Natural Vacancy Rate Analysis for Tokyo's 23 Wards Rental Apartment Market

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Abstract

Several studies conducted in other countries have analyzed the relationship between changes in vacancy rate and those in market rent for rental apartments (e.g., Gabriel and Nothaft, 1988; Belsky and Goodman, 1996). These studies have identified that changes in vacancy rate affect increases or decreases in market rent. However, to the best of our knowledge, no similar study has been conducted in the Japanese rental apartment market because the required time-series vacancy rate data have been unavailable.

In a previous study, our study group developed a vacancy index (TAS Vacancy Index; collectively called the vacancy rate TVI) for the rental apartment market in Tokyo's 23 Wards (Fujii et al., 2012). Furthermore, we created regression models in which the explained variable is the rent index variability rate, and the explanatory variables are the vacancy rate TVI and economic trends index variability rates. Consequently, we revealed that rent changes have a negative correlation with the vacancy rate and a positive correlation with economic trends (Fujii et al., 2013).

Some previous studies hypothesize the existence of a natural vacancy rate, i.e., the rate at which rents are in equilibrium (e.g., Smith, 1974). To analyze the natural vacancy rate, the relationship between rent and vacancy rate is the key. However, differences between actual and theoretical values for changes in rental rates were only observed based on our previous model. Thus, in this study's first phase, we improve the model introduced in our previous study. The Japanese real estate market reflects economic fluctuations at an early stage as changes in both property prices and number of construction begin. Additionally, rent changes can be observed as lagging from economic fluctuations. These facts indicate that developers and investors invest by forecasting economic trends, whereas property owners follow actual economic conditions. Nonetheless, expectations regarding economic trends may influence rent changes

by affecting the vacancy rate through impacts on housing starts. Therefore, the study group developed a new model that considers an anteroposterior relationship and a cycle between market rents and rent adjustment factors. Using this model, we confirmed reductions in the difference between actual value and theoretical value for changes in rental rates. As a second phase, the study group analyzed the natural vacancy rate for the rental apartment market in Tokyo's 23 Wards for the first time in Japan.

1. Introduction

Previous studies have hypothesized the existence of a natural vacancy rate, i.e., the rate at which rents are in equilibrium (e.g., Smith, 1974). Gabriel and Nothaft (1988) regress the rate of change in rent on the observed vacancy rate and on city dummy variables, observing that the vacancy rate has a significant negative effect on the rate of change in rents. Furthermore, they specify a natural vacancy rate model in which the natural rate is a function of the changes in the stock of rental units, median rent, dispersion in rent, proportion of minority population, and population. Belsky and Goodman (1996) discuss the paradox of rent increase despite an increasing vacancy rate in the 1980s resulting from several factors such as the following: increase in the natural vacancy rate, changes in landlords' rent-setting behavior, changes in tenants' housing-search behavior, measurements of nominal and real rent in the consumer price index, and distortions of the vacancy rate due to high levels of new construction. Gabriel and Nothaft (2001) provide derivation and analytical modeling of the duration and incidence of vacancies and describe the role of these elements in the price adjustment mechanism for rental housing. However, to the best of our knowledge, no similar study has been conducted in the Japanese rental apartment market. A model for the relationship between market rent and vacancy rate has not yet been defined because the required time-series vacancy rate data have been unavailable.

In a previous study, our study group developed a vacancy index (TAS Vacancy Index, hereinafter, collectively called the vacancy rate TVI) for the rental apartment market in Tokyo's 23 Wards. Furthermore, we confirmed that the vacancy rate TVI is available as a surrogate variable for the gap between demand (i.e., increase/decrease in number of households) and supply (i.e., increase/decrease in stock). Additionally, in the rental apartment market in these wards,

we confirmed the unique market for each “Madori” that provides categories for room types in Japan (Fujii et al., 2012).[1]

Next, our study group created regression models in which the explained variable is the rate of rent index variability, and the explanatory variables are the variability rates for the vacancy rate TVI and economic trends index for each Madori. To analyze the effect of the demand (residents) side, we adopted the “Monthly Labor Survey” by the Health, Labor and Welfare Ministry as the surrogate variable for changes in residents’ incomes. Furthermore, to analyze the effect of the supply (owners, developers, and investors) side, we adopted the lagging composite indexes (CI) of “Indexes of Business Conditions” announced by the Cabinet Office as the surrogate variable for macroeconomic changes. As a result, we revealed that rent changes have a negative correlation with the vacancy rate and a positive correlation with economic trends. We further confirmed that macroeconomic changes have a greater effect on change in rent than changes in residents' incomes (Fujii et al., 2013).

In our previous study, we developed hypotheses that were used for creating our model as follows: (i) a change in the vacancy rate TVI (one of vacancy factors) has a negative correlation with a change in rent, (ii) a change in the macroeconomy has a positive correlation with a change in rent, and (iii) a unique market exists for each Madori for rental apartments in Tokyo's 23 Wards. However, differences between the actual and theoretical values for changes in rental rates were only observed based on our previous model before the Lehman's shock and after 2011. Thus, in this study’s first phase, we improve the model introduced in our previous study. The Japanese real estate market reflects economic fluctuations at an early stage as changes in both property prices and number of construction begin.

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[1] The typical nine types of Madori in Japan are as follows; 1R, 1K, 1DK, 1LDK, 2K, 2DK, 2LDK, 3DK, 3LDK. "K" means a unit has individual kitchen, "D" means a unit has individual dining room, and "L" means a unit has individual living room. The number in front of each Madori represents the number of bedrooms. Additionally, 1R means a single room such as a studio apartment, which includes kitchen area. (see details in Table 1)

Moreover, changes in rent can be observed as lagging from economic fluctuations. These facts indicate that developers and investors choose investments by forecasting economic trends, whereas property owners follow actual economic conditions. Nonetheless, expectations regarding economic trends may influence rent changes by affecting the vacancy rate through impacts on housing starts. Therefore, the study group developed a new model that considers any anteroposterior relationship of examined factors. Additionally, our study group adds a new factor, namely, "vacancy duration," which also is a vacancy factor. Using this model, we confirm reductions in the difference between actual and theoretical values for changes in rate of rent. As a second phase, the study group analyzes the natural vacancy rate for the rental apartment market in Tokyo's 23 Wards.

2. Data

2.1. Dataset of Rental Apartments

Consistent with our previous study, the study group analyzes the trends in the rental apartment market by using a dataset of apartment rents and different types of attributes provided by At Home Co., which delivers real estate information media services to consumers and business solution services to real estate companies. At Home Co. has established a network of over 51,000 real estate companies and holds substantial real estate information. The dataset includes data on the following attributes: position coordinates (latitude and longitude); asking rental price; age of property; floor area; structural characteristics such as use of reinforced concrete; Madori; nearest station; and contract date. The study uses a sample of approximately 1,670,000 dwelling units from the available data covering the period from January 2004 to December 2013.

2.2. Market Rent Indices

This study created nine types of hedonic models for each Madori, where the explained variable is the logarithm of apartment rent (JPY/m^2 per month); the rent index is an exponent of the time dummy.

$$\ln RP = a + \sum_i b_i X_i + \sum_j c_j LD_j + \sum_k d_k TD_k + u \qquad (1)$$

RP: Monthly Rent (JPY)
a: Constant
X_i: Property attributes
LD_j: Location Dummy (each ward of Tokyo's 23 wards)
TD_k: Time Dummy (each month, base is Jan.2004)
u: Residual

(2)

$$RI(t) = \mathrm{Exp}(TD(t))$$

RI: Rent Index

For details of these models, refer to Fujii et al. (2013). Table 1 provides a description and numerical data for each Madori. Table 2 shows the statistics of these models. Table 3 shows the estimated result for each Madori. Furthermore, the rent index for each Madori is plotted in Figure 1.

2.3. Vacancy Rate

The required time-series vacancy rate data were previously unavailable in Japan. Thus, to tackle this problem, the study group developed the vacancy rate TVI using rental apartment data from At Home Co. The vacancy rate TVI is calculated by dividing the sampling data of vacant units by the sampling data of stock. Here the sampling data of vacant units are the number of units for rent listed on the At Home Co. database, and the sampling data of stock are the total number of units calculated from the At Home Co. database and government statistics.

$$\text{Vacancy Rate} = \frac{\text{vacant units}}{\text{Stock}} \tag{3}$$

$$TVI_{RAW}(t) \cong \frac{V_s(t)}{S_s(t)} \tag{4}$$

Vs: Sampling data of vacant units
Ss: Sampling data of stock

Additionally, the vacancy rate TVI is calculated as the 12-month backward moving average to adjust for seasonal fluctuation.

$$TVI(t) = \frac{\sum_{\tau=t-11}^{t} TVI_{RAW}(\tau)}{12} \tag{5}$$

For details of the vacancy rate TVI, refer to Fujii et al. (2013). We adopted the vacancy rate TVI as the vacancy rate of rental apartments. Table 4 shows the vacancy rate TVI for each Madori in Tokyo's 23 Wards. The vacancy rate TVI for each Madori is plotted in Figure 2.

2.4. Economic Trend Indices

This study adopted the "indexes of business conditions," which is announced by the Japanese Cabinet Office, to be a surrogate variable of economic trend. The "indexes of business conditions" are designed to be a useful tool for both analyzing current conditions and forecasting future economic conditions. These indices combine the behavior of key cyclical indicators that represent widely differing economic activities such as production and employment. There are CI and diffusion indexes in the "indexes of business conditions." In this paper, the study group adopted CI because it is the most appropriate to measure the tempo and magnitude ("the volume") of economic fluctuations. There are three types of composite indexes: the leading CI, the coincident CI, and the lagging CI. This study selected the lagging CI because it can be used to confirm actual conditions of economic trends.

2.5. Vacancy Duration

A rental apartment's vacancy duration, defined as tenant searching period of contracted units, is calculated using the rental apartment data from At Home Co.

$$VD_{RAW}(t) = \frac{\sum_{i \in I_{c(t)}} VD_i}{|I_c(t)|} \quad (6)$$

VD:	Vacancy Duration
$I_c(t)$:	observations contracted in time t
$VD_{RAW}(t)$:	VD of the observation contracted in time t
VDi:	VD of the i-th observation

Vacancy duration is calculated as the 12-month backward moving average to adjust for seasonal fluctuation.

$$VD(t) = \frac{\sum_{\tau=t-11}^{t} VD_{RAW}(\tau)}{12} \quad (7)$$

For details of the vacancy duration, refer to Hozumi et al. (2014). Table 5 shows the vacancy duration for each Madori in Tokyo's 23 Wards. The vacancy duration for each Madori is plotted in Figure 3.

Table 1 Description of Madori and Number of Data

Madori	Number of Data Points	Description	Area of unit (Average ± σ)
1R	303,254	One room with kitchen area included	$14m^2$ – $30m^2$
1K	634,797	1 bedroom, and a kitchen	$18m^2$ – $30m^2$
1DK	115,993	1 bedroom, a dining room, and a kitchen	$26m^2$ – $38m^2$
1LDK	166,002	1 bedroom, a living room, a dining room, and a kitchen	$37m^2$ – $58m^2$
2K	49,909	2 bedrooms, and a kitchen	$27m^2$ – $39m^2$
2DK	144,679	2 bedrooms, a dining room, and a kitchen	$37m^2$ – $48m^2$
2LDK	138,964	2 bedrooms, living room, and dining room with a kitchen	$48m^2$ – $78m^2$
3DK	39,342	3 bedrooms, a dining room, and a kitchen	$49m^2$ – $61m^2$
3LDK	81,196	3 bedrooms, a living room, a dining room, and a kitchen	$55m^2$ – $101m^2$

Table 2 Descriptive statistics

	Variable	Obs	Mean	Std. Dev.	Min	Max
1R	logprice	303,188	11.265	0.355	10	13
	Months	285,737	160.914	122.280	0	624
	Unit size	303,188	22.413	7.951	8	85
	Required time to station	303,188	6.294	3.723	1	36
	Access to CBD	303,137	26.426	8.840	0	49
	Number of storis	303,188	6.149	4.535	1	60
1K	logprice	634,566	11.290	0.261	10	13
	Months	607,410	102.704	109.637	0	634
	Unit size	634,566	23.371	5.170	8	69
	Required time to station	634,566	6.631	3.859	1	37
	Access to CBD	634,533	27.078	9.221	0	52
	Number of storis	634,566	6.022	4.411	1	67
1DK	logprice	115,975	11.463	0.315	10	13
	Months	107,321	165.356	135.412	0	601
	Unit size	115,975	31.688	5.974	10	65
	Required time to station	115,975	6.476	3.847	1	39
	Access to CBD	115,960	25.949	8.761	0	49
	Number of storis	115,975	6.199	4.773	1	60
1LDK	logprice	165,991	12.003	0.337	11	14
	Months	162,038	83.073	111.158	0	629
	Unit size	165,991	46.929	9.421	20	90
	Required time to station	165,991	5.948	3.703	1	39
	Access to CBD	165,949	22.868	8.642	0	49
	Number of storis	165,991	10.494	8.067	1	67
2K	logprice	49,878	11.335	0.273	10	13
	Months	45,118	269.253	122.392	0	629
	Unit size	49,878	33.302	5.758	15	70
	Required time to station	49,878	7.861	4.541	1	37
	Access to CBD	49,875	28.558	8.302	0	53
	Number of storis	49,878	4.025	2.602	1	32
2DK	logprice	144,612	11.529	0.250	10	13
	Months	132,600	224.645	99.993	0	617
	Unit size	144,612	42.214	5.716	20	75
	Required time to station	144,612	8.120	4.733	1	38
	Access to CBD	144,602	28.858	8.436	0	52
	Number of storis	144,612	4.833	3.136	1	50
2LDK	logprice	138,910	12.106	0.432	11	14
	Months	133,679	128.387	115.845	0	625
	Unit size	138,910	62.864	14.751	31	145
	Required time to station	138,910	7.127	4.358	1	38
	Access to CBD	138,876	25.315	9.178	0	50
	Number of storis	138,910	10.157	9.018	1	67
3DK	logprice	39,325	11.679	0.212	11	13
	Months	36,418	229.154	83.680	0	600
	Unit size	39,325	55.264	5.767	31	100
	Required time to station	39,325	8.488	4.954	1	36
	Access to CBD	39,317	30.941	8.571	5	49
	Number of storis	39,325	5.685	3.308	1	50
3LDK	logprice	81,098	12.214	0.474	11	14
	Months	77,718	153.618	105.489	0	598
	Unit size	81,098	78.758	23.452	18	283
	Required time to station	81,098	7.975	4.460	1	37
	Access to CBD	81,090	27.492	9.388	5	49
	Number of storis	81,098	9.609	8.386	1	60

