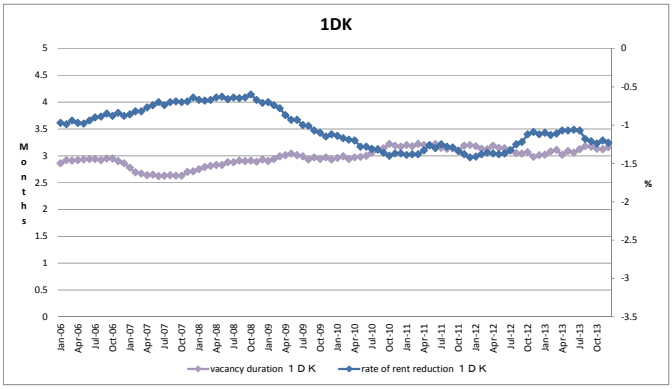
Figure 13: Change in vacancy duration and rate of rent reduction with contract month

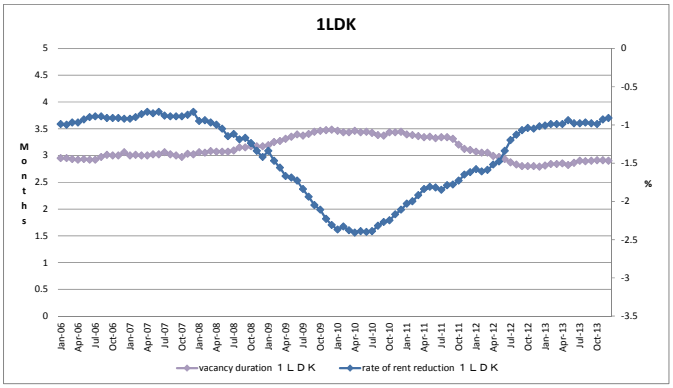
Table 5: Correlation coefficients for vacancy duration and rate of rent reduction categorized by *madori*