Table 3 Estimated Results of Hedonic Models

	1R		1K		1DK		1LDK		2K		2DK		2LDK		3DK		3LDK	
	Adjusted R2	0.9006	Adjusted R2	0.868	Adjusted R2	0.8756	Adjusted R2	0.8418	Adjusted R2	0.8214	Adjusted R2	0.8469	Adjusted R2	0.8987	Adjusted R2	0.7882	Adjusted R2	0.9073
logprice	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Unit size	0.0261	783.1800	0.0246	929.3600	0.0210	303.9900	0.0174	455.2900	0.0189	179.1700	0.0139	256.6900	0.0149	507.1400	0.0113	119.6800	0.0117	451.9900
Months	−0.0007	−276.6700	−0.0006	−417.7700	−0.0007	−224.4200	−0.0008	−202.7700	−0.0007	−126.6800	−0.0008	−218.0400	−0.0008	−190.7700	−0.0007	−87.4300	−0.0008	−139.0900
Required time to station	−0.0043	−71.2100	−0.0055	−161.9100	−0.0058	−60.3700	−0.0075	−75.4200	−0.0057	−41.6600	−0.0072	−110.5300	−0.0090	−91.7800	−0.0080	−68.1100	−0.0078	−59.9400
Bus dummy	−0.0832	−22.2800	−0.0743	−36.1300	−0.1205	−31.0500	−0.1050	−18.4000	−0.0738	−21.2300	−0.0899	−61.2700	−0.0986	−34.8200	−0.1189	−50.2100	−0.1252	−36.4100
New construction dummy	0.0016	2.1700	−0.0076	−22.1200	0.0175	15.4000	−0.0055	−6.3400	0.0251	7.1200	0.0147	7.6100	0.0177	15.2300	0.0095	1.1100	0.0485	22.6600
Access to CBD	−0.0057	−134.8900	−0.0056	−236.7900	−0.0066	−93.7100	−0.0045	−64.8000	−0.0068	−61.7000	−0.0066	−124.5400	−0.0071	−93.5500	−0.0076	−73.1000	−0.0084	−78.4300
1st(ground) floor dummy	−0.0328	−48.1500	−0.0285	−72.7500	−0.0355	−32.0700	−0.0403	−30.7200	−0.0184	−10.3800	−0.0227	−26.8900	−0.0364	−27.0600	−0.0301	−19.3800	−0.0315	−18.2700
Top story dummy	0.0113	17.9200	0.0171	45.4000	0.0098	9.9600	0.0287	27.3200	0.0054	3.4300	0.0076	10.0500	0.0264	22.7900	0.0081	5.7700	0.0248	15.7500
Number of stories	0.0069	97.3100	0.0076	175.4200	0.0053	52.2700	0.0042	83.0700	0.0090	22.9900	0.0058	40.4300	0.0031	56.6500	0.0030	11.0900	0.0040	47.6300
Structure dummy																		
Steel	0.0129	15.7700	0.0226	49.3100	0.0357	26.4200	0.0484	18.7300	0.0623	34.9400	0.0331	32.9600	0.0345	11.3300	0.0158	4.3900	−0.0241	−3.7000
RC	0.0426	56.9200	0.0540	117.0000	0.0833	63.8900	0.1155	49.5000	0.0843	43.9100	0.0616	58.9200	0.0860	31.0500	0.0344	10.0200	0.0471	7.9500
SRC	0.0316	30.2600	0.0444	66.7800	0.0827	48.0300	0.1123	44.8800	0.0665	19.1300	0.0520	34.3200	0.0709	24.2000	0.0228	5.7100	0.0410	6.7600
LGS	−0.0083	−5.1200	−0.0009	−1.5800	0.0009	0.3800	−0.0166	−4.6800	0.0225	9.3400	0.0015	1.2100	−0.0306	−7.6500	−0.0204	−5.1700	−0.0482	−5.2300
Time Dummy																		
Feb-04	−0.0059	−1.5700	0.0045	1.8600	0.0004	0.0600	0.0009	0.1100	0.0064	0.6700	−0.0006	−0.1400	0.0060	0.9600	−0.0016	−0.2400	0.0006	0.0700
Mar-04	−0.0088	−2.4400	0.0079	3.5100	−0.0052	−0.8500	−0.0059	−0.7500	−0.0108	−1.1700	−0.0019	−0.4700	−0.0018	−0.3000	−0.0061	−0.8900	−0.0095	−1.3100
Apr-04	−0.0193	−4.9100	0.0046	1.9200	−0.0122	−1.8700	0.0007	0.0900	−0.0045	−0.4700	−0.0047	−1.1200	−0.0056	−0.8800	0.0066	0.8800	−0.0085	−1.0800
May-04	−0.0083	−2.1000	−0.0001	−0.0500	−0.0231	−3.5900	−0.0102	−1.2800	−0.0143	−1.5300	−0.0051	−1.2500	0.0048	0.7500	−0.0143	−1.9500	−0.0074	−0.9300
Jun-04	−0.0125	−3.3500	0.0003	0.1300	−0.0142	−2.2400	0.0083	1.0200	0.0007	0.0700	−0.0126	−3.1500	−0.0131	−2.0900	−0.0155	−2.1700	−0.0195	−2.5100
Jul-04	−0.0180	−4.7800	−0.0057	−2.3800	−0.0264	−4.2200	0.0039	0.4900	−0.0220	−2.4200	−0.0035	−0.8800	0.0003	0.0500	−0.0099	−1.3200	−0.0111	−1.4300
Aug-04	−0.0197	−4.7800	−0.0115	−4.5500	−0.0269	−4.1200	0.0097	1.1100	−0.0077	−0.7600	−0.0140	−3.1900	−0.0056	−0.8200	−0.0026	−0.3300	−0.0056	−0.6700
Sep-04	−0.0111	−3.0800	−0.0099	−4.3800	−0.0226	−3.7200	0.0092	1.1600	−0.0201	−2.2200	−0.0113	−2.8700	0.0021	0.3300	−0.0038	−0.5400	−0.0029	−0.3700
Oct-04	−0.0210	−5.7200	−0.0083	−3.6400	−0.0264	−4.4100	−0.0002	−0.0300	−0.0211	−2.3600	−0.0063	−1.5700	−0.0017	−0.2800	−0.0064	−0.8900	0.0029	0.3700
Nov-04	−0.0275	−7.5300	−0.0113	−4.9400	−0.0175	−2.8700	0.0237	3.0200	−0.0151	−1.6600	−0.0064	−1.6000	0.0058	0.9500	−0.0052	−0.7300	0.0064	0.7900
Dec-04	−0.0327	−8.0700	−0.0134	−5.4900	−0.0264	−3.8600	0.0120	1.4400	−0.0293	−2.9500	−0.0057	−1.2100	−0.0062	−0.9300	0.0036	0.4400	−0.0028	−0.3300
Jan-05	−0.0130	−3.9100	−0.0066	−3.1400	−0.0240	−4.1900	0.0057	0.7900	−0.0202	−2.3800	−0.0109	−2.8800	−0.0041	−0.7300	−0.0118	−1.7500	0.0074	1.0000
Feb-05	−0.0119	−3.5700	−0.0062	−2.9700	−0.0214	−3.7400	0.0081	1.1300	−0.0194	−2.2700	−0.0035	−0.9000	−0.0077	−1.3400	−0.0023	−0.3400	0.0032	0.4500
Mar-05	−0.0211	−6.3800	−0.0087	−4.1800	−0.0076	−1.3500	0.0163	2.3600	−0.0257	−3.0600	−0.0072	−1.9200	−0.0052	−0.9300	−0.0081	−1.2300	−0.0045	−0.6500
Apr-05	−0.0151	−4.2400	−0.0005	−0.2400	−0.0033	−0.5700	0.0173	2.4400	−0.0278	−3.2200	−0.0042	−1.0800	−0.0035	−0.5900	−0.0095	−1.3800	0.0091	1.2100
May-05	−0.0291	−8.0300	−0.0058	−2.6300	−0.0041	−0.7000	0.0029	0.4100	−0.0236	−2.7200	−0.0136	−3.5200	−0.0163	−2.8300	−0.0084	−1.2100	−0.0091	−1.2400
Jun-05	−0.0251	−7.0300	−0.0099	−4.5100	−0.0247	−4.1800	−0.0004	−0.0500	−0.0223	−2.6400	−0.0157	−4.1200	−0.0210	−3.6600	−0.0097	−1.4400	0.0063	0.8600
Jul-05	−0.0243	−6.7800	−0.0108	−4.9600	−0.0159	−2.6600	−0.0003	−0.0500	−0.0218	−2.5100	−0.0028	−0.7300	−0.0210	−3.6400	−0.0112	−1.5900	−0.0015	−0.2100
Aug-05	−0.0283	−7.5100	−0.0137	−6.0400	−0.0159	−2.6500	−0.0102	−1.3700	−0.0245	−2.6600	−0.0076	−1.9000	−0.0264	−4.3700	−0.0108	−1.4800	0.0063	0.8300
Sep-05	−0.0281	−8.0000	−0.0158	−7.4400	−0.0152	−2.6400	0.0052	0.7400	−0.0180	−2.0900	−0.0111	−3.0000	−0.0247	−4.3700	−0.0132	−1.9400	−0.0113	−1.6100
Oct-05	−0.0369	−10.4000	−0.0254	−11.8100	−0.0191	−3.2800	0.0018	0.2500	−0.0221	−2.5600	−0.0133	−3.4600	−0.0142	−2.3900	−0.0177	−2.6100	0.0010	0.1300
Nov-05	−0.0308	−8.8200	−0.0181	−8.4700	−0.0169	−2.9000	0.0107	1.4900	−0.0263	−3.0700	−0.0129	−3.3500	−0.0055	−0.9400	−0.0191	−2.8000	−0.0070	−0.9400
Dec-05	−0.0317	−7.9300	−0.0193	−8.0300	−0.0239	−3.6800	−0.0087	−1.1700	−0.0317	−3.1900	−0.0152	−3.4300	−0.0042	−0.6400	−0.0118	−1.5200	0.0030	0.3700
Jan-06	−0.0254	−7.7700	−0.0067	−3.3300	−0.0283	−5.0300	−0.0042	−0.6100	−0.0103	−1.2700	−0.0135	−3.6600	−0.0028	−0.4900	−0.0129	−1.9500	−0.0093	−1.3500
Feb-06	−0.0211	−6.4200	−0.0079	−3.8900	−0.0228	−4.0200	0.0202	2.9400	−0.0204	−2.4700	−0.0107	−2.8800	0.0055	0.9800	0.0000	0.0100	−0.0002	−0.0300
Mar-06	−0.0117	−3.6300	−0.0067	−3.4000	−0.0192	−3.4600	0.0198	2.9600	−0.0044	−0.5300	−0.0087	−2.3500	0.0169	3.0900	−0.0163	−2.4700	−0.0029	−0.4300
Apr-06	−0.0076	−2.1700	−0.0028	−1.3000	−0.0169	−2.9400	0.0188	2.7400	−0.0173	−2.0200	−0.0115	−2.9500	0.0179	3.1300	−0.0118	−1.7400	−0.0001	−0.0200
May-06	−0.0151	−4.3100	−0.0105	−4.9700	−0.0177	−3.0500	0.0298	4.3400	−0.0161	−1.8900	−0.0080	−2.1000	0.0097	1.7400	−0.0223	−3.3400	−0.0075	−1.0700
Jun-06	−0.0229	−6.6100	−0.0107	−5.0900	−0.0131	−2.2200	0.0279	4.0800	−0.0075	−0.8800	−0.0036	−0.9100	0.0039	0.6800	−0.0093	−1.3300	0.0015	0.2100
Jul-06	−0.0274	−7.7000	−0.0091	−4.2400	−0.0100	−1.6600	0.0324	4.6000	0.0024	0.2800	−0.0062	−1.5600	0.0097	1.6900	−0.0044	−0.6200	0.0056	0.7700
Aug-06	−0.0295	−8.3400	−0.0174	−7.9900	−0.0090	−1.4800	0.0310	4.3100	−0.0170	−1.9000	−0.0016	−0.4000	0.0111	1.9000	−0.0022	−0.3000	−0.0100	−1.3700
Sep-06	−0.0176	−5.2100	−0.0110	−5.3000	−0.0066	−1.1400	0.0307	4.4400	−0.0019	−0.2200	−0.0016	−0.4200	0.0156	2.8200	−0.0048	−0.7200	−0.0067	−0.9600
Oct-06	−0.0133	−3.9600	−0.0139	−6.8800	−0.0051	−0.8700	0.0373	5.3000	−0.0122	−1.4500	−0.0069	−1.8400	0.0177	3.0600	−0.0132	−2.0400	0.0105	1.4800
Nov-06	−0.0230	−6.6500	−0.0022	−1.0500	−0.0134	−2.2200	0.0425	6.0000	−0.0073	−0.8300	−0.0035	−0.8700	0.0162	2.6600	−0.0021	−0.2900	0.0024	0.3200
Dec-06	−0.0111	−3.0300	−0.0062	−2.8100	−0.0045	−0.7200	0.0221	3.0900	−0.0042	−0.4200	−0.0033	−0.7200	0.0261	3.9900	−0.0055	−0.6800	0.0171	2.0000
Jan-07	−0.0116	−3.6100	−0.0060	−3.0700	0.0016	0.2900	0.0266	3.9800	−0.0057	−0.6900	−0.0005	−0.1300	0.0265	4.7500	0.0015	0.2200	0.0183	2.6500
Feb-07	−0.0181	−5.7900	−0.0078	−4.1300	−0.0033	−0.6000	0.0469	7.1100	−0.0113	−1.3400	0.0082	2.1600	0.0538	9.7200	0.0010	0.1400	0.0311	4.3700
Mar-07	−0.0143	−4.5700	0.0020	1.0300	−0.0046	−0.8600	0.0436	6.6900	−0.0054	−0.6600	0.0060	1.5900	0.0513	9.4900	0.0089	1.3200	0.0277	4.0400
Apr-07	−0.0110	−3.2900	0.0011	0.5400	0.0053	0.9500	0.0519	7.8000	0.0000	0.0000	0.0103	2.6100	0.0470	8.3100	0.0086	1.2000	0.0295	4.1200
May-07	−0.0045	−1.3600	0.0050	2.5000	0.0048	0.8400	0.0523	7.8600	0.0029	0.3300	0.0099	2.5100	0.0483	8.7600	0.0209	2.9100	0.0396	5.4400
Jun-07	−0.0115	−3.4700	0.0015	0.7200	0.0139	2.4900	0.0522	7.8500	−0.0074	−0.8500	0.0077	1.9600	0.0413	7.4200	0.0078	1.0800	0.0278	3.7800
Jul-07	−0.0121	−3.5600	−0.0012	−0.5700	0.0074	1.2900	0.0555	8.1900	0.0049	0.5500	0.0168	4.1700	0.0480	8.5600	0.0194	2.7000	0.0302	4.0200
Aug-07	−0.0066	−1.9100	0.0024	1.1700	0.0185	3.1100	0.0597	8.9000	−0.0036	−0.4000	0.0157	3.7500	0.0571	10.0100	0.0207	2.8300	0.0262	3.4400
Sep-07	−0.0131	−3.9400	0.0037	1.8900	0.0238	4.0900	0.0610	9.1200	0.0044	0.5300	0.0149	3.7500	0.0514	9.1200	0.0148	2.0600	0.0291	3.9100
Oct-07	−0.0067	−2.0200	0.0015	0.7400	0.0189	3.2700	0.0537	8.0600	0.0060	0.7000	0.0196	4.8700	0.0604	10.6600	0.0205	2.8000	0.0428	5.6600
Nov-07	−0.0137	−4.1500	−0.0001	−0.0400	0.0115	1.9900	0.0569	8.5200	−0.0030	−0.3500	0.0126	3.1100	0.0519	8.9800	0.0150	1.9700	0.0528	6.9000
Dec-07	−0.0148	−4.2900	0.0036	1.8000	0.0161	2.6500	0.0491	7.2500	0.0077	0.8200	0.0212	4.7600	0.0457	7.3600	0.0236	2.7000	0.0567	6.5700
Jan-08	−0.0090	−2.8800	−0.0006	−0.3100	0.0169	3.0900	0.0467	7.1300	−0.0032	−0.3900	0.0141	3.7300	0.0520	9.3800	0.0077	1.1000	0.0369	4.9700
Feb-08	−0.0094	−3.0300	0.0024	1.2900	0.0101	1.8600	0.0467	7.1900	−0.0037	−0.4500	0.0177	4.5900	0.0491	8.9000	0.0219	3.0800	0.0370	5.2400
Mar-08	0.0028	0.8900	0.0061	3.1600	0.0164	2.9900	0.0591	9.1300	0.0012	0.1400	0.0175	4.4900	0.0649	11.6400	0.0251	3.5000	0.0859	12.0800

Apr-08	0.0034	1.0300	0.0108	5.4300	0.0256	4.5800	0.0571	8.7100	0.0067	0.7900	0.0236	5.8600	0.0528	9.3300	0.0198	2.5800	0.0553	7.5100
May-08	-0.0038	-1.1600	0.0032	1.5900	0.0044	0.7900	0.0482	7.3400	0.0054	0.6300	0.0242	6.0300	0.0460	8.2300	0.0105	1.3800	0.0612	8.4200
Jun-08	-0.0045	-1.3800	0.0038	1.9200	0.0091	1.6100	0.0615	9.3700	0.0043	0.5000	0.0183	4.5700	0.0521	9.2900	0.0188	2.4600	0.0619	8.6100
Jul-08	0.0003	0.0800	0.0042	2.1300	0.0144	2.5500	0.0493	7.5200	0.0075	0.8800	0.0215	5.3000	0.0508	8.9900	0.0264	3.5200	0.0551	7.5100
Aug-08	-0.0076	-2.2700	-0.0032	-1.5900	0.0088	1.5100	0.0500	7.4800	0.0015	0.1700	0.0148	3.4500	0.0614	10.4600	0.0322	4.0700	0.0552	7.3700
Sep-08	-0.0065	-2.0300	0.0013	0.6700	0.0136	2.4100	0.0507	7.7400	0.0077	0.9100	0.0245	6.1500	0.0438	7.9700	0.0481	6.4800	0.0343	4.8200
Oct-08	-0.0097	-3.0400	0.0038	1.9500	0.0128	2.3000	0.0511	7.7800	0.0102	1.2200	0.0223	5.6500	0.0572	10.2300	0.0337	4.6500	0.0427	5.9400
Nov-08	-0.0103	-3.2000	-0.0021	-1.0700	0.0106	1.8700	0.0415	6.2900	0.0026	0.3000	0.0151	3.7600	0.0492	8.6100	0.0296	4.0100	0.0577	7.7700
Dec-08	-0.0130	-3.8600	-0.0096	-4.6700	0.0123	2.0700	0.0405	5.9500	0.0190	2.0700	0.0226	5.0400	0.0337	5.6900	0.0340	4.2400	0.0465	6.0900
Jan-09	-0.0182	-5.9300	-0.0043	-2.2600	0.0089	1.6400	0.0392	6.0300	0.0069	0.8500	0.0231	6.0600	0.0419	7.7600	0.0266	3.8800	0.0462	6.7800
Feb-09	-0.0191	-6.2600	-0.0047	-2.4800	0.0152	2.7800	0.0238	3.6700	0.0023	0.2800	0.0159	4.0400	0.0272	5.0600	0.0221	3.1500	0.0333	4.8700
Mar-09	-0.0227	-7.3900	-0.0081	-4.2900	0.0111	2.0600	0.0216	3.3800	-0.0045	-0.5600	0.0179	4.6500	0.0253	4.8400	0.0289	4.1500	0.0256	3.8500
Apr-09	-0.0203	-6.4700	-0.0079	-4.0900	0.0036	0.6600	0.0272	4.2000	0.0069	0.8600	0.0226	5.9100	0.0247	4.6800	0.0409	5.5600	0.0385	5.6400
May-09	-0.0221	-7.4100	-0.0069	-3.8200	0.0157	3.0500	0.0177	2.8100	0.0102	1.3500	0.0226	6.5800	0.0258	5.2200	0.0212	3.5300	0.0193	3.1200
Jun-09	-0.0268	-9.0400	-0.0099	-5.4700	0.0117	2.2600	0.0135	2.1500	0.0122	1.6200	0.0214	6.2700	0.0233	4.7700	0.0206	3.4400	0.0235	3.8500
Jul-09	-0.0287	-9.7400	-0.0147	-8.1400	0.0072	1.3900	0.0150	2.4000	0.0104	1.3800	0.0172	5.0400	0.0216	4.4400	0.0159	2.6500	0.0243	4.0000
Aug-09	-0.0276	-9.2000	-0.0132	-7.1800	0.0071	1.3500	0.0127	2.0000	0.0145	1.9000	0.0196	5.6100	0.0234	4.7100	0.0179	2.9200	0.0169	2.7200
Sep-09	-0.0246	-7.2000	-0.0171	-7.9700	0.0016	0.2700	0.0220	3.2100	0.0077	0.8300	0.0122	2.7500	0.0305	5.1600	0.0375	4.3300	0.0192	2.5100
Oct-09	-0.0264	-7.6400	-0.0181	-8.4900	-0.0007	-0.1200	0.0115	1.6700	0.0105	1.0800	0.0117	2.5800	0.0284	4.6400	0.0313	3.4500	0.0391	4.8800
Nov-09	-0.0276	-7.8700	-0.0175	-7.9500	-0.0049	-0.7800	0.0124	1.7700	0.0040	0.4100	0.0104	2.2300	0.0094	1.5000	0.0231	2.4500	-0.0046	-0.5300
Dec-09	-0.0272	-7.1700	-0.0171	-7.2300	-0.0094	-1.4100	0.0050	0.6900	-0.0139	-1.1700	0.0158	2.9800	0.0081	1.1900	0.0469	4.1000	0.0122	1.2700
Jan-10	-0.0325	-9.7400	-0.0181	-8.8200	-0.0033	-0.5700	-0.0001	-0.0100	0.0107	1.1800	0.0114	2.7300	0.0185	3.2300	0.0277	3.3700	0.0155	1.9700
Feb-10	-0.0299	-9.1800	-0.0238	-11.5900	-0.0017	-0.3100	-0.0029	-0.4300	-0.0014	-0.1500	0.0085	1.9600	0.0148	2.5000	0.0350	4.1600	0.0053	0.6300
Mar-10	-0.0402	-12.1500	-0.0218	-10.5500	-0.0014	-0.2500	-0.0031	-0.4700	0.0136	1.4700	0.0141	3.2900	0.0005	0.0900	0.0240	2.8300	0.0145	1.8200
Apr-10	-0.0436	-12.2500	-0.0294	-12.9800	-0.0097	-1.5500	-0.0028	-0.4000	-0.0051	-0.5200	0.0081	1.7200	0.0108	1.6900	0.0304	3.4000	0.0145	1.6800
May-10	-0.0400	-11.0000	-0.0225	-9.9700	-0.0048	-0.7900	-0.0099	-1.4200	0.0009	0.0900	0.0095	2.0700	0.0021	0.3200	0.0181	2.0000	0.0064	0.7300
Jun-10	-0.0465	-12.6900	-0.0320	-14.3900	-0.0109	-1.7500	-0.0042	-0.6000	-0.0097	-0.9400	0.0036	0.7900	-0.0007	-0.1100	0.0062	0.7000	0.0115	1.3300
Jul-10	-0.0459	-12.3000	-0.0370	-16.4600	-0.0184	-2.9600	-0.0083	-1.1700	0.0092	0.9000	0.0038	0.8500	-0.0039	-0.6100	0.0176	2.0300	0.0066	0.7300
Aug-10	-0.0627	-15.7200	-0.0349	-14.2300	-0.0106	-1.5800	-0.0089	-1.1800	0.0146	1.3100	0.0188	3.8000	-0.0228	-3.3100	0.0210	1.9800	0.0129	1.3700
Sep-10	-0.0465	-13.0500	-0.0312	-13.8800	-0.0150	-2.4000	-0.0007	-0.1000	0.0013	0.1300	0.0121	2.7000	0.0012	0.2000	0.0076	0.8500	-0.0007	-0.0800
Oct-10	-0.0489	-13.7300	-0.0345	-15.3600	-0.0082	-1.3200	-0.0098	-1.3600	-0.0009	-0.0900	0.0081	1.8000	0.0018	0.2700	0.0354	3.9100	0.0191	2.1400
Nov-10	-0.0542	-15.1400	-0.0396	-17.1700	-0.0107	-1.7000	-0.0190	-2.6200	-0.0250	-2.4100	0.0086	1.8500	-0.0084	-1.2800	0.0189	2.0700	-0.0026	-0.2900
Dec-10	-0.0450	-11.1400	-0.0399	-15.9000	-0.0202	-2.9500	-0.0153	-2.0100	-0.0238	-1.7100	0.0216	3.8100	0.0046	0.6100	0.0102	0.8100	0.0029	0.2700
Jan-11	-0.0449	-13.5100	-0.0362	-17.2700	-0.0122	-2.0900	-0.0160	-2.3100	-0.0079	-0.8800	0.0054	1.3300	0.0049	0.8100	0.0152	1.9200	0.0193	2.3900
Feb-11	-0.0442	-15.3200	-0.0330	-18.5100	0.0007	0.1400	-0.0051	-0.8200	0.0032	0.4400	0.0156	4.7600	0.0089	1.8400	0.0113	1.9800	0.0042	0.6900
Mar-11	-0.0494	-13.6900	-0.0346	-14.9800	-0.0149	-2.3900	0.0005	0.0700	-0.0083	-0.8400	0.0021	0.4700	0.0011	0.1700	0.0174	2.0100	0.0043	0.4700
Apr-11	-0.0437	-12.0100	-0.0331	-14.1600	-0.0075	-1.2000	-0.0093	-1.3300	-0.0078	-0.7800	0.0040	0.8400	-0.0058	-0.9000	-0.0050	-0.5600	0.0026	0.2800
May-11	-0.0434	-11.3300	-0.0332	-13.0500	-0.0089	-1.3900	-0.0287	-3.9200	-0.0124	-1.2200	0.0030	0.6400	-0.0070	-1.0400	0.0050	0.5600	0.0137	1.4200
Jun-11	-0.0491	-13.4600	-0.0385	-15.9000	-0.0158	-2.4500	-0.0333	-4.6000	-0.0005	-0.0500	0.0021	0.4500	0.0008	0.1300	-0.0171	-1.8100	-0.0071	-0.7500
Jul-11	-0.0510	-13.3200	-0.0446	-17.6300	-0.0114	-1.7300	-0.0208	-2.7700	-0.0131	-1.2400	0.0023	0.4600	-0.0040	-0.5600	0.0301	2.8700	0.0141	1.4600
Aug-11	-0.0482	-12.0700	-0.0408	-15.3800	-0.0172	-2.5400	-0.0207	-2.7200	-0.0078	-0.6800	-0.0038	-0.7400	-0.0143	-1.9600	0.0100	1.0700	0.0105	1.0300
Sep-11	-0.0529	-14.7100	-0.0428	-17.7900	-0.0193	-3.0000	-0.0076	-1.0100	-0.0243	-2.5700	0.0050	1.0900	0.0016	0.2400	0.0063	0.7300	0.0036	0.3900
Oct-11	-0.0615	-15.9100	-0.0446	-17.6800	-0.0306	-4.5700	-0.0211	-2.7800	-0.0116	-1.0900	0.0062	1.2600	-0.0061	-0.8300	0.0190	1.9300	-0.0017	-0.1600
Nov-11	-0.0623	-16.5400	-0.0463	-18.4800	-0.0217	-3.2400	-0.0167	-2.1800	-0.0327	-3.2900	-0.0032	-0.6600	-0.0074	-1.0600	0.0100	1.1600	-0.0066	-0.6900
Dec-11	-0.0642	-14.4000	-0.0515	-17.7900	-0.0263	-3.4000	-0.0114	-1.3700	-0.0473	-3.8600	0.0099	1.6500	-0.0098	-1.1600	0.0118	1.0600	-0.0007	-0.0600
Jan-12	-0.0538	-15.1300	-0.0468	-20.5500	-0.0230	-3.6300	-0.0145	-1.9800	-0.0150	-1.6000	0.0009	0.2100	-0.0030	-0.4400	0.0211	2.5100	0.0124	1.2900
Feb-12	-0.0591	-16.5800	-0.0473	-20.6200	-0.0234	-3.7300	-0.0149	-2.0200	-0.0106	-1.0800	-0.0066	-1.4700	-0.0051	-0.7600	-0.0010	-0.1200	-0.0040	-0.4300
Mar-12	-0.0686	-18.6300	-0.0368	-15.4300	-0.0235	-3.6300	-0.0111	-1.4800	-0.0290	-2.9200	-0.0031	-0.6900	0.0048	0.7100	-0.0030	-0.3600	0.0052	0.5500
Apr-12	-0.0535	-13.2600	-0.0427	-15.9200	-0.0195	-2.9100	-0.0012	-0.1500	-0.0121	-1.1200	-0.0161	-3.3300	0.0048	0.6400	0.0021	0.2300	0.0002	0.0200
May-12	-0.0535	-13.3800	-0.0432	-16.1100	-0.0172	-2.4700	-0.0008	-0.1100	-0.0330	-3.2300	-0.0035	-0.7500	0.0027	0.3800	-0.0093	-1.0600	-0.0144	-1.4000
Jun-12	-0.0546	-13.5800	-0.0395	-15.1000	-0.0182	-2.6300	-0.0062	-0.8100	-0.0084	-0.8300	-0.0090	-1.8800	0.0021	0.2900	0.0176	2.0400	-0.0110	-1.0400
Jul-12	-0.0518	-12.1900	-0.0485	-18.0200	-0.0126	-1.7800	0.0050	0.6500	-0.0253	-2.3600	-0.0037	-0.7300	-0.0022	-0.2900	0.0117	1.1400	-0.0040	-0.3700
Aug-12	-0.0564	-13.1200	-0.0513	-18.6600	-0.0241	-3.2400	-0.0072	-0.9100	-0.0248	-2.1900	-0.0063	-1.1500	-0.0103	-1.3200	0.0258	2.7100	-0.0106	-0.9000
Sep-12	-0.0572	-14.0700	-0.0480	-18.3200	-0.0118	-1.6500	0.0059	0.7600	-0.0158	-1.4800	-0.0039	-0.8100	0.0039	0.5600	-0.0112	-1.2700	-0.0077	-0.7500
Oct-12	-0.0606	-14.7000	-0.0460	-18.0900	-0.0114	-1.6400	-0.0130	-1.7500	-0.0263	-2.4700	-0.0105	-2.1900	0.0013	0.1700	-0.0014	-0.1500	0.0035	0.3400
Nov-12	-0.0527	-13.1700	-0.0406	-15.7900	-0.0048	-0.6900	-0.0085	-1.1200	-0.0372	-3.5100	-0.0042	-0.8500	0.0007	0.1000	-0.0005	-0.0500	-0.0092	-0.8200
Dec-12	-0.0565	-11.1500	-0.0519	-16.1700	0.0014	0.1700	-0.0025	-0.2900	-0.0546	-3.7300	-0.0048	-0.6800	0.0106	1.1900	0.0132	1.0700	0.0266	1.7600
Jan-13	-0.0637	-16.4300	-0.0405	-16.7600	-0.0127	-1.9400	-0.0069	-0.9400	-0.0252	-2.5300	-0.0120	-2.6100	0.0121	1.7700	0.0085	0.9500	0.0074	0.7700
Feb-13	-0.0590	-15.0400	-0.0353	-14.0300	-0.0277	-4.1700	-0.0075	-0.9900	-0.0310	-3.1600	-0.0069	-1.4600	0.0048	0.6900	0.0095	1.0400	-0.0142	-1.4700
Mar-13	-0.0512	-12.7100	-0.0326	-12.4200	-0.0166	-2.4700	-0.0051	-0.6900	-0.0209	-2.0800	-0.0060	-1.3100	-0.0018	-0.2500	0.0156	1.8000	-0.0013	-0.1300
Apr-13	-0.0423	-9.6900	-0.0401	-14.3700	-0.0026	-0.3700	-0.0041	-0.5600	-0.0322	-2.9000	-0.0017	-0.3400	0.0104	1.4900	-0.0061	-0.6100	0.0218	2.0300
May-13	-0.0466	-10.7500	-0.0383	-13.1100	-0.0152	-2.0600	-0.0023	-0.3100	-0.0119	-1.0500	-0.0139	-2.7100	0.0030	0.3900	0.0104	1.0500	0.0181	1.6200
Jun-13	-0.0479	-10.5400	-0.0534	-18.4500	-0.0131	-1.7200	0.0036	0.4600	-0.0301	-2.5300	-0.0083	-1.5400	-0.0020	-0.2400	-0.0022	-0.2200	0.0112	1.0600
Jul-13	-0.0512	-11.7100	-0.0328	-11.2500	0.0045	0.5900	0.0000	0.0000	-0.0185	-1.6200	-0.0164	-3.0400	0.0123	1.5200	0.0204	1.9200	-0.0150	-1.3600
Aug-13	-0.0438	-9.5300	-0.0379	-13.2100	-0.0062	-0.7800	-0.0014	-0.1800	-0.0351	-2.8900	-0.0017	-0.3000	-0.0012	-0.1500	0.0036	0.3100	0.0279	2.5600
Sep-13	-0.0471	-10.7200	-0.0349	-12.4000	-0.0041	-0.5600	0.0122	1.6000	-0.0150	-1.2800	-0.0143	-2.8200	0.0390	5.1100	-0.0114	-1.1400	-0.0078	-0.7200
Oct-13	-0.0455	-10.5300	-0.0478	-17.4200	0.0078	1.0500	0.0001	0.0200	-0.0295	-2.6400	-0.0013	-0.2500	0.0013	0.1700	-0.0126	-1.1800	-0.0029	-0.2600
Nov-13	-0.0451	-10.0600	-0.0437	-15.9700	0.0042	0.5400	0.0014	0.1800	-0.0287	-2.4400	-0.0023	-0.4300	0.0045	0.5300	-0.0074	-0.6900	-0.0029	-0.2600
Dec-13	-0.0313	-6.2100	-0.0417	-13.7600	0.0007	0.0700	0.0100	1.1900	-0.0116	-0.7900	0.0132	1.8400	0.0448	4.8000	0.0180	1.3500	-0.0373	-2.9100

(Location Dummy was omitted from this table.)

Figure 1 Rent Index for each Madori in Tokyo's 23 Wards (Jan.04 = 100)

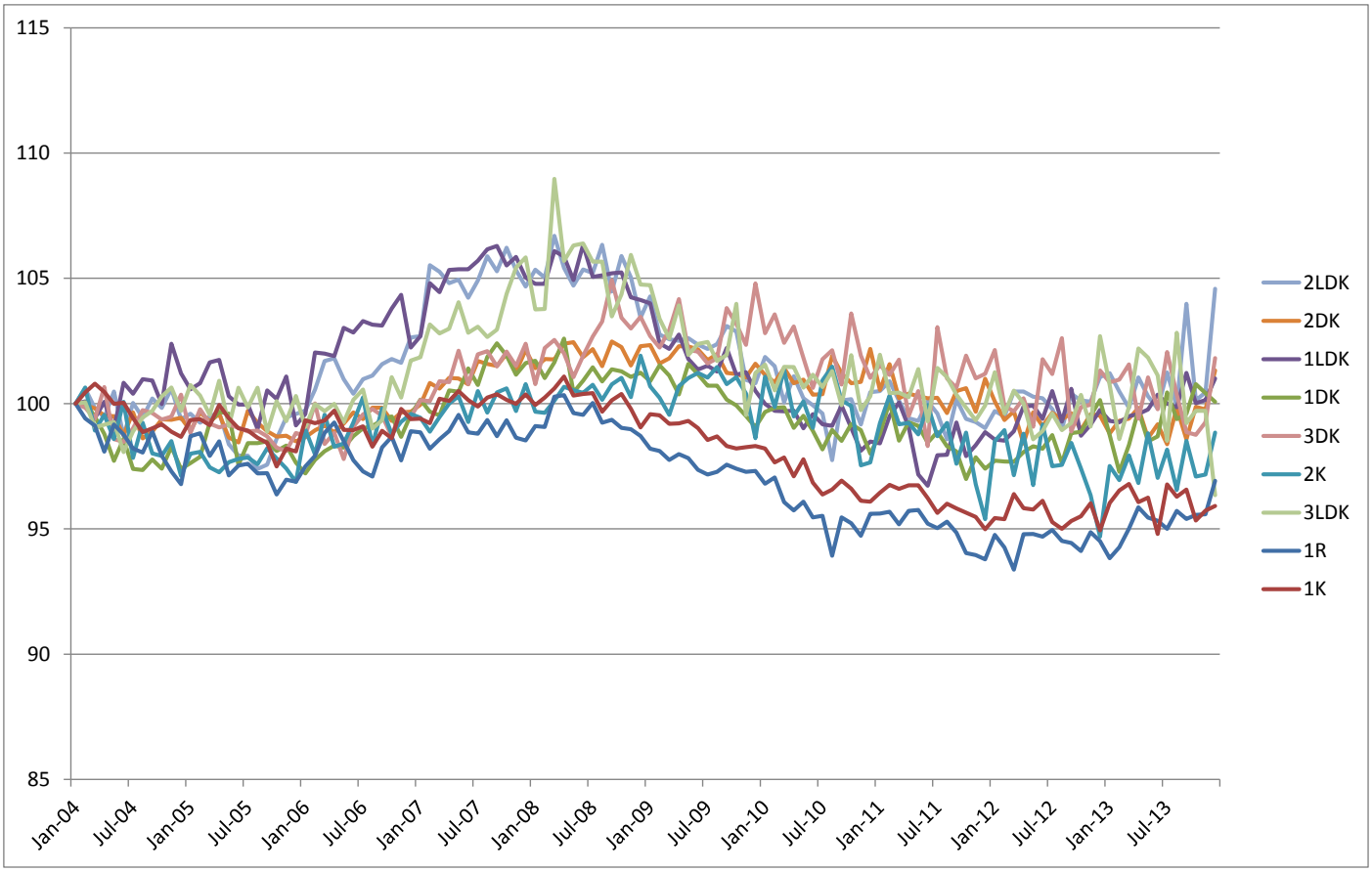


Table 4 Vacancy Rate TVI for each Madori in Tokyo's 23 Wards

	1R	1K	1DK	1LDK	2K	2DK	2LDK	3DK	3LDK
Dec-04	9.81	13.32	8.72	6.21	10.51	9.67	6.72	7.80	5.69
Jan-05	9.83	13.40	8.83	6.32	10.50	9.68	6.79	7.79	5.65
Feb-05	9.92	13.55	9.01	6.47	10.48	9.63	6.81	7.80	5.58
Mar-05	10.06	13.66	9.09	6.63	10.60	9.62	6.85	7.77	5.58
Apr-05	10.11	13.68	9.27	6.79	10.70	9.65	6.85	7.76	5.64
May-05	10.11	13.68	9.35	6.87	10.79	9.71	6.91	7.88	5.62
Jun-05	10.17	13.71	9.44	7.01	10.87	9.78	6.96	7.98	5.63
Jul-05	10.14	13.78	9.42	7.05	10.91	9.72	6.96	7.92	5.66
Aug-05	10.12	13.79	9.41	7.07	11.02	9.78	7.05	8.04	5.66
Sep-05	10.05	13.74	9.36	7.17	11.03	9.83	7.07	8.01	5.72
Oct-05	10.01	13.75	9.34	7.23	11.11	9.90	7.02	7.98	5.75
Nov-05	10.05	13.77	9.40	7.34	11.30	9.97	7.03	7.98	5.79
Dec-05	10.05	13.72	9.54	7.42	11.40	10.05	7.00	7.99	5.87
Jan-06	10.01	13.77	9.47	7.49	11.53	10.09	6.96	7.98	5.95
Feb-06	10.06	13.85	9.49	7.52	11.57	10.16	7.00	8.00	6.00
Mar-06	10.11	13.94	9.54	7.57	11.61	10.17	6.99	7.98	6.05
Apr-06	10.16	13.98	9.48	7.52	11.73	10.18	7.02	7.99	6.10
May-06	10.18	14.02	9.47	7.57	11.73	10.13	7.00	7.96	6.14
Jun-06	10.18	13.98	9.43	7.61	11.81	10.11	6.94	7.89	6.17
Jul-06	10.22	13.90	9.37	7.66	11.85	10.16	6.88	7.99	6.15
Aug-06	10.35	13.83	9.30	7.64	11.87	10.13	6.76	7.97	6.14
Sep-06	10.45	13.86	9.25	7.66	11.94	10.21	6.74	8.13	6.13
Oct-06	10.56	13.96	9.18	7.63	11.97	10.24	6.72	8.24	6.18
Nov-06	10.59	14.01	9.12	7.62	11.79	10.23	6.66	8.26	6.20
Dec-06	10.71	14.05	9.07	7.63	12.03	10.31	6.62	8.22	6.06
Jan-07	10.79	14.14	9.18	7.67	12.03	10.30	6.63	8.30	6.03
Feb-07	10.91	14.32	9.13	7.78	12.03	10.36	6.66	8.31	5.99
Mar-07	10.93	14.46	9.03	7.86	12.08	10.40	6.66	8.37	5.91
Apr-07	10.96	14.50	9.02	7.91	11.93	10.39	6.63	8.31	5.79
May-07	10.96	14.44	8.97	7.95	11.80	10.41	6.62	8.20	5.72
Jun-07	10.94	14.46	8.94	7.96	11.69	10.40	6.57	8.19	5.59
Jul-07	10.96	14.53	8.99	7.93	11.63	10.33	6.56	8.13	5.52
Aug-07	10.89	14.60	8.88	8.03	11.49	10.23	6.56	8.16	5.50
Sep-07	10.88	14.56	8.80	7.99	11.47	10.11	6.53	7.97	5.41
Oct-07	10.84	14.44	8.75	8.03	11.41	10.01	6.50	7.83	5.30
Nov-07	10.83	14.35	8.71	8.02	11.38	9.98	6.47	7.74	5.17
Dec-07	10.75	14.32	8.60	8.03	11.10	9.90	6.46	7.67	5.13
Jan-08	10.65	14.12	8.48	7.94	11.03	9.93	6.33	7.69	4.99
Feb-08	10.49	13.86	8.47	7.86	11.00	9.92	6.26	7.67	4.96
Mar-08	10.39	13.55	8.41	7.75	10.91	9.86	6.20	7.66	5.01
Apr-08	10.34	13.37	8.38	7.72	10.95	9.81	6.15	7.62	5.00
May-08	10.28	13.27	8.36	7.67	10.97	9.74	6.07	7.59	5.00
Jun-08	10.20	13.19	8.33	7.69	11.03	9.68	6.06	7.55	5.07
Jul-08	10.15	13.04	8.25	7.67	11.02	9.66	6.00	7.56	5.06
Aug-08	10.06	12.84	8.27	7.53	11.07	9.65	5.91	7.43	5.00
Sep-08	9.97	12.64	8.30	7.48	10.92	9.59	5.83	7.44	4.99
Oct-08	9.88	12.45	8.32	7.43	10.92	9.54	5.75	7.43	5.01
Nov-08	9.80	12.21	8.25	7.35	10.98	9.48	5.70	7.53	5.02
Dec-08	9.72	11.92	8.22	7.20	11.05	9.34	5.61	7.49	5.06
Jan-09	9.69	11.70	8.12	7.11	11.11	9.23	5.59	7.41	5.10
Feb-09	9.64	11.38	8.02	6.98	11.10	9.07	5.54	7.40	5.12
Mar-09	9.57	11.19	7.98	6.89	10.98	8.98	5.55	7.35	5.09
Apr-09	9.50	11.03	7.84	6.75	10.96	8.92	5.55	7.34	5.07

May-09	9.53	11.08	7.78	6.66	11.01	8.99	5.59	7.49	5.08
Jun-09	9.59	11.14	7.73	6.57	10.95	9.04	5.64	7.65	5.12
Jul-09	9.65	11.21	7.77	6.58	11.02	9.12	5.72	7.79	5.19
Aug-09	9.77	11.33	7.75	6.59	11.14	9.21	5.82	8.00	5.25
Sep-09	9.81	11.53	7.74	6.64	11.31	9.30	5.89	8.04	5.26
Oct-09	9.86	11.77	7.73	6.65	11.28	9.35	5.96	7.94	5.23
Nov-09	9.97	12.06	7.77	6.72	11.26	9.36	6.06	7.78	5.25
Dec-09	10.04	12.49	7.86	6.77	11.20	9.47	6.20	7.82	5.20
Jan-10	10.11	12.84	7.87	6.85	11.20	9.53	6.29	7.86	5.17
Feb-10	10.22	13.21	8.03	6.96	11.23	9.66	6.28	7.87	5.15
Mar-10	10.29	13.51	8.09	7.05	11.33	9.71	6.26	7.88	5.15
Apr-10	10.37	13.82	8.13	7.19	11.37	9.79	6.29	7.99	5.18
May-10	10.36	13.90	8.18	7.16	11.36	9.79	6.24	7.91	5.20
Jun-10	10.34	13.96	8.24	7.17	11.37	9.80	6.14	7.77	5.14
Jul-10	10.27	14.03	8.28	7.11	11.24	9.84	6.03	7.61	5.05
Aug-10	10.22	14.10	8.35	7.08	11.17	9.85	6.00	7.75	4.97
Sep-10	10.20	14.12	8.35	7.03	11.13	9.90	5.98	7.77	4.94
Oct-10	10.24	14.09	8.41	6.96	11.18	9.97	5.90	7.88	4.93
Nov-10	10.21	14.12	8.43	6.87	11.30	10.04	5.84	8.05	4.92
Dec-10	10.18	14.02	8.38	6.84	11.31	10.01	5.73	8.12	4.93
Jan-11	10.17	13.79	8.43	6.76	11.19	10.11	5.70	8.10	4.94
Feb-11	10.03	13.49	8.29	6.67	11.27	10.16	5.74	8.26	5.01
Mar-11	9.99	13.33	8.30	6.64	11.23	10.26	5.78	8.31	4.97
Apr-11	9.97	13.18	8.31	6.53	11.23	10.26	5.71	8.26	4.91
May-11	9.97	13.12	8.24	6.55	11.28	10.20	5.71	8.21	4.81
Jun-11	9.99	12.99	8.17	6.44	11.27	10.17	5.70	8.20	4.76
Jul-11	10.05	12.92	8.15	6.39	11.43	10.11	5.68	8.15	4.77
Aug-11	10.12	12.87	8.12	6.38	11.38	10.16	5.62	8.01	4.78
Sep-11	10.20	12.80	8.13	6.29	11.38	10.11	5.56	8.01	4.78
Oct-11	10.19	12.73	8.03	6.28	11.41	10.01	5.54	8.07	4.75
Nov-11	10.20	12.64	8.06	6.26	11.34	10.02	5.57	8.09	4.75
Dec-11	10.30	12.63	8.03	6.22	11.49	10.00	5.53	8.43	4.66
Jan-12	10.31	12.72	7.97	6.21	11.65	9.94	5.52	8.55	4.67
Feb-12	10.35	12.84	7.97	6.14	11.54	9.86	5.49	8.54	4.61
Mar-12	10.38	12.87	7.94	6.00	11.57	9.82	5.44	8.61	4.58
Apr-12	10.34	12.81	7.89	5.97	11.63	9.81	5.44	8.62	4.60
May-12	10.41	12.77	7.92	5.93	11.52	9.83	5.43	8.80	4.63
Jun-12	10.40	12.75	7.92	5.95	11.60	9.92	5.46	8.91	4.66
Jul-12	10.29	12.69	7.86	5.94	11.59	9.89	5.48	8.94	4.61
Aug-12	10.34	12.73	7.92	5.96	11.68	9.84	5.46	8.81	4.61
Sep-12	10.27	12.69	7.87	6.00	11.82	9.82	5.53	8.83	4.57
Oct-12	10.32	12.66	7.93	6.06	11.73	9.89	5.56	8.80	4.60
Nov-12	10.37	12.59	7.84	6.11	11.84	9.87	5.52	8.78	4.53
Dec-12	10.18	12.48	7.81	6.14	11.66	9.98	5.51	8.42	4.52
Jan-13	10.10	12.39	7.77	6.20	11.66	9.94	5.52	8.29	4.50
Feb-13	10.09	12.46	7.81	6.28	11.71	10.02	5.55	8.19	4.48
Mar-13	10.08	12.51	7.83	6.46	11.74	10.04	5.60	8.12	4.57
Apr-13	10.03	12.53	7.82	6.57	11.60	10.00	5.66	8.01	4.59
May-13	9.96	12.48	7.75	6.66	11.56	10.07	5.70	7.89	4.55
Jun-13	9.86	12.44	7.74	6.66	11.35	10.03	5.69	7.83	4.54
Jul-13	9.97	12.37	7.74	6.70	11.19	10.04	5.72	7.80	4.60
Aug-13	9.90	12.27	7.61	6.74	10.90	10.08	5.77	7.82	4.72
Sep-13	9.92	12.25	7.75	6.86	10.72	10.15	5.79	7.77	4.86
Oct-13	9.88	12.29	7.78	6.86	10.80	10.20	5.85	7.72	4.84
Nov-13	9.74	12.36	7.82	6.90	10.67	10.30	5.86	7.81	4.90
Dec-13	9.75	12.49	7.81	6.93	10.84	10.24	5.91	7.83	5.22