1R	1K	1LDK	2K	2DK	2LDK	3DK	3LDK	ALL
−0.94375	−0.89341	−0.89071	−0.74174	−0.87363	−0.88433	−0.80646	−0.89249	−0.95972









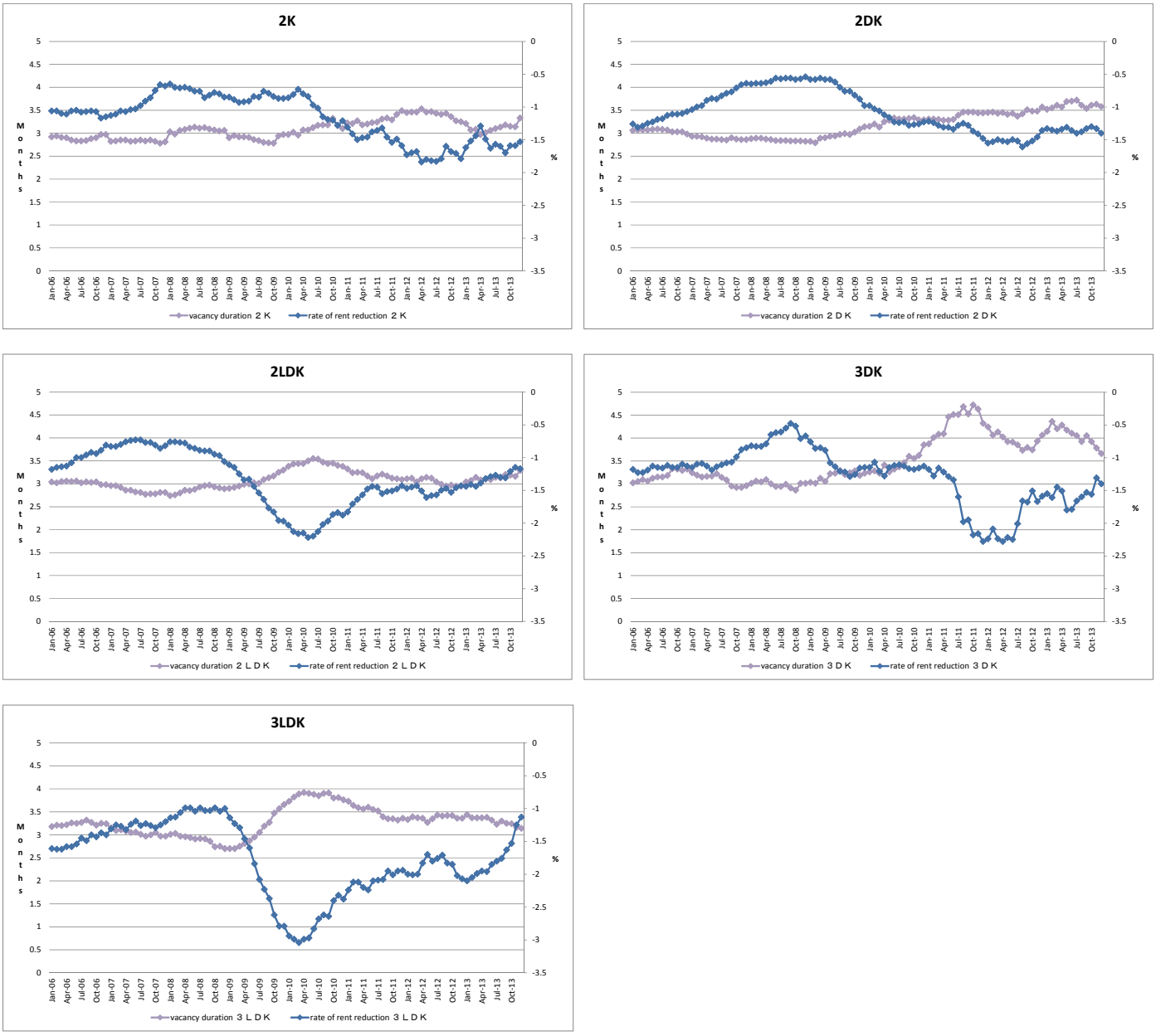


Figure 14: Change in vacancy duration and rate of rent reduction with contract month, categorized by *madori*

4.4. Relationship between rate of rent reduction due to vacancy duration and economic trends

4.4.1. Impact of economic trends

We can observe the influence of economic trends on rates of rent reduction due to vacancy duration. From the results that we obtained in Section 4.2 (Change in rate of rent reduction with vacancy duration), we will only consider the following four intervals: [1 to 2 months], during which there was little change in rent prices; [3 to 5 months], when the discount rate began to escalate; [6 to 8 months], when the discount rate increased even further; and [9 to 12 months], at which point fluctuations stabilized, though the discount rate remained high. We analyzed the influence of economic conditions during these four intervals after taking an average of the rate of rent reduction for each contract month.

Figure 15 plots the change in the average rate of rent reduction for the four vacancy duration intervals. Rates of rent reductions had been trending downward during the economic upswing that led up to the Lehman Shock (and the subsequent global financial crisis). However, rates of rent reductions began to show an upward tendency following the crisis. While units for which contracts were signed for about two months after the third month of vacancy (when rents first began to be reduced) showed no more than around a 1% rates of rent reductions increase even after the Lehman Shock, rates of rent

reductions for units in the vacancy duration interval of 6 to 8 months increased by about 2% from 2.5% to 4.5%. Moreover, rates of rent reductions for units in the vacancy duration interval of 9 to 12 months increased significantly from about 3.5% to 7%. While the rates of rent reductions fell temporarily with the subsequent economic recovery, it once again rose slightly as an effect of the Great East Japan Earthquake Disaster. In addition, the trend observed in the range of reduction across the four intervals was similar to that experienced with the Lehmann Shock. In this way, as confirmed by these results, a strong pressure to reduce rent will be exerted in times of economic recession to the extent that a unit has diminished market competitiveness and its vacancy period (the so-called market stagnation period) continues.

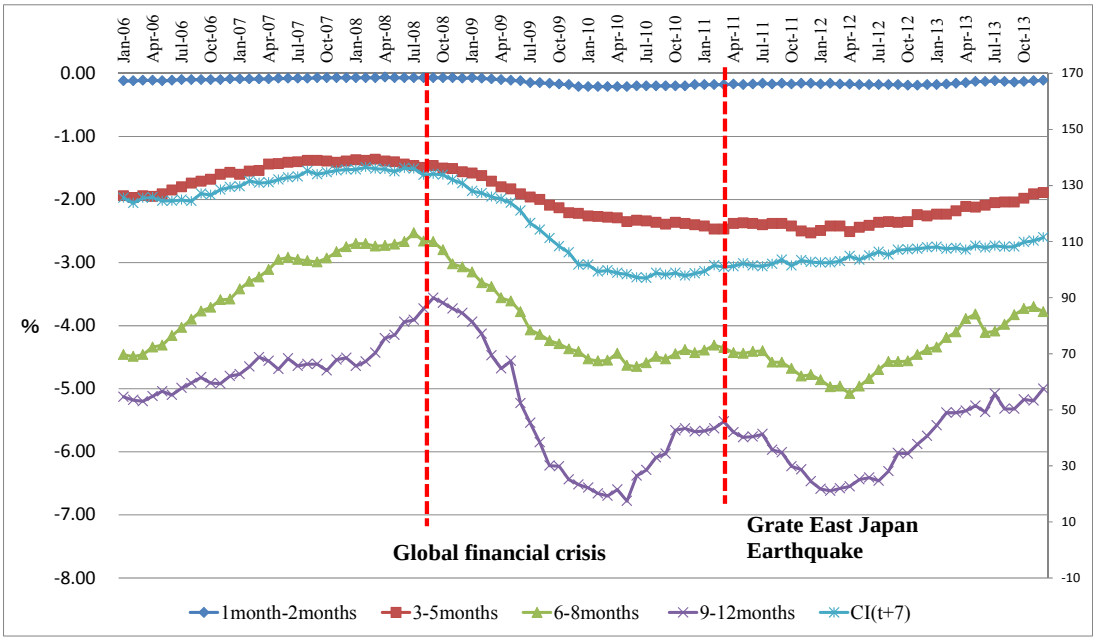


Figure 15: Change in vacancy duration average reduction rate for four vacancy duration intervals