Figure 2 Vacancy Rate TVI for each Madori in Tokyo's 23 Wards

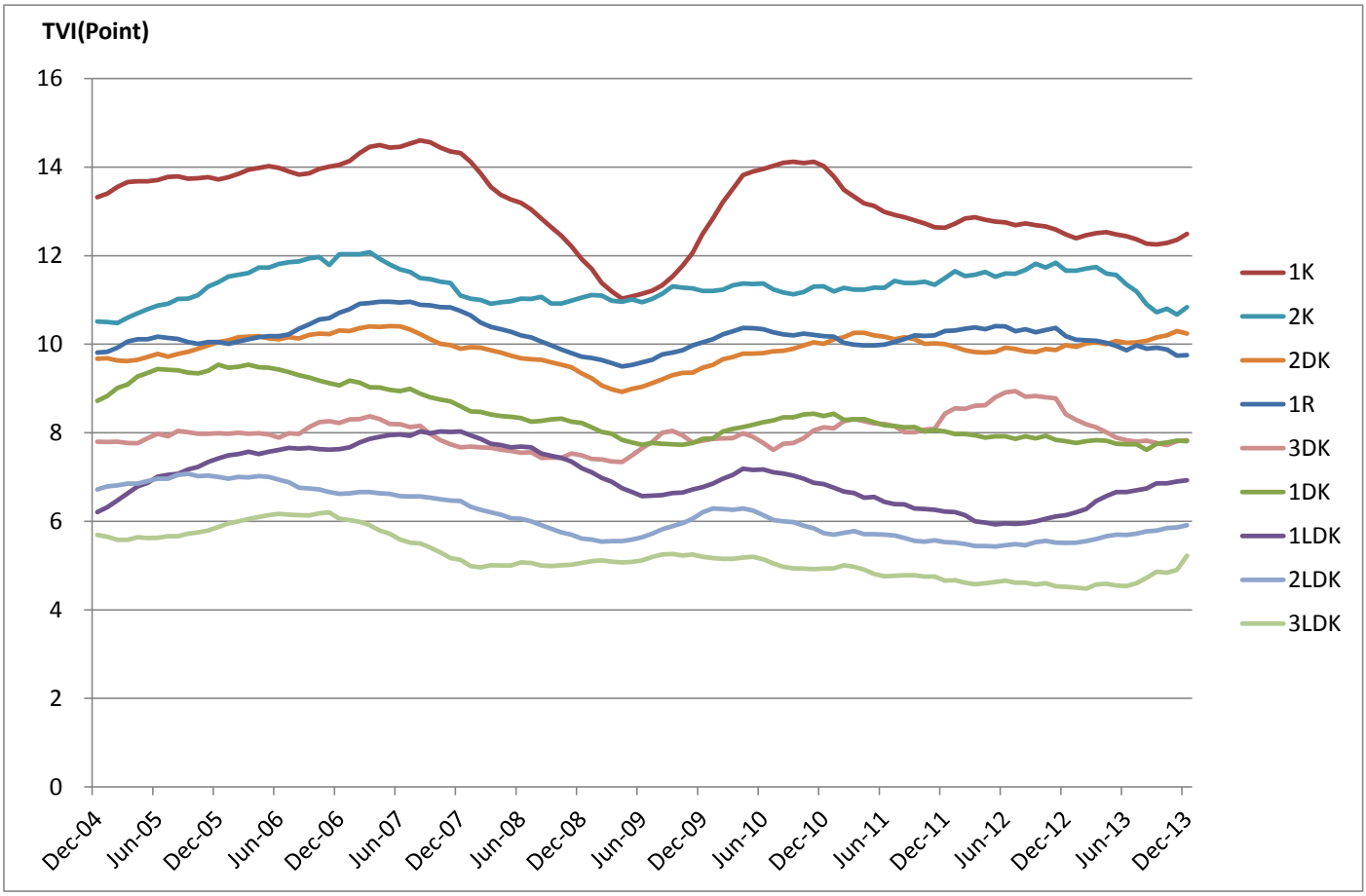


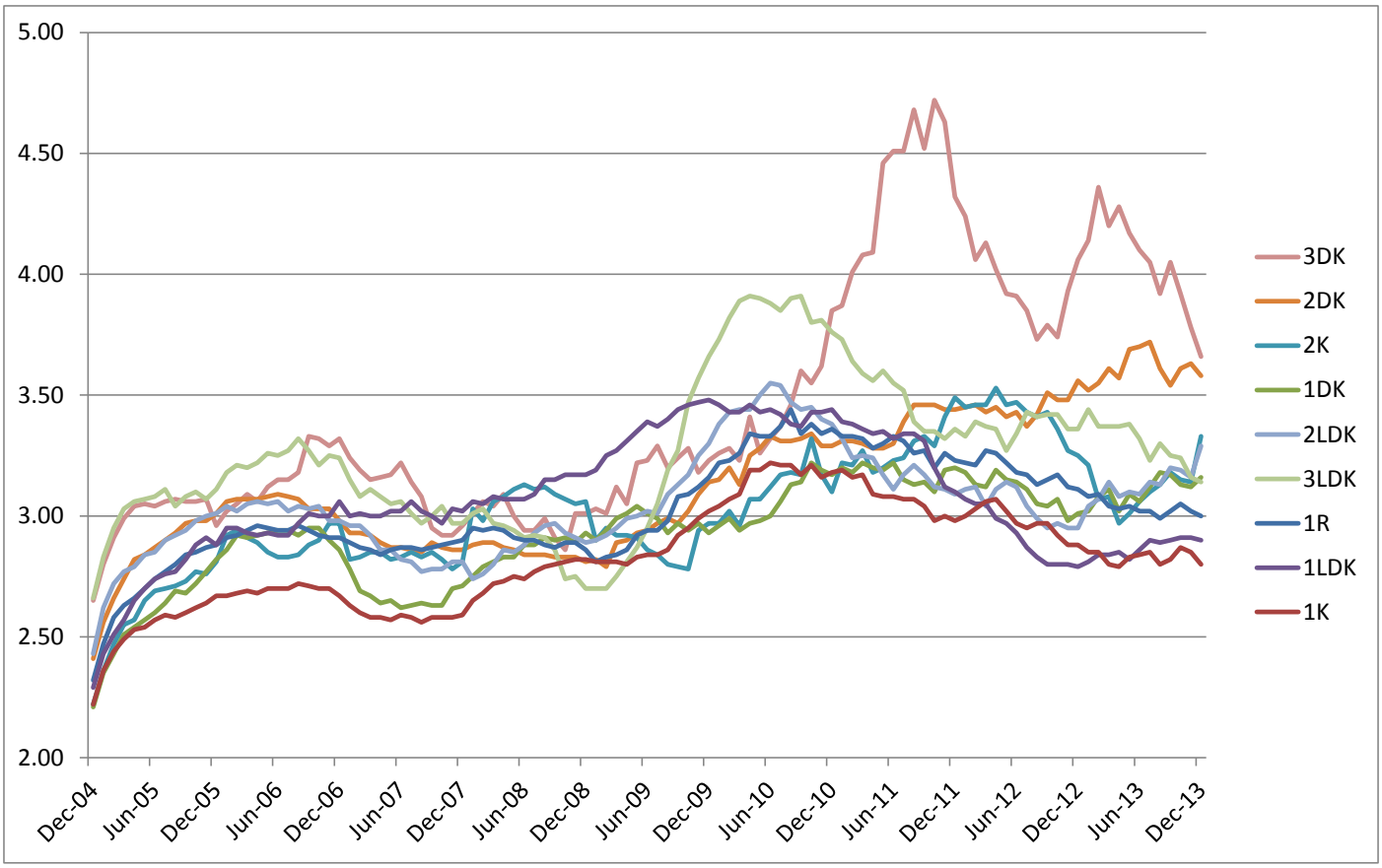
Table 5 Vacancy Duration for each Madori in Tokyo's 23 Wards

(Months)

	1R	1K	1DK	1LDK	2K	2DK	2LDK	3DK	3LDK
Dec-04	2.32	2.22	2.21	2.29	2.22	2.41	2.43	2.65	2.66
Jan-05	2.47	2.36	2.35	2.43	2.36	2.56	2.62	2.80	2.83
Feb-05	2.58	2.44	2.43	2.51	2.47	2.66	2.72	2.91	2.95
Mar-05	2.63	2.49	2.51	2.57	2.55	2.74	2.77	2.99	3.03
Apr-05	2.66	2.53	2.54	2.65	2.57	2.82	2.79	3.04	3.06
May-05	2.70	2.54	2.57	2.70	2.65	2.84	2.84	3.05	3.07
Jun-05	2.74	2.57	2.60	2.74	2.69	2.87	2.85	3.04	3.08
Jul-05	2.77	2.59	2.64	2.76	2.70	2.90	2.90	3.06	3.11
Aug-05	2.80	2.58	2.69	2.77	2.71	2.93	2.92	3.07	3.04
Sep-05	2.84	2.60	2.68	2.82	2.73	2.97	2.94	3.06	3.08
Oct-05	2.85	2.62	2.72	2.88	2.77	2.98	2.98	3.06	3.10
Nov-05	2.87	2.64	2.77	2.91	2.76	2.98	3.00	3.07	3.07
Dec-05	2.88	2.67	2.82	2.88	2.81	3.01	3.01	2.96	3.11
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	3.20
Apr-06	2.96	2.68	2.92	2.92	2.89	3.07	3.06	3.06	3.22
May-06	2.95	2.70	2.93	2.93	2.85	3.08	3.05	3.12	3.26
Jun-06	2.94	2.70	2.94	2.92	2.83	3.09	3.06	3.15	3.25
Jul-06	2.94	2.70	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	2.70	2.95	3.00	2.90	3.03	3.04	3.32	3.21
Nov-06	2.91	2.70	2.90	3.00	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	3.00	2.82	2.93	2.96	3.24	3.15
Feb-07	2.87	2.60	2.69	3.01	2.83	2.93	2.96	3.19	3.08
Mar-07	2.86	2.58	2.67	3.00	2.85	2.92	2.92	3.15	3.11
Apr-07	2.84	2.58	2.64	3.00	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	3.00	2.85	2.89	2.78	2.95	3.00
Oct-07	2.88	2.58	2.63	2.97	2.82	2.87	2.78	2.92	3.04
Nov-07	2.89	2.58	2.70	3.03	2.78	2.86	2.81	2.92	2.97
Dec-07	2.90	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	2.80	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	3.00	2.94
Jun-08	2.90	2.74	2.88	3.07	3.13	2.84	2.88	2.94	2.91
Jul-08	2.90	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	2.80	2.90	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	2.81	2.89	3.01	2.70
Jan-09	2.81	2.81	2.90	3.19	2.90	2.82	2.90	3.03	2.70
Feb-09	2.83	2.81	2.94	3.25	2.95	2.79	2.92	3.01	2.70
Mar-09	2.84	2.81	2.99	3.27	2.92	2.89	2.95	3.12	2.75
Apr-09	2.86	2.80	3.01	3.31	2.92	2.90	2.99	3.05	2.81

May-09	2.92	2.83	3.04	3.35	2.91	2.93	3.00	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	3.40	2.80	2.99	3.09	3.20	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	3.30	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	3.20	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	3.91
May-10	3.33	3.19	2.98	3.43	3.07	3.28	3.50	3.26	3.90
Jun-10	3.33	3.22	3.00	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	3.90
Sep-10	3.34	3.17	3.14	3.37	3.17	3.32	3.44	3.60	3.91
Oct-10	3.38	3.21	3.22	3.43	3.32	3.34	3.45	3.55	3.80
Nov-10	3.34	3.16	3.19	3.43	3.17	3.29	3.40	3.62	3.81
Dec-10	3.36	3.18	3.17	3.44	3.10	3.29	3.38	3.85	3.76
Jan-11	3.33	3.19	3.20	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	3.30	3.25	4.08	3.59
Apr-11	3.28	3.09	3.20	3.34	3.18	3.28	3.24	4.09	3.56
May-11	3.30	3.08	3.19	3.35	3.20	3.28	3.17	4.46	3.60
Jun-11	3.33	3.08	3.22	3.32	3.23	3.30	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	3.20	2.98	3.10	3.20	3.29	3.46	3.12	4.72	3.35
Nov-11	3.26	3.00	3.19	3.12	3.41	3.44	3.11	4.63	3.32
Dec-11	3.23	2.98	3.20	3.10	3.49	3.44	3.09	4.32	3.36
Jan-12	3.22	3.00	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	3.34
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	2.80	3.43	3.51	2.95	3.79	3.42
Oct-12	3.17	2.92	3.07	2.80	3.36	3.48	2.97	3.74	3.42
Nov-12	3.12	2.88	2.98	2.80	3.27	3.48	2.95	3.93	3.36
Dec-12	3.11	2.88	3.01	2.79	3.25	3.56	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	2.80	3.11	2.84	3.08	3.61	3.14	4.20	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	3.10	4.17	3.38
Jun-13	3.02	2.84	3.06	2.86	3.06	3.70	3.09	4.10	3.32
Jul-13	3.02	2.85	3.12	2.90	3.10	3.72	3.14	4.05	3.23
Aug-13	2.99	2.80	3.18	2.89	3.13	3.61	3.13	3.92	3.30
Sep-13	3.02	2.82	3.17	2.90	3.18	3.54	3.20	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	3.00	2.80	3.16	2.90	3.33	3.58	3.29	3.66	3.14

Figure 3 Vacancy Duration for each Madori in Tokyo's 23 Wards



3. Analysis of Rent Adjustment Factors

3.1. Model

In a previous study, our study group created models based on the following three hypotheses: (i) changes in rent and vacancy factor(s) have a negative correlation, (ii) changes in rent and economic trends have a positive correlation, and (iii) each Madori, which is a unique category of room type and is an important factor in Japan's residential market, has a unique market.

In a phase of economic fluctuation, an order is observed in the Japanese rental apartment market as change in rent lags change in property prices and the number of new constructions. This order is caused by a behavioral characteristic because developers and investors decide what actions to take based on forecasting of economic trends, and apartment owners decide based on actual economic conditions. Thus, economic trends may affect the market rent not only directly but also indirectly through changes in vacancy rate by an increase or decrease in the number of new constructions.

Additionally, property owners have an incentive to reduce rent if the period required to find a new tenant after losing a tenant (hereinafter, collectively called the vacancy duration) is longer (Hozumi et al., 2014). Thus, the market rent level may affect vacancy duration. Furthermore, an increase or decrease in vacancy duration affects the vacancy rate, and consequently, may also affect the market rent. In this manner, we can observe an order and a cycle between market rent and rent adjustment factors; it is important to consider these factors when we define the model.

Therefore, our study group added vacancy duration to the model as a factor of vacancy. Furthermore, we defined three additional hypotheses and developed a new model that considers an order and a cycle between market rent and

rent adjustment factors: (iv) changes in vacancy rate antedate those in rent, (v) changes in economic trends antedate those in rent, and (vi) changes in vacancy duration lag those in rent.

Market rent R can be expressed as

$$R = f(E, X, Z), \tag{8}$$

where *E*, *X*, and Z denote fundamentals, macroeconomic factor(s), and vacancy factor(s) respectively. Based on the hypothesis (i) and (ii),

$$\frac{\partial R}{\partial X} > 0, \quad \frac{\partial R}{\partial Z} < 0 \tag{9}$$

Now we assume Cobb–Douglas function for rent function (2), we can describe

$$R = f(E, X, Z) = \overline{E} X^{\alpha} Z^{\beta}, \quad X, Z > 0 \tag{10}$$

where $\overline{E}$ is constant term for fundamentals *E*, and α and β are parameters. Then we take the natural logarithm of both sides of equation (10),

$$\ln R = \ln \overline{E} + \alpha \ln X + \beta \ln Z \tag{11}$$

Then we obtain the total differential for equation (11) as follows:

$$\begin{aligned} dR &= \frac{\partial R}{\partial X} dX + \frac{\partial R}{\partial Z} dZ, \\ dR &= \alpha \frac{R}{X} dX + \beta \frac{R}{Z} dZ, \\ \frac{dR}{R} &= \alpha \frac{dX}{X} + \beta \frac{dZ}{Z}. \end{aligned} \tag{12}$$

Therefore, the model for analyzing rent adjustment factors is given by the following expression:

$$RI^* = \alpha TVI^* + \beta VD^* + \gamma IBC^* \tag{13}$$

RI : hedonic rent index,
TVI : vacancy rate TVI,
VD : vacancy duration calculated by equation (1),
IBC : indexes of business conditions (lagged CI),
Y^* : year - on - year changes in Y ($Y = RI^*, IBC^*, TVI^*$, and VD^*)

$$Y^*(t) := \frac{Y(t) - Y(t-12)}{Y(t-12)},$$

where the rent index (RI^*) is a surrogate variable for market rent; indexes of business conditions (lagged CI, IBC^*) is a surrogate variable for macroeconomic factors; and vacancy rate TVI (TVI^*) and vacancy duration VD (VD^*) are surrogate variables for factors of vacancy. Hence, from conditions (Eq. 9), we obtain following sing conditions of equation (13):

$$\begin{aligned} &\frac{\partial R}{\partial X} = \alpha \frac{R}{X} > 0, \quad \frac{\partial R}{\partial Z} = \beta \frac{R}{Z_{TVI}}, \gamma \frac{R}{Z_{VD}} < 0, \\ &\alpha > 0, \quad \beta, \gamma < 0 \quad \left(\because R, X, Z_{TVI}, Z_{VD} > 0\right) \end{aligned} \tag{14}$$

Lags between RI and other factors were chosen by simplified searching analysis based on the hypotheses (iv), (v), and (vi) for each Madori as the largest coefficient of correlation as follows:

$$\begin{aligned} &Lag_{Y^*} = \arg\max_{Lag} Corr\left(RI^*(t), Y^*(t - Lag)\right), \quad Lag \in \{1,2,\ldots,24\}, \\ &Y^* : IBC^*, TVI^*, VD^*, \end{aligned} \tag{15}$$

where $Corr$ calculates the Pearson's product-moment correlation coefficient.

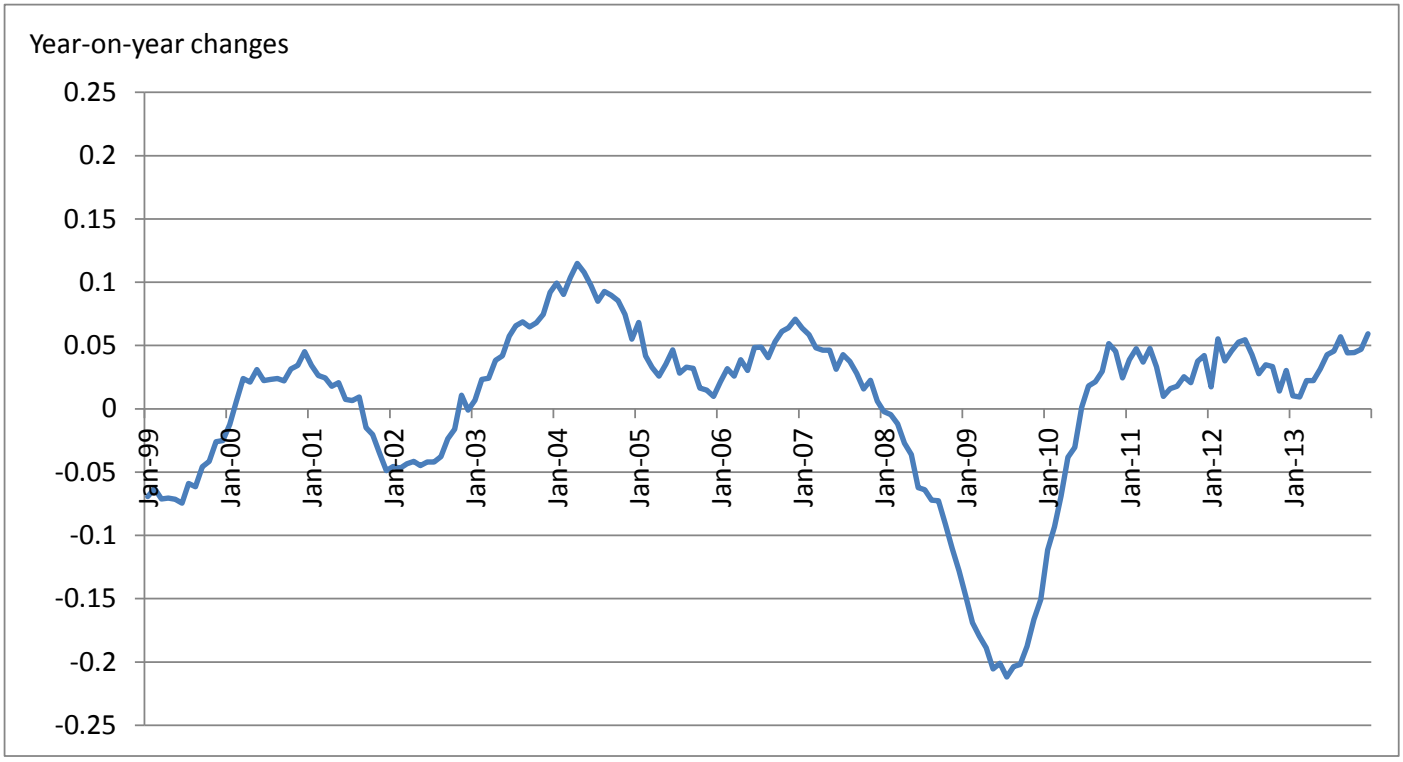
As shown in Figure 4, we can observe the change in IBC^* occurring in cycles lasting roughly 3–4 years. Thus, in this study, we analyzed the correlation of IBC^* as leading rather than lagging to ensure a longer regression analysis period. If the IBC^*cycle is assumed to the last 3 years, then when RI^* precedes IBC^* by 12 months, we can translate time differences as RI^* being delayed by 24 months from IBC^*.

Now, therefore, we estimate the following rent function, without the intercept term,

$$RI^*(t) = \alpha IBC^*(t - Lag_{IBC^*}) + \beta TVI^*(t - Lag_{TVI^*}) + \gamma VD^*(t - Lag_{VD^*}) \quad (16)$$

by OLS (ordinary least squares) method, and equation (16) has the sign condition expressed as equation (14). From hypothesis (iii), we estimate the rent function (Eq. 16) with respect to each Madori.

Figure 4 Fluctuations in Changes in Lagging CI of Indexes of Business Conditions



3.2. Estimated Results

Table 6 shows the coefficients of correlation for *RI**, *TVI**, *VD**, and *IBC** for each Madori. For all Madoris, *TVI** and *VD** have a negative correlation with *RI**, and *IBC** has a positive correlation with *RI**. Table 6 also indicates that macroeconomic factors strongly affect the market rent in Tokyo's 23 Wards rental apartment market because the coefficients of correlation for *IBC** are large for all Madoris. Furthermore, the time difference between *RI** and *IBC** is large for 2K, 2DK, and 3DK apartments. If the economic cycle is assumed to the last 3–4 years, these Madoris are

around one lap behind the *IBC**. This indicates that the *RI** cycle for these Madoris nearly synchronizes with the *IBC** cycle. Very few younger properties exist in these Madoris because new constructions in them decreased dramatically over the last 20 years. That is, stock levels for these Madoris may have shown long-term stagnation. Thus, the effect from vacancy factors may be reduced.

Table 7 shows the estimated results for each Madori. Estimated results and *RI** for each Madori are plotted in Figures 5–13. While the adjusted R2 for 3DK is somewhat lower, the adjusted R2 for other Madoris are approximately greater than 0.6. Thus, this model has good explanatory power. We also observed that *TVI** and *VD** have negative correlations with *RI** for all Madori, but *IBC** has a positive correlation with *RI**. These findings support hypotheses (i) and (ii). However, the t-value of *VD** for 1K, 2LDK, and 3LDK was insignificant in the significance level of 0.05, and the t-value of *VD** for 1LDK was significant but small. These Madoris have a high rate of new construction units, and vacancy duration for younger properties is shorter. Thus, vacancy duration may have a smaller impact on these Madoris. In a previous model, our study group confirmed the differences between *RI** and the estimated result before the Lehman shock (2008). In this model, our study group confirmed that the difference is smaller than determined in the previous model. For some Madoris (1R, 1K, 1DK, 1LDK, 2LDK, and 3LDK), we can observe a difference between *RI** and the estimated result from 2011 to 2012; this difference became smaller after 2013. This result indicates that some factors existed to reduce *RI**, and these factors persisted for roughly two years. Additionally, this difference was not observed for Madori types 2K, 2DK, and 3DK, which have few newly constructed units. Thus, these factors might affect mainly the market rent charged for newly constructed properties. One other possible influence is the Great East Japan Earthquake; our study group will analyze this subject hereafter.

4. Estimate of the Natural Vacancy Rate

Some previous studies have hypothesized the existence of a natural vacancy rate, i.e., the vacancy rate at which rents are in equilibrium (e.g., Smith, 1974; Gabriel and Nothaft, 1988; Gabriel and Nothaft, 1999; Belsky and Goodman, 2001). These studies created models using changes in rent as the explained variable, and changes in vacancy rate as the explanatory variable. They then calculated the natural vacancy rate as the vacancy rate when the rate of changes in rent equals 0. The model in this study is the first model in Japanese rental apartment market for examining the relationship between market rent and vacancy rate. Our study group uses this model to calculate the natural vacancy rate for Tokyo's 23 Wards rental apartment market for the first time in Japan.

Following previous studies, our study group modified expression (16) as $RI^* = 0$ and obtain

$$TVI^*(t) = -\frac{\hat{\gamma}}{\hat{\beta}} VD^*(t - Lag_{VD^*}) - \frac{\hat{\alpha}}{\hat{\beta}} IBC^*(t - Lag_{IBC^*}) \qquad (17)$$

where $\hat{\alpha}, \hat{\beta},$ and $\hat{\gamma}$ is OLS (ordinary least squares) estimators for the equation (16). Hence, the natural vacancy rate NV is calculated from expressions (13) and (17):

$$\begin{aligned} NV(t) &= \left(-\frac{\hat{\gamma}}{\hat{\beta}} VD^*(t - Lag_{VD^*}) - \frac{\hat{\alpha}}{\hat{\beta}} IBC^*(t - Lag_{IBC^*}) \right) \times TVI(t-12) + TVI(t-12) \\ &= \left[\left(-\frac{\hat{\gamma}}{\hat{\beta}} VD^*(t - Lag_{VD^*}) - \frac{\hat{\alpha}}{\hat{\beta}} IBC^*(t - Lag_{IBC^*}) \right) + 1 \right] \times TVI(t-12). \end{aligned} \qquad (18)$$

Table 8 shows the natural vacancy rate for each Madori, which was calculated using expression (18). Differences between RI^* and the estimated result for each Madori are plotted in Figures 14–22. Because TVI, IBC^* and VD^* have different values by time t, the calculated natural vacancy rates do not hold a constant value; rather, they fluctuate. For

all Madoris, the market rent faces downward pressure if the vacancy rate TVI is greater than the natural vacancy rate. Conversely, the market rent faces upward pressure if the vacancy rate TVI is smaller than the natural vacancy rate.

The estimated value of the natural vacancy rate is reasonable for all Madoris except 1K, because the range of the natural vacancy rate is at the same level as that of vacancy rate TVI. However, for 1Ks, the estimated value of the natural vacancy rate is not reasonable, because fluctuations in the estimated values are substantial and occasionally have negative values. One factor, the impact of economic trends to 1K, is overwhelmingly large compared with the corresponding value observed for other Madoris. These findings indicate that market rents for 1K may be decided mainly by economic trends rather than vacancy factors (e.g., vacancy rate and vacancy duration).

In Japan, rental apartments are supplied not only as part of a rental business but also for tax purposes. Particularly in Tokyo's 23 Wards, where land prices are high, a high percentage of apartments are owned for tax purposes. Additionally, units for singles tend to be supplied for tax purposes because they yield a high market rent per square meter and owners believe as tenant leasing for them is easy. Such rental apartments owned for tax purposes are built and supplied as a result of business transactions between land owners and house builders. House builders negotiate a sublease in many cases with land owners who have little knowledgeable about the rental apartment market. Accordingly, house builders have scope to influence the sublease conditions in the contract determined by offering a rosy view of future income. As a result, the rental rate of the supplied rental apartment for tax purposes can be decided based on mainly economic trends, with the impact of vacancy having little impact. Moreover, 75% of the supply of new rental apartments for singles in Tokyo's 23 Wards after 2000 can be classified as 1K. Thus, the percentage of sublease properties for tax purposes can therefore be said to be large for 1Ks; as a result, 1Ks are strongly affected by economic trends, but weakly affected by vacancies. Therefore, when computing the natural vacancy rate of 1Ks, it may be necessary to exempt the impact of economic trends.

Table 6 Coefficients of Correlation between *RI*, TVI*, VD*,* and *IBC**

1R	RI*(t)	TVI*(t-9)	VD*(t-1)	IBC*(t+14)
RI*(t)	1.0000			
TVI*(t-9)	-0.4032	1.0000		
VD*(t-1)	-0.4891	0.2787	1.0000	
IBC*(t+14)	0.7406	-0.1060	-0.4447	1.0000

1K	RI*(t)	TVI*(t-6)	VD*(t+6)	IBC*(t+16)
RI*(t)	1.0000			
TVI*(t-6)	-0.4201	1.0000		
VD*(t+6)	-0.4403	0.1482	1.0000	
IBC*(t+16)	0.7988	-0.2525	-0.5804	1.0000

1DK	RI*(t)	TVI*(t-3)	VD*(t+6)	IBC*(t+14)
RI*(t)	1.0000			
TVI*(t-3)	-0.6073	1.0000		
VD*(t+6)	-0.3913	-0.0104	1.0000	
IBC*(t+14)	0.7058	-0.7903	-0.0816	1.0000

1LDK	RI*(t)	TVI*(t-21)	VD*(t+5)	IBC*(t+10)
RI*(t)	1.0000			
TVI*(t-21)	-0.1449	1.0000		
VD*(t+5)	-0.0274	-0.3801	1.0000	
IBC*(t+10)	0.7283	0.3490	-0.2509	1.0000

2K	RI*(t)	TVI*(t-10)	VD*(t)	IBC*(t+35)
RI*(t)	1.0000			
TVI*(t-10)	-0.3635	1.0000		
VD*(t)	-0.3217	0.4820	1.0000	
IBC*(t+35)	0.8377	-0.1313	-0.1295	1.0000

2DK	RI*(t)	TVI*(t-8)	VD*(t+3)	IBC*(t+41)
RI*(t)	1.0000			
TVI*(t-8)	-0.6639	1.0000		
VD*(t+3)	-0.6495	0.5866	1.0000	
IBC*(t+41)	0.6536	-0.2373	-0.1096	1.0000

2LDK	RI*(t)	TVI*(t-4)	VD*(t+3)	IBC*(t+11)
RI*(t)	1.0000			
TVI*(t-4)	-0.3609	1.0000		
VD*(t+3)	-0.5293	0.0595	1.0000	
IBC*(t+11)	0.7538	-0.2488	-0.7073	1.0000

3DK	RI*(t)	TVI*(t-4)	VD*(t+2)	IBC*(t+27)
RI*(t)	1.0000			
TVI*(t-4)	-0.3943	1.0000		
VD*(t+2)	-0.5627	0.4239	1.0000	
IBC*(t+27)	0.5568	-0.3458	-0.5933	1.0000

3LDK	RI*(t)	TVI*(t)	VD*(t-1)	IBC*(t+11)
RI*(t)	1.0000			
TVI*(t)	-0.4905	1.0000		
VD*(t-1)	-0.6440	0.3952	1.0000	
IBC*(t+11)	0.7074	-0.1883	-0.7084	1.0000

Table 7 Estimated Results

1R Adjusted R2 0.6293

logprice	Coef.	t
TVI*(t-9)	-0.0499	-3.4706
VD*(t-1)	-0.0367	-2.8533
IBC*(t+14)	0.0748	8.0186

1K Adjusted R2 0.6521

logprice	Coef.	t
TVI*(t-6)	-0.0151	-2.4265
VD*(t+6)	-0.0185	-1.4823
IBC*(t+16)	0.0777	8.0772

1DK Adjusted R2 0.6181

logprice	Coef.	t
TVI*(t-3)	-0.0849	-4.0929
VD*(t+6)	-0.0507	-5.0685
IBC*(t+14)	0.0566	4.9475

1LDK Adjusted R2 0.6862

logprice	Coef.	t
TVI*(t-21)	-0.0512	-5.2920
VD*(t+5)	-0.0243	-2.0654
IBC*(t+10)	0.0971	11.4281

2K Adjusted R2 0.7792

logprice	Coef.	t
TVI*(t-10)	-0.0455	-3.6109
VD*(t)	-0.0151	-2.4942
IBC*(t+35)	0.0769	15.4089

2DK Adjusted R2 0.7710

logprice	Coef.	t
TVI*(t-8)	-0.0707	-5.7768
VD*(t+3)	-0.0406	-5.0926
IBC*(t+41)	0.0532	10.0858

2LDK Adjusted R2 0.5924

logprice	Coef.	t
TVI*(t-4)	-0.0696	-3.4566
VD*(t+3)	-0.0082	-0.3493
IBC*(t+11)	0.1522	6.5906

3DK Adjusted R2 0.3609

logprice	Coef.	t
TVI*(t-4)	-0.0317	-2.0036
VD*(t+2)	-0.0137	-1.5758
IBC*(t+27)	0.0443	3.7348

3LDK Adjusted R2 0.6381

logprice	Coef.	t
TVI*(t)	-0.0903	-5.3709
VD*(t-1)	-0.0142	-1.1670
IBC*(t+11)	0.1180	6.3848

Figure 5 Estimated Result for 1R

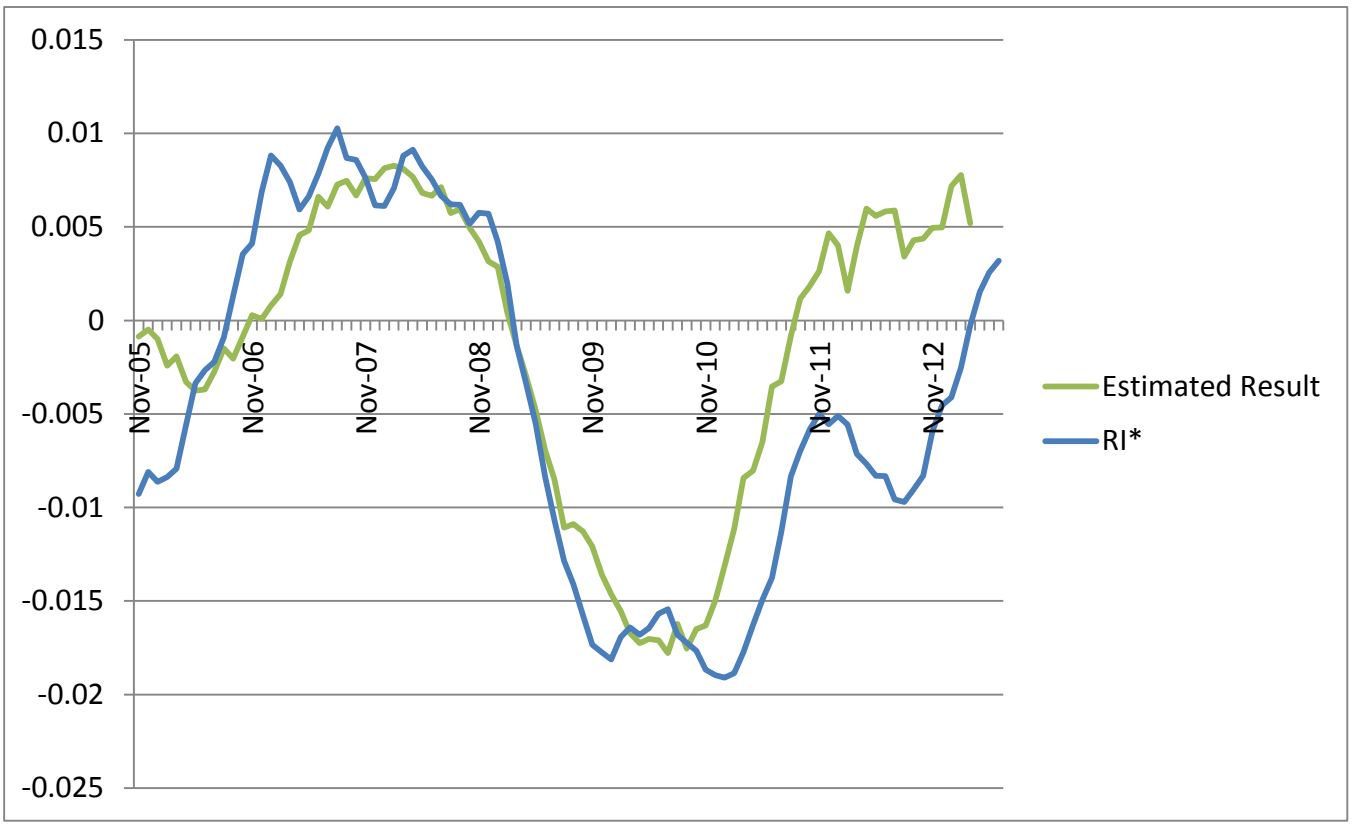


Figure 6 Estimated Result for 1K

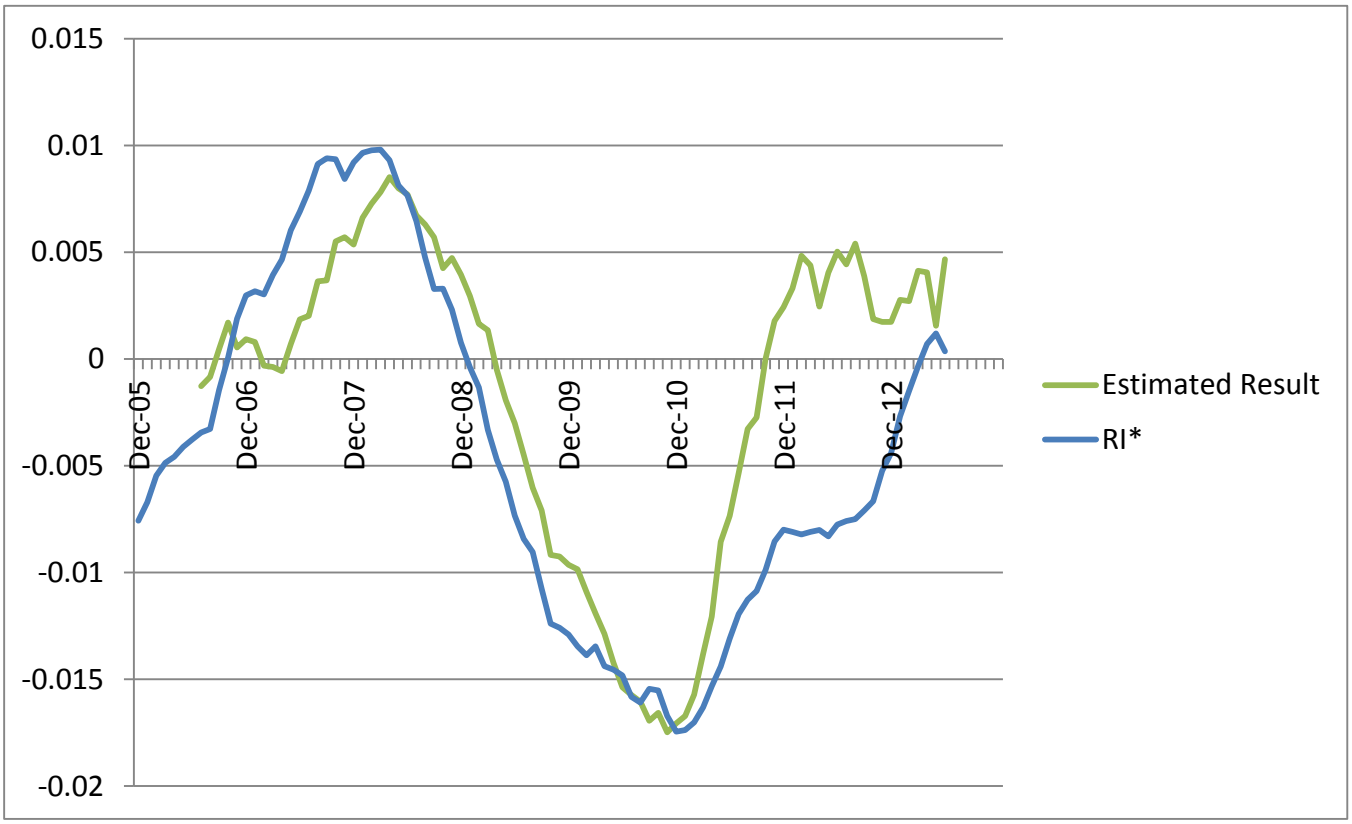

0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
Dec-05
Dec-06
Dec-07
Dec-08
Dec-09
Dec-10
Dec-11
Dec-12
Estimated Result
RI*

Figure 7 Estimated Result for 1DK

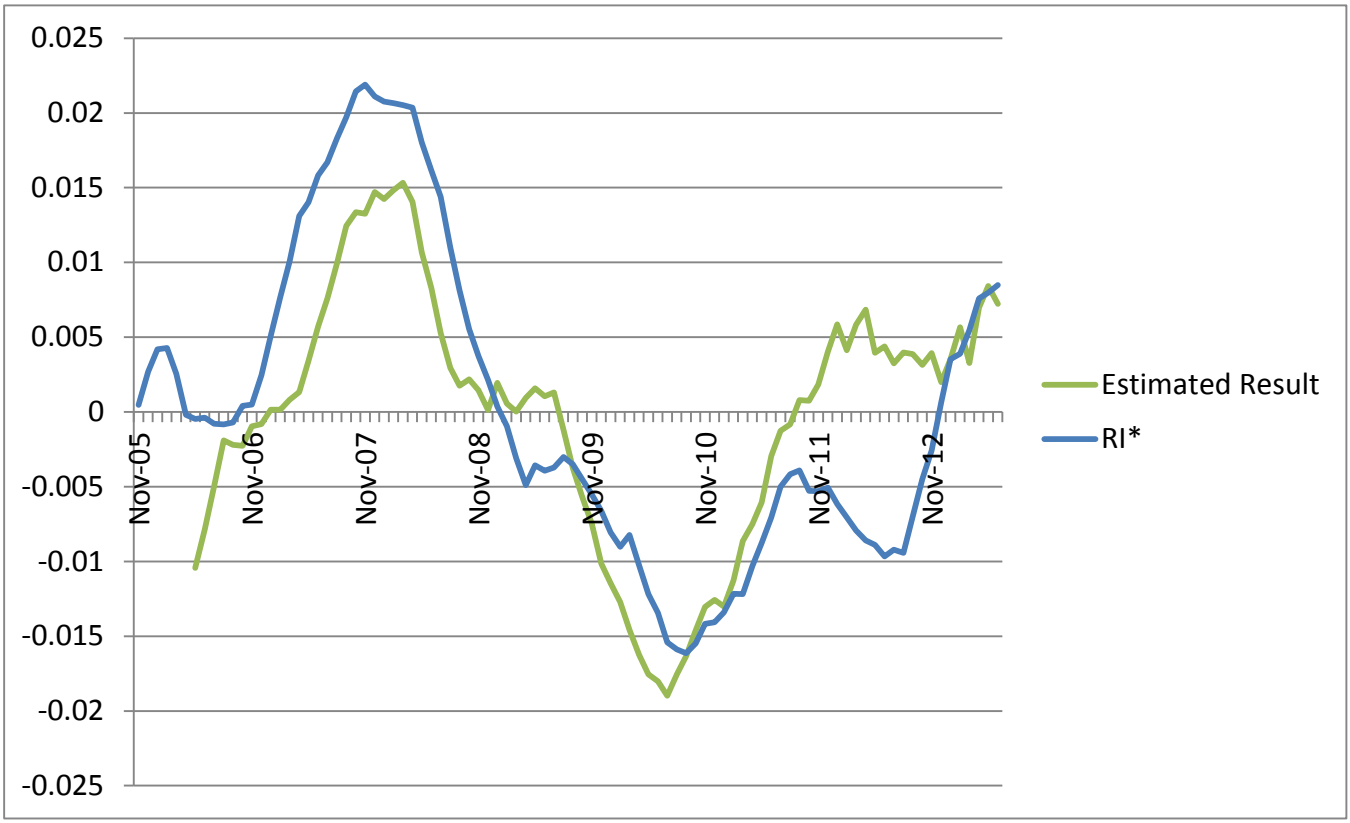


Figure 8 Estimated Result for 1LDK

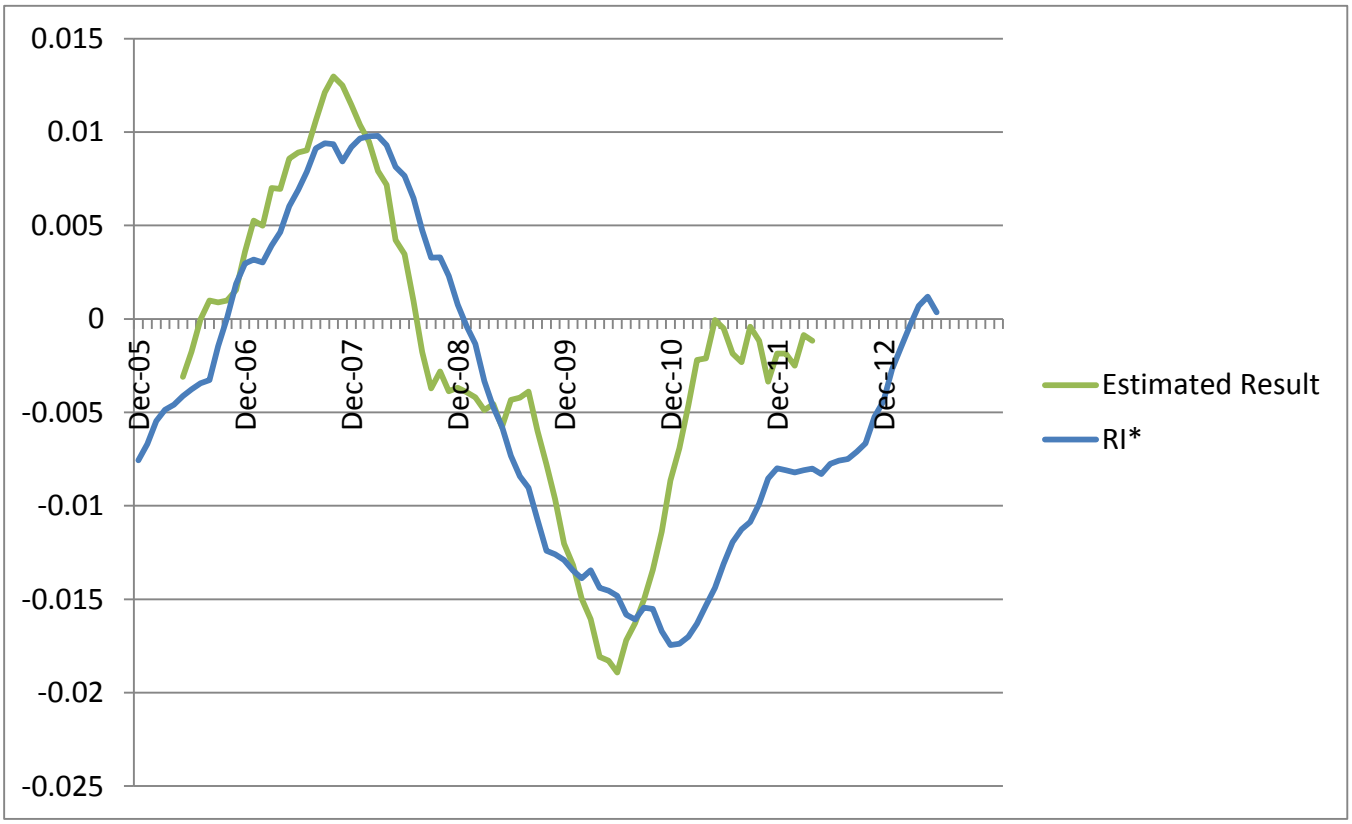

0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
-0.025
Dec-05
Dec-06
Dec-07
Dec-08
Dec-09
Dec-10
Dec-11
Dec-12
Estimated Result
RI*