4.4.2. Relationship with indexes of business conditions (IBC)

Next, in order to identify the effect of economic trends, we calculated the correlation between IBC (CI Lagging Indicators) and the rate of rent reduction due to vacancy duration. Based on our hypothesis (ii) that economic trends will anticipate change in rent reductions, we calculated the correlation with the rate of rent reduction after determining a given lag (*Lag*) from the IBC. Lag values were tentatively determined for the four vacancy duration intervals using the formula (8). Here, *Corr* is a function used to calculate Pearson's product-moment correlation coefficient.

$$\mathrm{Lag} = \arg\max_{\mathrm{Lag}} Corr\left(RR^*_C(t), IBC(t-\mathrm{Lag})\right), \quad \mathrm{Lag} \in \{1,2,\ldots,12\} \tag{8}$$

IBC: Indexes of Business Conditions

The results showed that while only the rate of rent reduction for vacancies in the interval of [1 to 2 months] had a high correlation with the IBC for a delay of 6 months, the other three intervals had correlations with the IBC for a delay of 7 months. Thus, all intervals were confirmed have a positive correlation with the IBC. The correlation coefficients are shown in Table 6. The change in CI (t+7) for the four vacancy duration intervals is also plotted in Figure 15. The correlation with the IBC increased slightly as the vacancy duration grew shorter. As confirmed above, it is possible that units with prolonged vacancy durations may be more strongly affected by economic pressures to reduce rent than those for which contracts are signed within an average-length period. It should again be noted that the correlations for the different time-series data in this study were determined in a simple fashion using the Pearson correlation coefficient.

Table 6: Correlation with IBC (CI Lagging Indicators) for different vacancy duration intervals

	RR (t-6) 1month-2months	*RR* (t-7) 3-5months	*RR* (t-7) 6-8months	*RR* (t-7) 9-12months
CI(t)	0.95379438	0.962934391	0.878737434	0.877347057

4.5. Results of analysis of rate of rent reduction due to vacancy duration

All of our analyses have confirmed that vacancy duration has an impact on rent reduction. This trend was evident in our analyses of the change in rate of rent reduction with vacancy duration, *madori*, and building age. The change in rate of rent reduction with contract month showed a negative correlation with the change in vacancy duration. In addition, a correlation was also observed with the IBC; we were able to confirm conditions whereby rates of rent reductions rose during times of recession, particularly when a vacancy period was prolonged, and where owners faced strong discount pressures during times of economic recession to the extent that the market competitiveness of the units was diminished.

5. Conclusion

In this study, we used rental apartment data to determine vacancy durations by calculating the period from when a given apartment was initially advertised as available for rent and the signing of a rental contract, and then conducted an analysis to identify the characteristic features that distinguish units with brief vacancy durations from units with prolonged vacancy durations. Additionally, we confirmed that the length of vacancy duration has an impact on rent prices. Then, with these rent reductions as a primary factor, we used time-series data for vacancy period reduction rates and indexes of business conditions to confirm the influence of economic trends

Our findings are as follows:

(a) The length of vacancy duration tends to vary depending on *madori* (Japanese floor plan) and building age.
(b) The prolonging of vacancy duration has a major influence on rent reductions. When we observe the rate of rent reduction due to vacancy duration as a time-series, we find this correlates negatively with vacancy duration for all *madori*. Trends exist in rate of rent reductions due to vacancy duration depending on *madori* and building age.
(c) Rate of rent reductions due to vacancy duration are generally affected by economic trends, and properties whose market competitiveness is diminished tend to be more affected by economic trends that occur in times of economic recession. In addition, based on our hypothesis that economic trends would anticipate trends in rent changes due to vacancy duration, a positive correlation was observed with indexes of business conditions.

The research results identified in this paper allow us to confirm that the length of vacancy duration has an effect on the magnitude of rent reductions. Our analysis of these rates of rent reductions has shown a relationship between the rate of rent reduction due to vacancy duration and both *madori* and building age. We have also identified the existence of units for which rent reductions are implemented relatively quickly, as well as of units with diminished market competitiveness that are strongly influenced by economic trends to implement significant rent reductions. Conceivable factors include the possibility that initially advertised rents are set higher than market rates will allow, forcing owners to lower prices, as well as the existence of units for which initially advertised rents are deliberately too high, on the assumption that the advertised rent can be lowered relatively early in the event that no contract can be signed. In either case, the fact that such rent setting may be considered to deviate from the market rate suggests the possibility of determining the validity of initially advertised rent by a comparison of rent estimates using a rent estimation model. Our research group will investigate this in the future. Thereafter, we will attempt to develop an even more accurate rent estimation model that will take into account influences arising from units where rents deviate from the market rate, as well as the influence of *madori* and building ages discussed above. Because the vacancies represent a period of null income, there is a significant risk associated with the prolonging of vacancy duration. While units that face prolonged vacancies continue to exist, and for which rents must be lowered as a result, we intend to continue developing more accurate models, and demonstrating the usefulness of rent estimation models for establishing reasonable asking rents.

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