Figure 9 Estimated Result for 2K

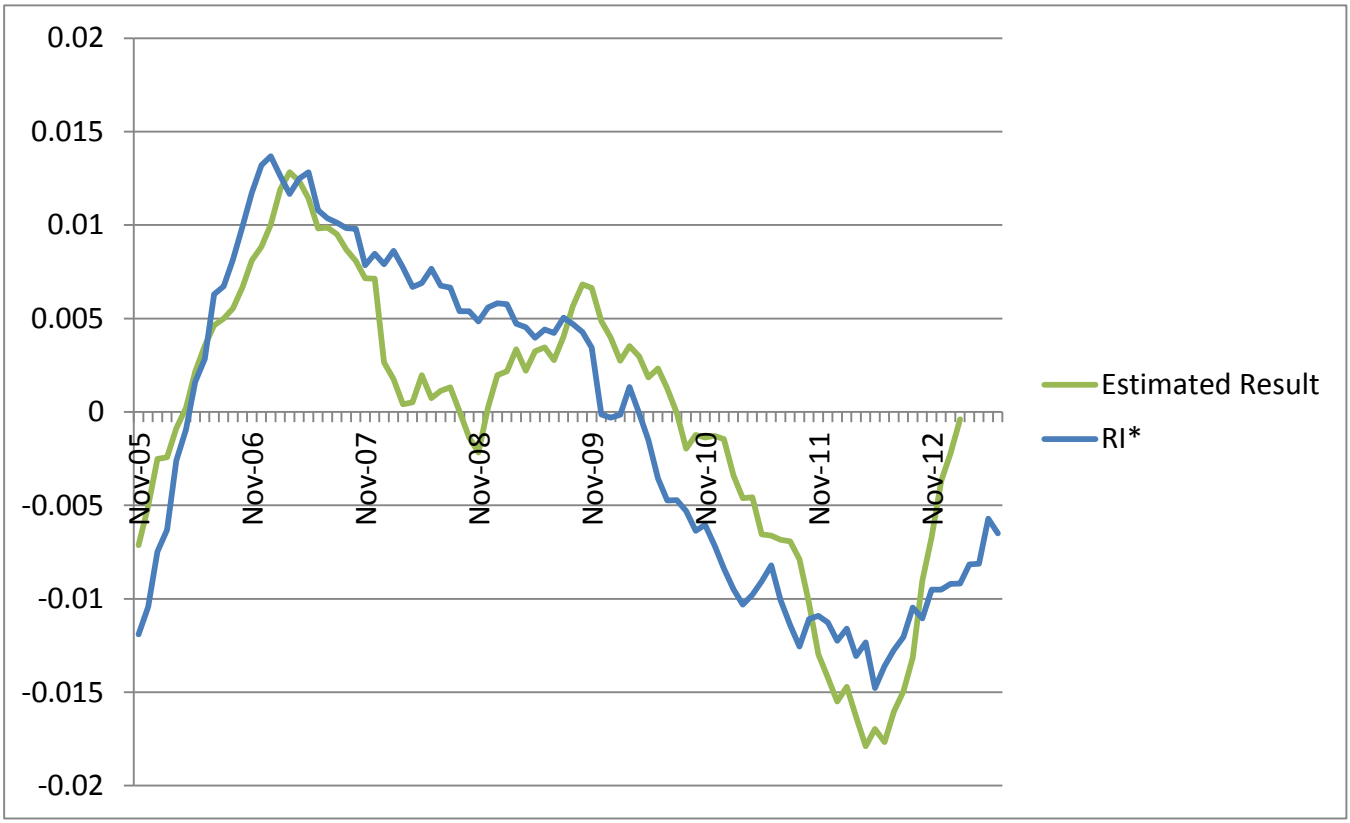


Figure 10 Estimated Result for 2DK

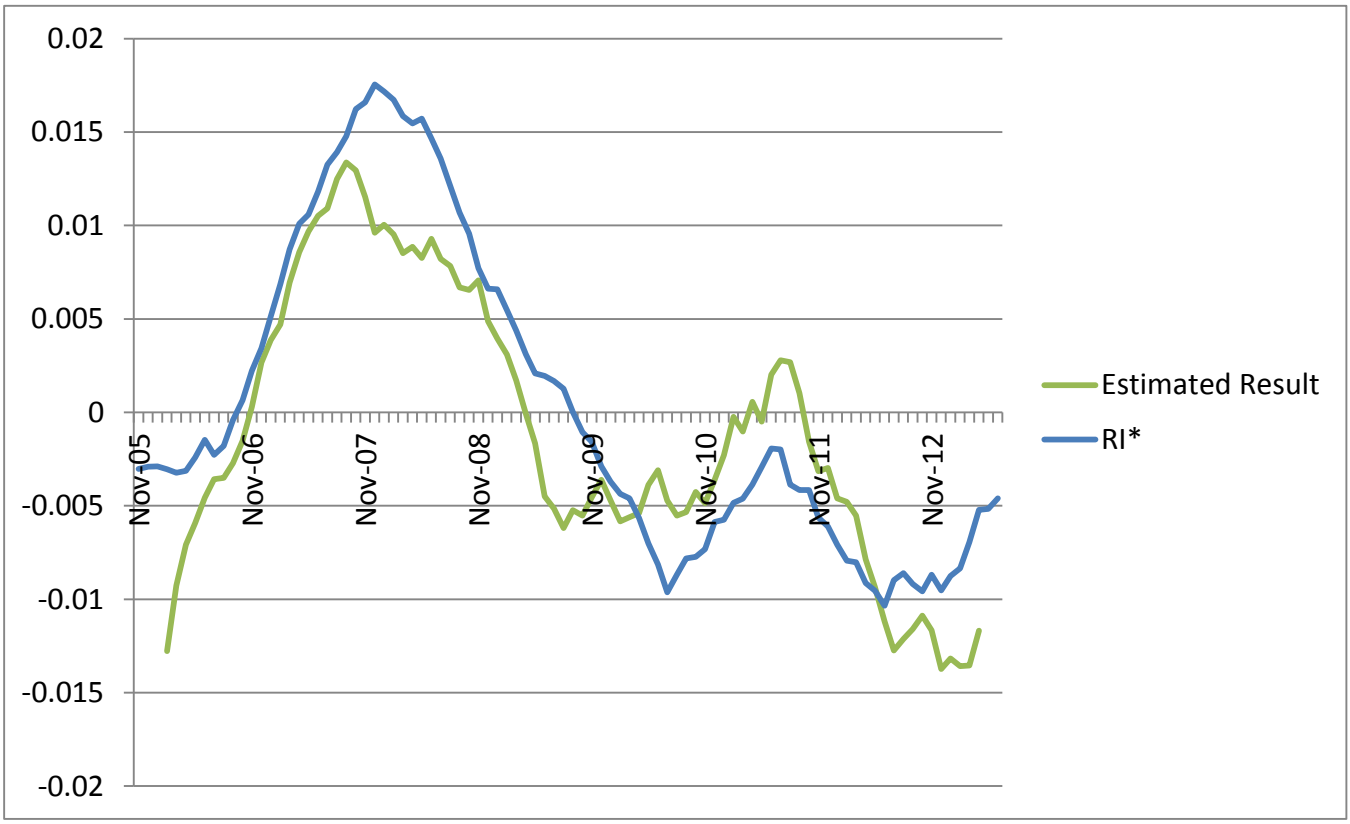

0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
Nov-05
Nov-06
Nov-07
Nov-08
Nov-09
Nov-10
Nov-11
Nov-12
Estimated Result
RI*

Figure 11 Estimated Result for 2LDK

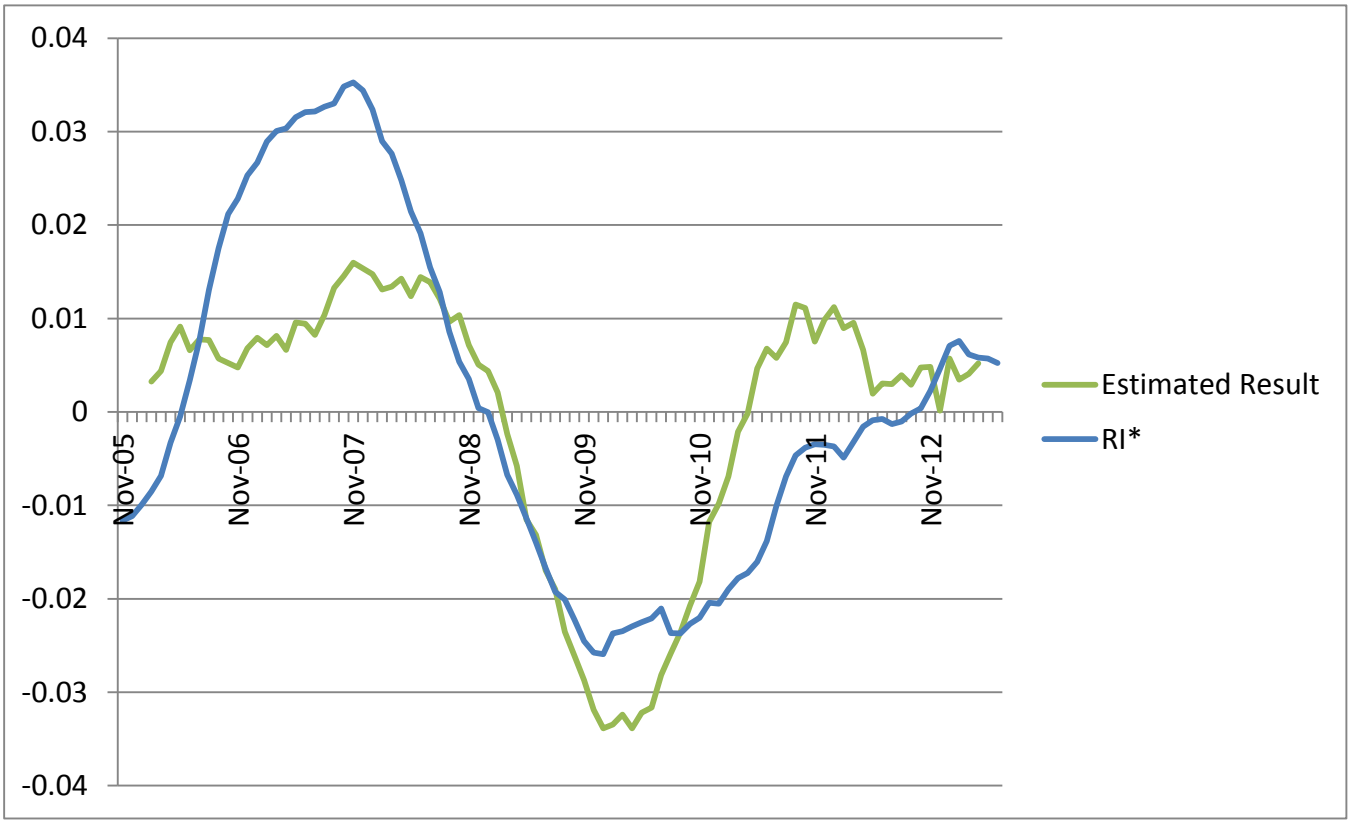


Figure 12 Estimated Result for 3DK

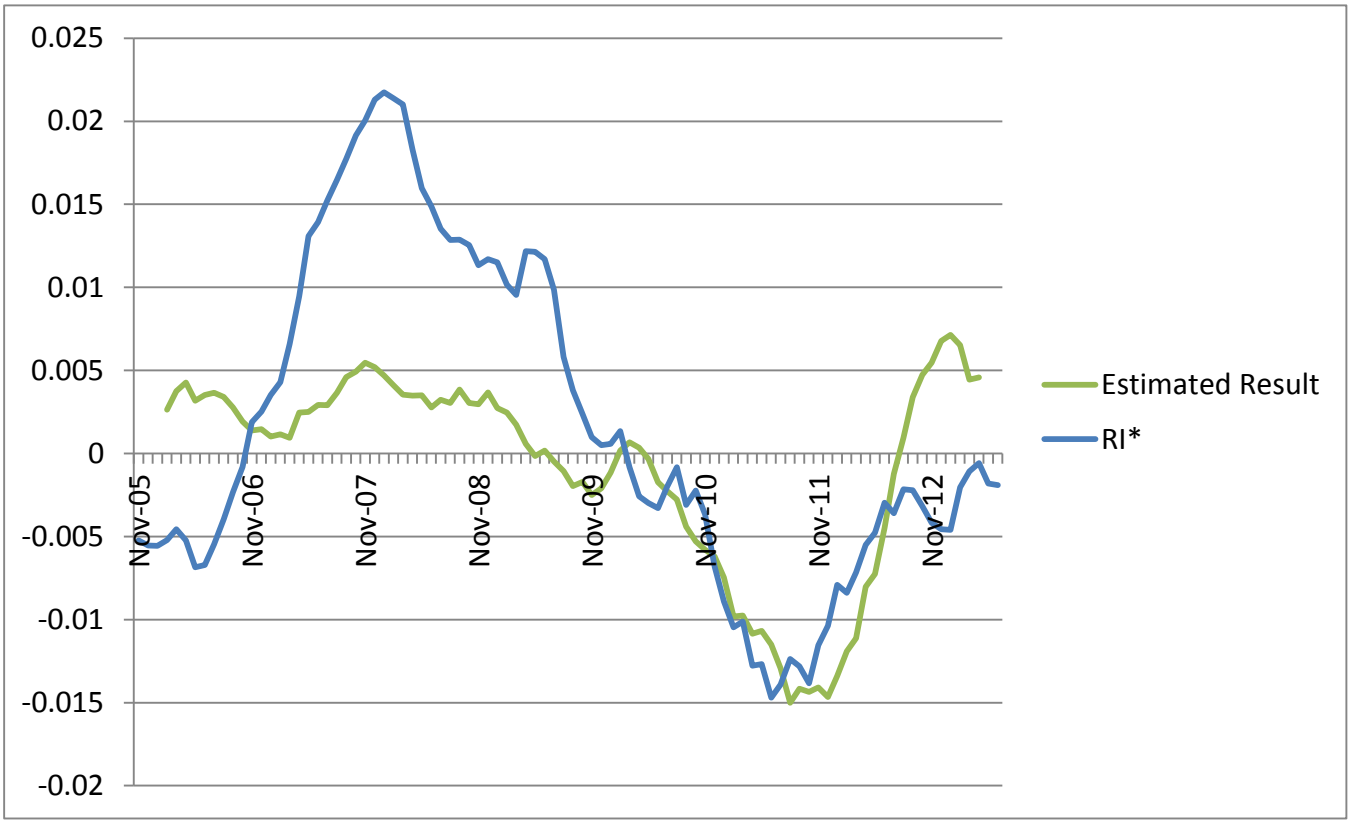


Figure 13 Estimated Result for 3LDK

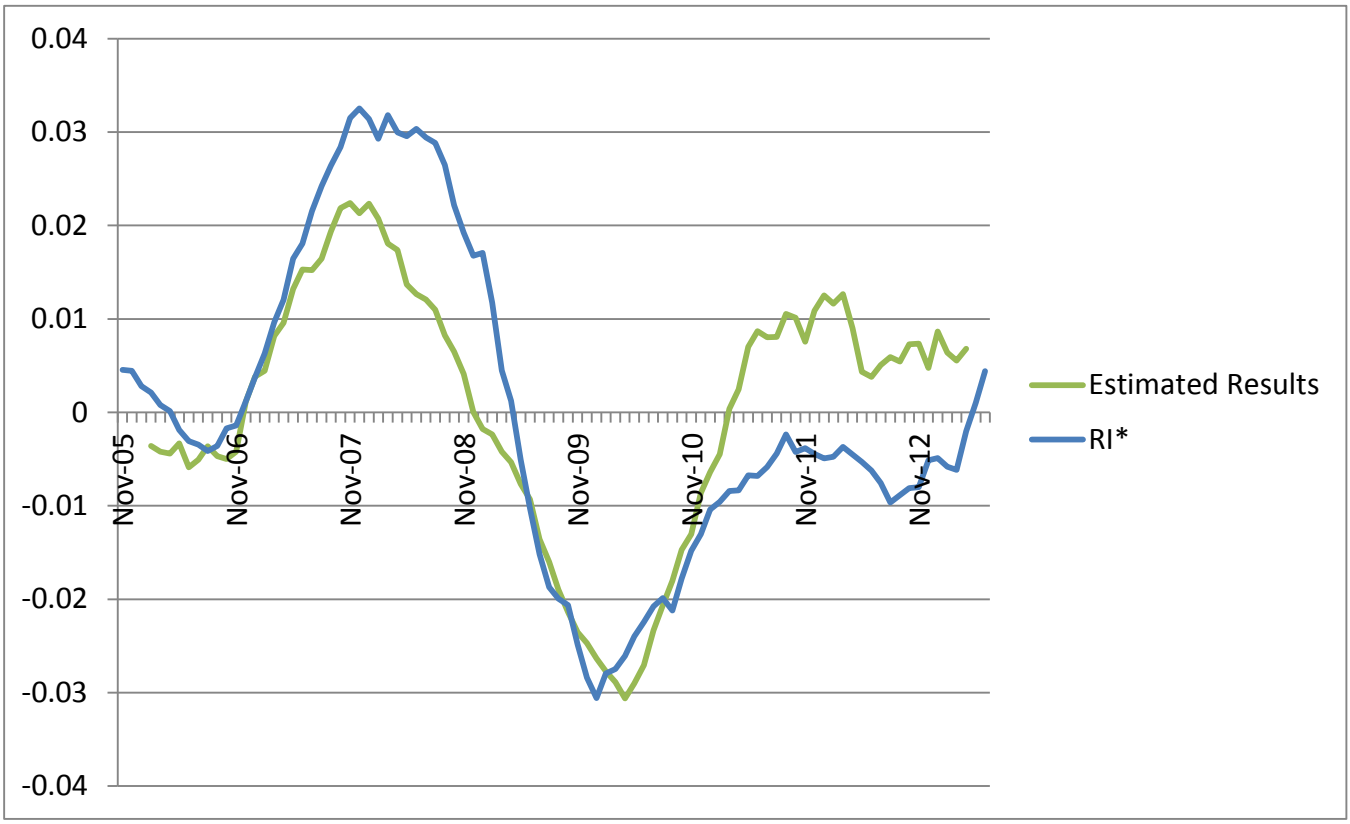

0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
Nov-05
Nov-06
Nov-07
Nov-08
Nov-09
Nov-10
Nov-11
Nov-12
Estimated Results
RI*

Table 8 Natural Vacancy Rate for each Madori in Tokyo's 23 Wards

	1R	1K	1DK	1LDK	2K	2DK	2LDK	3DK	3LDK
Jan-08	11.52	15.84	9.97	7.36	14.42	10.75	7.09	8.68	6.51
Feb-08	11.52	17.19	9.99	7.51	14.22	10.84	7.40	8.64	6.40
Mar-08	11.81	17.05	9.98	7.70	14.08	11.07	7.42	8.65	6.30
Apr-08	11.68	18.72	9.94	7.83	13.64	11.14	7.27	8.64	6.18
May-08	11.89	18.72	9.96	7.80	13.63	11.27	7.44	8.78	5.98
Jun-08	11.82	18.27	9.90	7.87	13.53	11.32	7.51	8.78	5.92
Jul-08	11.68	19.36	9.84	7.81	13.38	11.22	7.54	8.89	5.82
Aug-08	11.73	19.93	9.46	8.13	13.13	11.00	7.64	8.92	5.75
Sep-08	11.65	20.29	9.20	8.26	12.78	10.93	7.49	8.57	5.59
Oct-08	11.66	20.69	8.90	8.22	12.74	10.80	7.37	8.28	5.52
Nov-08	11.67	19.85	8.66	8.44	11.92	10.81	7.19	8.03	5.29
Dec-08	11.56	19.42	8.52	8.37	11.55	10.74	7.17	7.99	5.20
Jan-09	11.47	18.22	8.35	8.51	11.24	10.66	7.01	8.16	5.03
Feb-09	11.17	17.43	8.22	8.45	11.32	10.70	6.70	8.03	4.94
Mar-09	11.01	16.46	8.02	8.28	11.41	10.71	6.78	8.30	4.87
Apr-09	11.03	14.88	8.05	8.40	11.12	10.63	6.64	8.15	4.78
May-09	10.79	15.31	7.86	8.46	11.22	10.49	6.42	8.25	4.59
Jun-09	10.85	14.72	7.81	8.54	11.28	10.32	6.23	8.02	4.61
Jul-09	10.74	13.94	7.84	8.57	10.97	10.43	6.25	8.00	4.49
Aug-09	10.71	12.91	7.88	8.32	10.96	10.38	5.94	8.05	4.37
Sep-09	10.53	12.84	7.82	8.20	10.79	10.27	5.77	8.02	4.19
Oct-09	10.51	11.59	7.92	8.10	11.28	10.13	5.67	8.09	4.03
Nov-09	10.13	10.79	7.68	8.00	11.66	10.01	5.52	8.31	3.90
Dec-09	9.81	10.34	7.59	7.87	11.67	9.95	5.24	8.19	3.78
Jan-10	9.58	9.71	7.42	7.56	12.03	9.70	5.12	7.98	3.66
Feb-10	9.37	8.88	7.37	7.52	11.89	9.26	4.77	7.85	3.61
Mar-10	9.03	8.44	7.28	7.32	12.13	9.08	4.74	7.52	3.54
Apr-10	8.72	7.04	7.13	7.06	12.15	8.99	4.65	7.50	3.45
May-10	8.18	7.03	7.07	6.78	12.09	9.12	4.68	7.49	3.53
Jun-10	8.18	6.75	6.87	6.80	12.27	8.99	4.51	7.78	3.54
Jul-10	7.96	6.56	6.81	6.60	12.49	9.05	4.31	7.75	3.65
Aug-10	7.81	5.66	6.76	6.55	12.67	9.17	4.15	8.00	3.76
Sep-10	7.48	4.72	6.72	6.51	12.81	9.06	3.92	8.02	3.92
Oct-10	7.24	3.70	6.64	6.34	12.40	8.92	3.67	7.96	4.06
Nov-10	7.03	2.25	6.73	6.18	12.35	8.82	3.58	7.57	4.21
Dec-10	6.75	0.91	6.86	6.16	11.99	8.92	3.53	7.62	4.46
Jan-11	6.57	0.00	6.91	5.88	12.03	9.17	3.34	7.61	4.59
Feb-11	6.47	-0.86	7.00	6.00	11.90	9.41	3.41	7.54	4.75
Mar-11	6.39	-2.16	7.06	5.93	11.65	9.38	3.25	7.55	4.96
Apr-11	6.29	-2.08	7.01	6.01	11.82	9.36	3.37	7.56	5.03
May-11	6.62	-3.05	7.09	5.70	11.58	9.47	3.35	7.04	5.27
Jun-11	6.42	-2.88	7.29	5.40	11.38	9.56	3.52	6.85	5.34
Jul-11	6.71	-2.70	7.35	5.08	11.02	9.49	3.76	6.52	5.30
Aug-11	6.80	-1.85	7.52	4.76	11.12	9.68	3.96	6.58	5.25
Sep-11	7.10	-0.11	7.78	4.54	10.99	9.89	4.48	6.38	5.37
Oct-11	7.52	1.43	7.89	4.33	10.98	10.18	4.68	6.05	5.31
Nov-11	7.95	4.71	8.02	4.13	10.97	10.32	4.96	5.99	5.15
Dec-11	8.59	6.01	8.06	3.88	10.77	10.29	5.27	5.59	5.25
Jan-12	8.82	8.11	8.18	3.88	10.43	10.22	5.36	5.50	5.29
Feb-12	9.08	10.06	8.14	3.70	10.45	10.44	5.79	5.28	5.29
Mar-12	9.69	10.60	8.33	3.87	9.95	10.62	6.06	4.89	5.33
Apr-12	9.69	12.88	8.53	3.88	9.95	10.71	6.05	4.69	5.18
May-12	10.22	14.44	8.39	4.11	9.83	10.46	6.16	4.83	4.91
Jun-12	10.57	14.91	8.50	4.31	9.72	10.36	6.40	4.71	4.85
Jul-12	10.59	15.57	8.55	4.53	9.66	10.15	6.29	4.87	4.87
Aug-12	10.79	16.92	8.29	4.97	9.12	10.16	5.97	4.70	4.92
Sep-12	11.23	16.48	8.39	5.16	8.55	9.93	6.08	5.21	4.89
Oct-12	11.13	14.82	8.21	5.51	8.23	9.92	6.17	5.79	4.98
Nov-12	10.59	15.98	8.25	5.88	7.82	9.84	6.06	6.19	5.00
Dec-12	10.99	16.61	8.23	5.89	7.78	9.74	6.13	7.14	4.76
Jan-13	11.30	16.02	8.06	6.26	7.59	9.63	5.95	7.40	5.01
Feb-13	11.22	17.03	8.21	6.37	7.14	9.51	5.65	8.08	4.84
Mar-13	11.33	15.87	8.06	6.28	7.37	9.33	5.64	8.63	4.83
Apr-13	11.18	14.15	8.12	6.35	7.19	9.36	5.65	8.75	4.91
May-13	10.68	13.97	8.28	6.59	7.42	9.30	5.74	9.48	4.98
Jun-13	10.86	13.97	8.10	6.54	7.55	9.59	5.74	9.81	4.96
Jul-13	10.82	14.66	8.33	6.29	7.75	9.42	5.97	9.96	4.80
Aug-13	10.99	14.60	8.44	6.48	8.45	9.22	6.00	9.90	4.86
Sep-13	10.89	15.76	8.36	6.58	9.06	9.08	5.77	9.81	4.79
Oct-13	11.32	15.77	8.38	6.51	9.75	9.00	6.26	9.52	4.73
Nov-13	11.54	13.77	8.19	6.76	10.26	8.74	6.01	9.00	4.77

Figure 14 NV-TVI and Rent Index for 1R

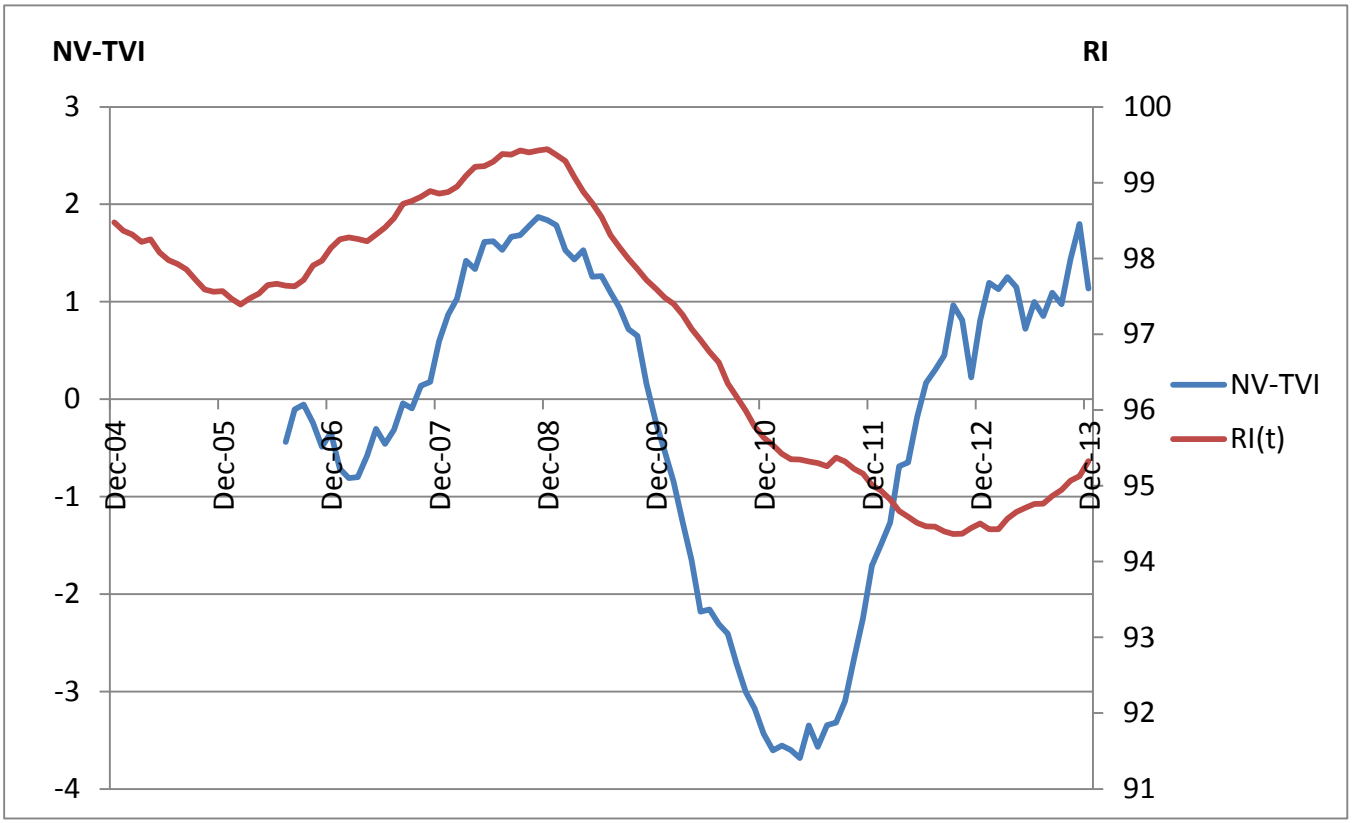


Figure 15 NV-TVI and Rent Index for 1K

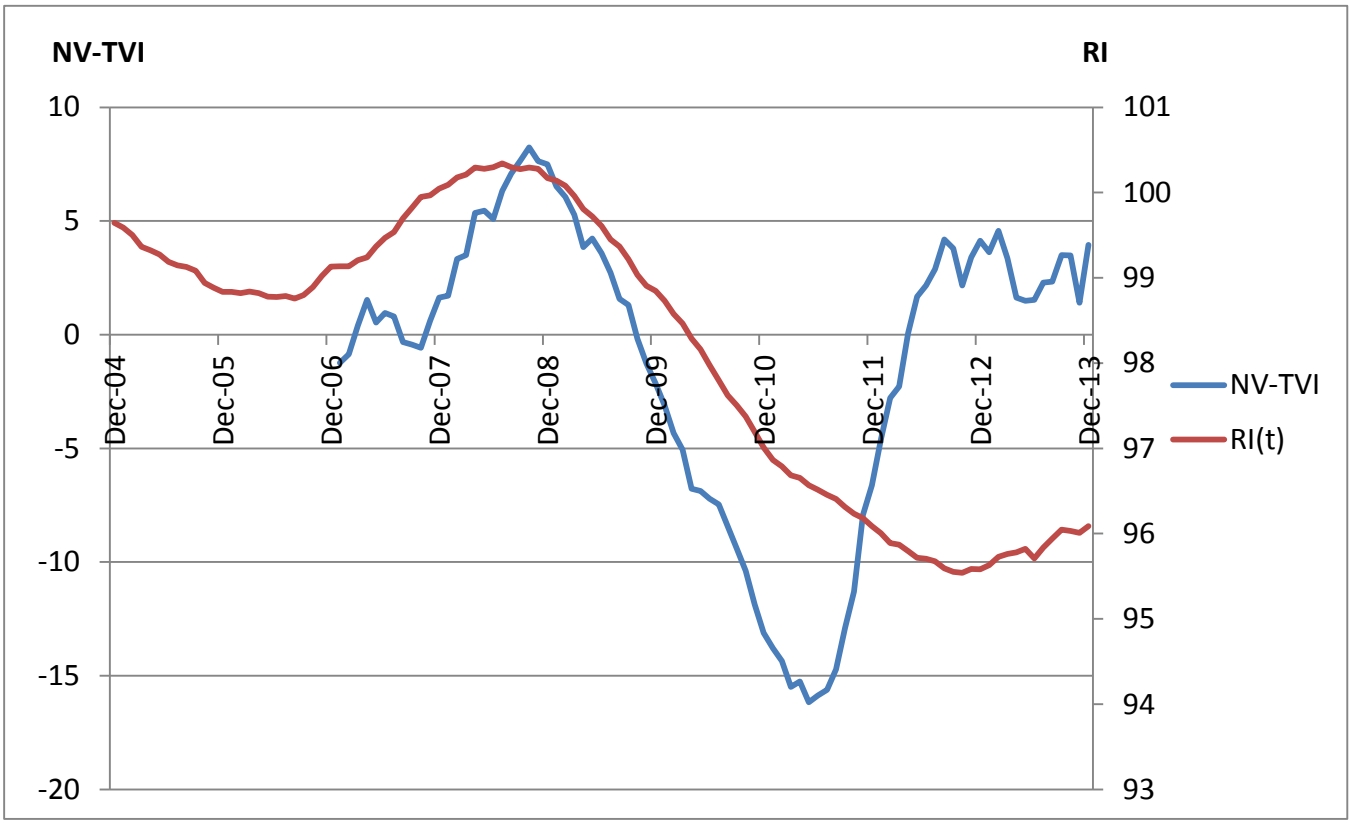

NV-TVI
RI
10
5
0
-5
-10
-15
-20
101
100
99
98
97
96
95
94
93
Dec-04
Dec-05
Dec-06
Dec-07
Dec-08
Dec-09
Dec-10
Dec-11
Dec-12
Dec-13
NV-TVI
RI(t)

Figure 16 NV-TVI and Rent Index for 1DK

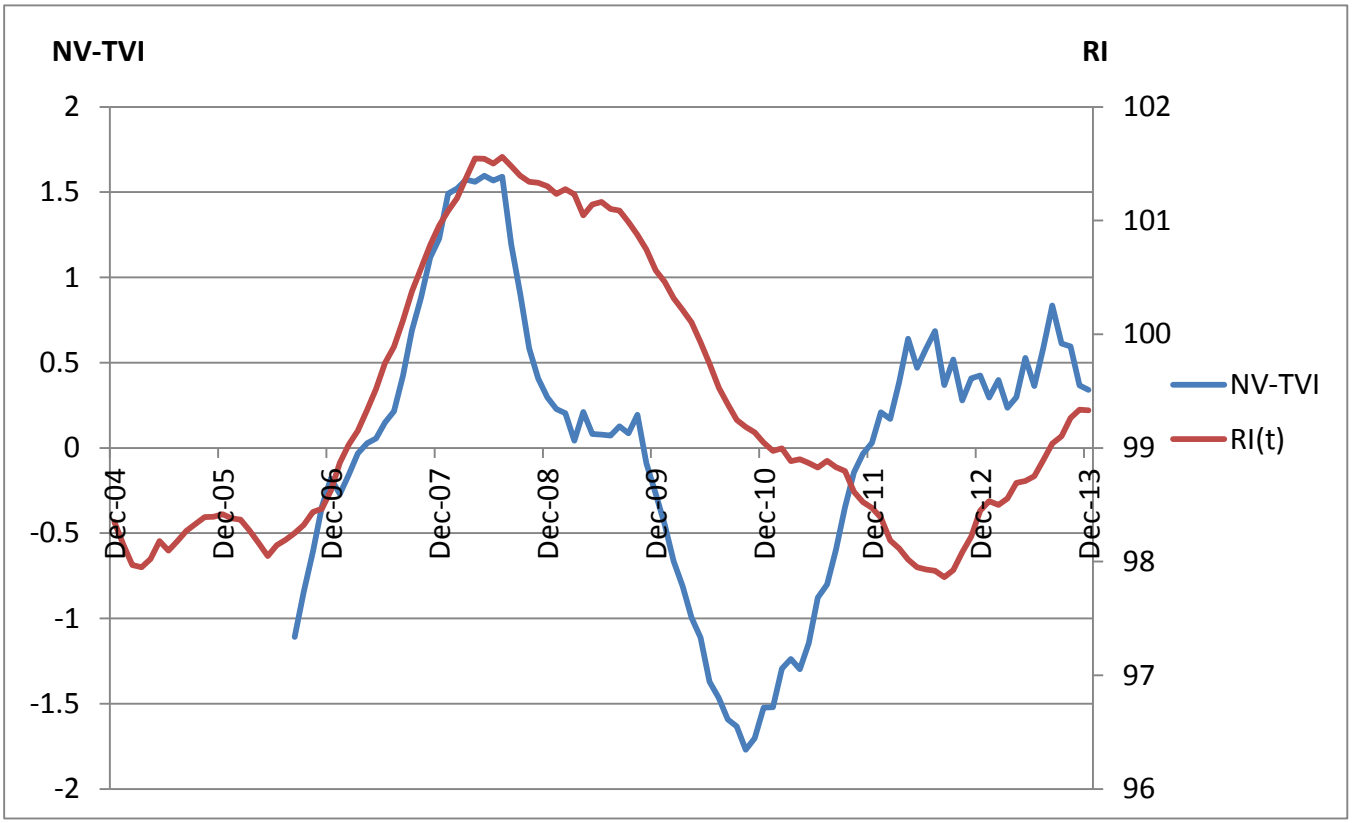


Figure 17 NV-TVI and Rent Index for 1LDK

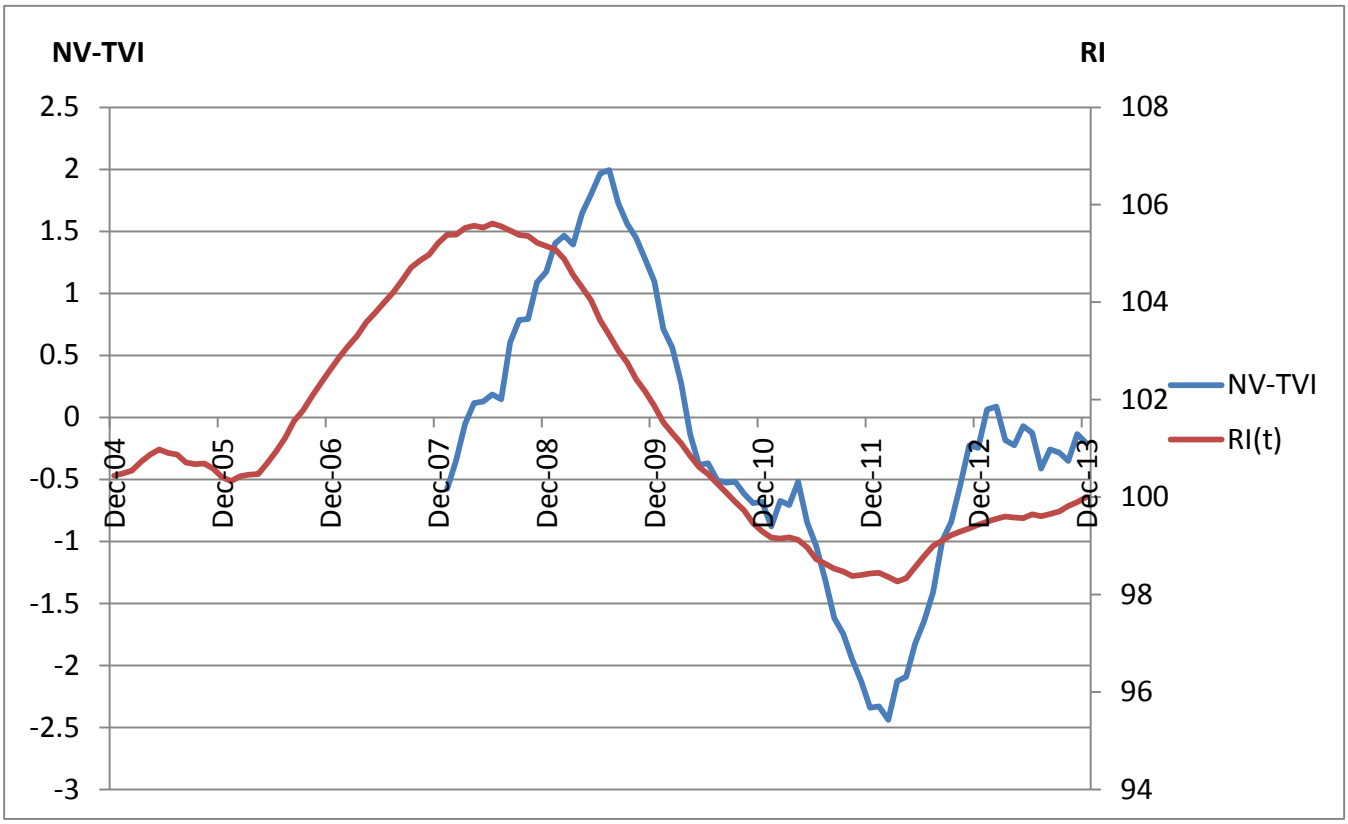

NV-TVI
RI
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
108
106
104
102
100
98
96
94
Dec-04
Dec-05
Dec-06
Dec-07
Dec-08
Dec-09
Dec-10
Dec-11
Dec-12
Dec-13
NV-TVI
RI(t)

Figure 18 NV-TVI and Rent Index for 2K

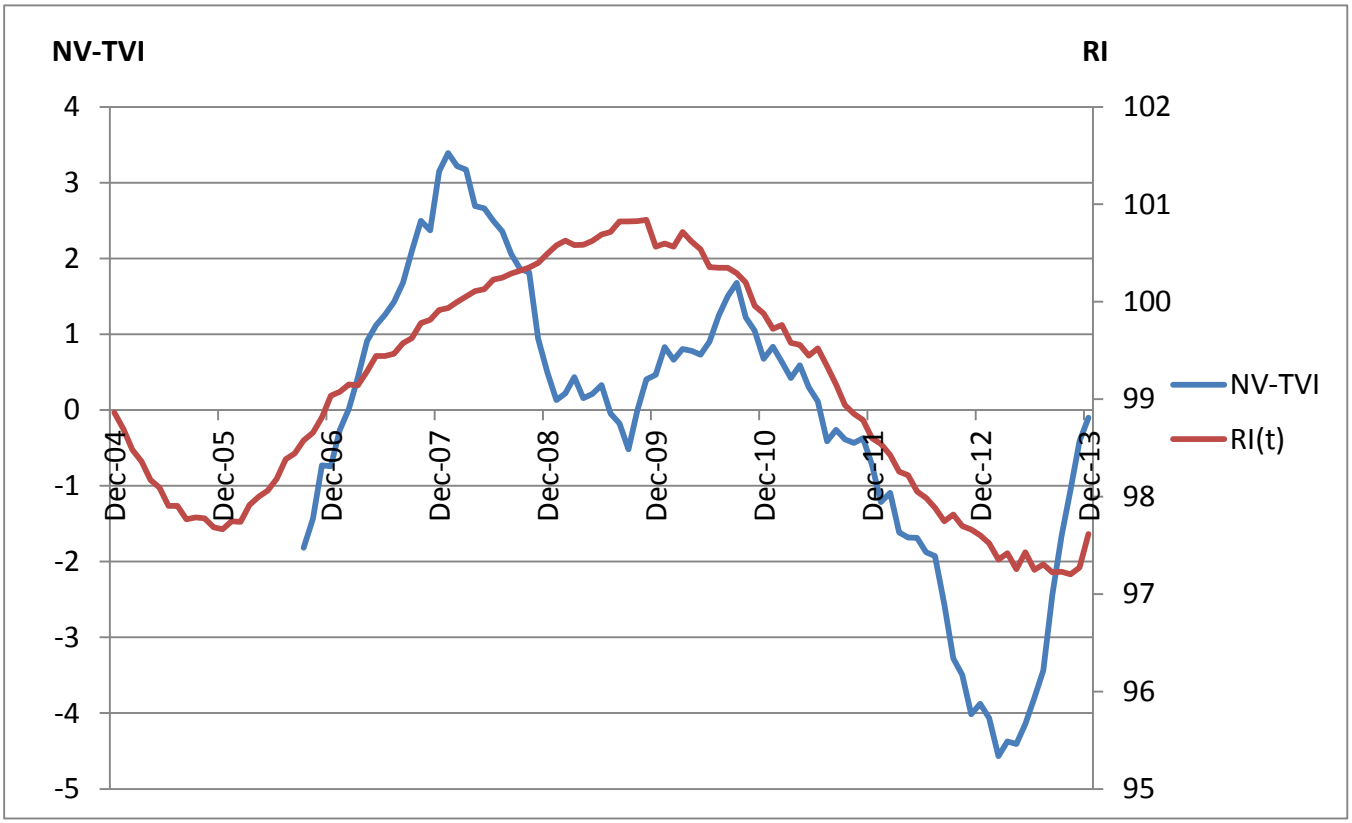


Figure 19 NV-TVI and Rent Index for 2DK

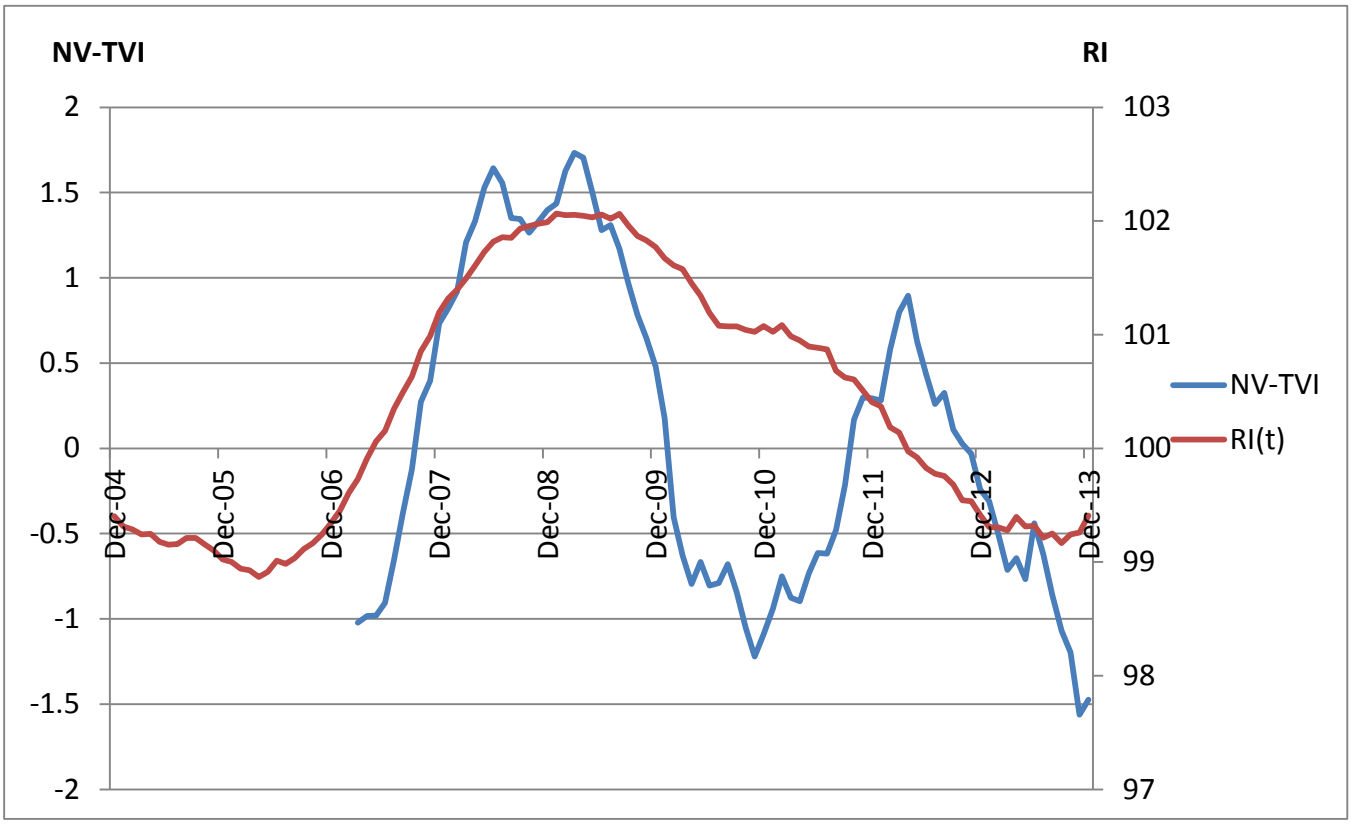

NV-TVI
RI
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
103
102
101
100
99
98
97
Dec-04
Dec-05
Dec-06
Dec-07
Dec-08
Dec-09
Dec-10
Dec-11
Dec-12
Dec-13
NV-TVI
RI(t)

Figure 20 NV-TVI and Rent Index for 2LDK

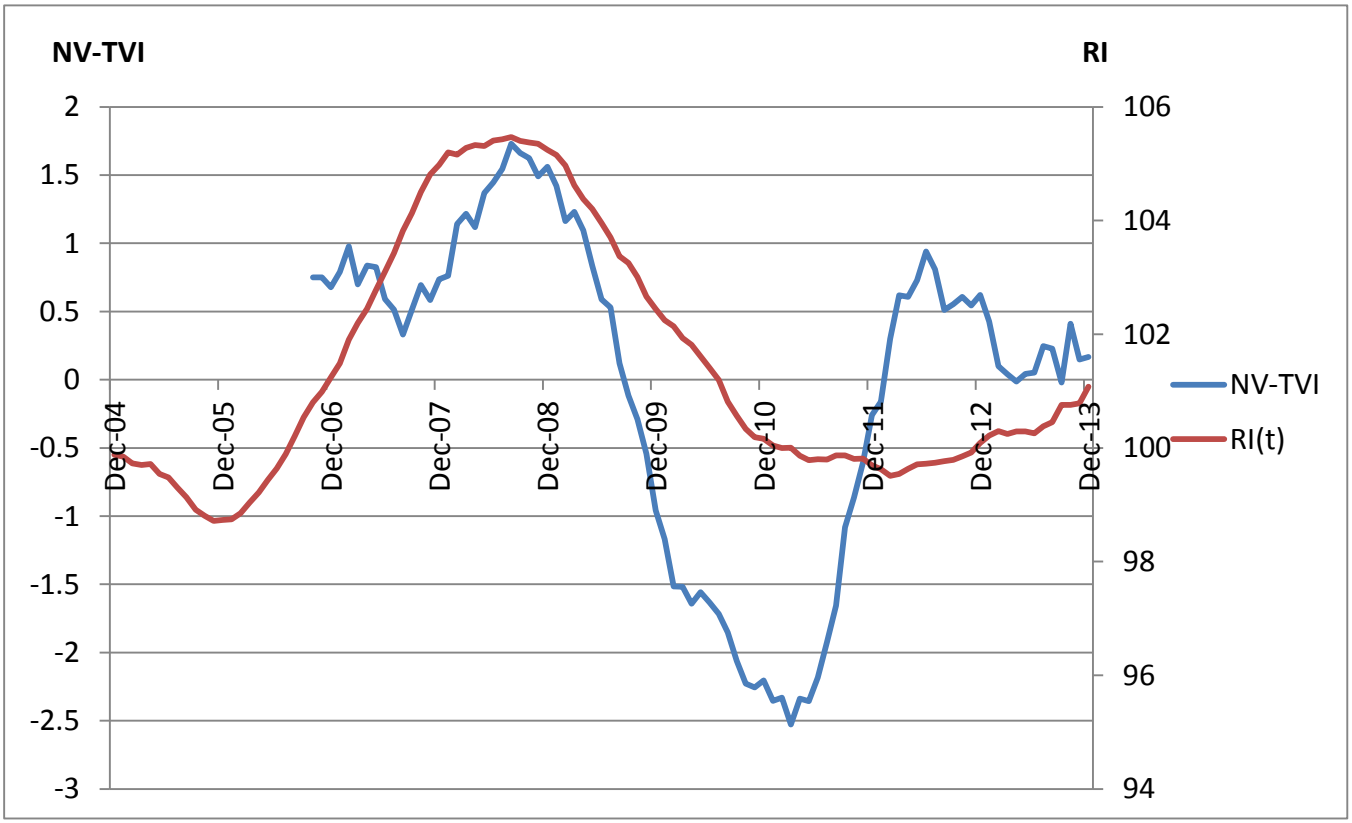


Figure 21 NV-TVI and Rent Index for 3DK

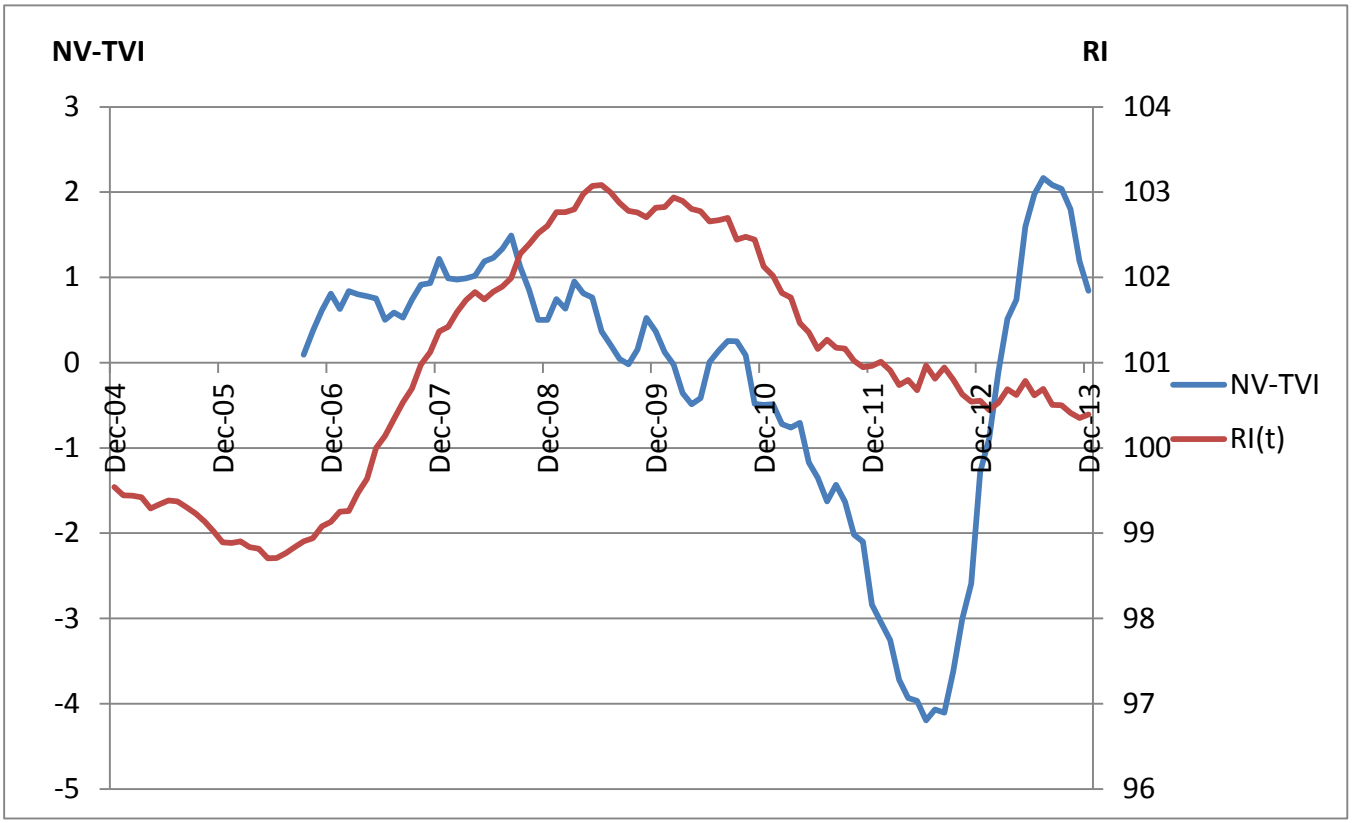
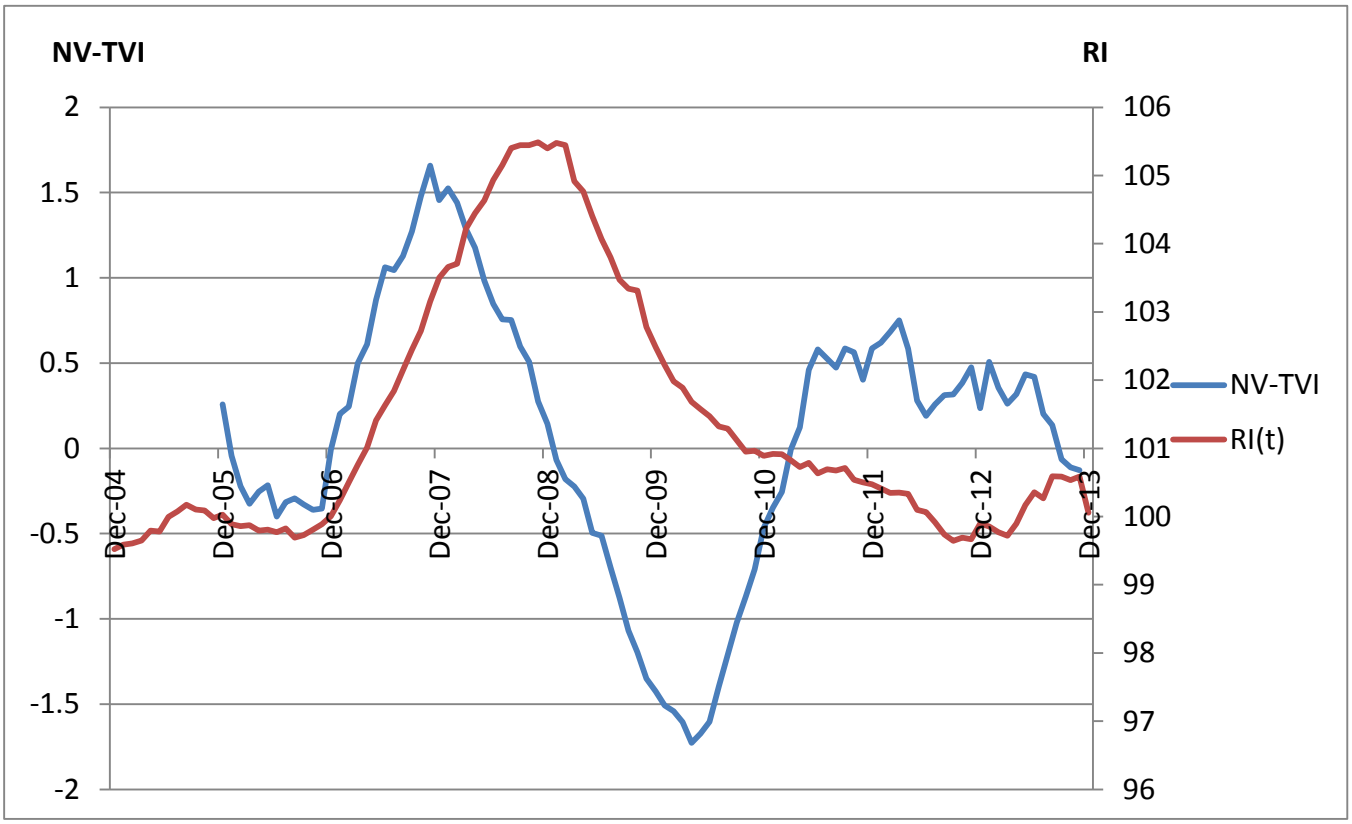


Figure 22 NV-TVI and Rent Index for 3LDK


NV-TVI
RI
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
106
105
104
103
102
101
100
99
98
97
96
Dec-04
Dec-05
Dec-06
Dec-07
Dec-08
Dec-09
Dec-10
Dec-11
Dec-12
Dec-13
NV-TVI
RI(t)

5. Conclusion

In this study, our study group developed regression models in which the explained variable denotes the rate of rent index variability, and the explanatory variables denote variability in the rates of vacancy rate TVI, vacancy duration, and indexes of business conditions (lagging CI) for each Madori. Furthermore, these models are based on the following six hypotheses: (i) changes in rent have a negative correlation with changes in vacancy factor(s), (ii) changes in rent have a positive correlation with changes in economic trends, (iii) each Madori, which is a unique category for room types and is an important factor in the Japanese residential rental market, has a unique market, (iv) changes in the vacancy rate antedate changes in rent, (v) changes in economic trends antedate changes in rent, and (vi) changes in vacancy duration lag changes in rent. As a result, our study group confirmed the following observations:

(a) For all Madoris, a change in vacancy rate TVI and a change in vacancy duration as vacancy factors have a negative correlation with changes in rent indexes. However, the t-value of changes in vacancy duration for 1K, 2LDK, and 3LDK were insignificant, and the t-value of *VD** for 1LDK was significant but small. These Madoris do share one characteristic, a high rate of new construction;

(b) For all Madoris, a change in indices of business conditions (lagging CI) as a macroeconomic factor has a positive correlation with a change in rent indices;

(c) For 1R, 1K, 1DK, 1LDK, 2LDK, and 3LDK, we can observe a difference between changes in rent indices and estimated results from 2011 to 2012, and this difference became smaller after 2013. This finding indicates that some factors existed to reduce the change in rent indices, and these factors persisted for roughly two years.

Next, our study group calculated the natural vacancy rate for Tokyo's 23 Wards rental apartment market first in Japan by using this model. As a result, our study group confirmed the following findings:

(d) For all Madoris, the market rent faces downward pressure if the vacancy rate TVI is greater than the natural vacancy rate. Furthermore, the market rent faces upward pressure if the vacancy rate TVI is smaller than the natural vacancy rate.

(e) For 1Ks, the estimated value of the natural vacancy rate is not reasonable because fluctuation in estimated values is substantial and occasionally takes negative values. These facts indicate that the market rent for 1Ks may be more strongly affected by economic trends compared with other Madoris.

The model developed by our study group in this study has good explanatory power for all Madoris. We will next extend the research area to other prefectures around Tokyo's 23 Wards, and will analyze the difference between regions. Additionally, our study group will analyze factors for the difference between the actual and theoretical values for changes in rental rates from 2011 to 2012.

Acknowledgments

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References

Belsky, E. and Goodman, L.J. (1996), Explaining the Vacancy Rate—Rent Paradox of the 1980s, *The Journal of real Estate Research*, 11, 3, 309−323.

Fujii, K., Hozumi, Y., Iida, T., and Tsutsumi, M. (2012), Analysis by "Madori" of Tokyo's 23 Wards Rental Apartment Market, AsRES & AREUEA Joint International Conference 2012.

Fujii, K., Hozumi, Y., Iida, T., and Tsutsumi, M. (2013), Effect of Vacancy Rate and Economic Trends Index: Rent Adjustment Factors for Rental Apartments in Tokyo's 23 Wards, The 18th AsRES Annual Conference 2013.

Gabriel, S.A. and Nothaft, F.E. (1988), Rental Housing Markets and the Natural Vacancy Rate, *Real Estate Economics*, 16, 4, 419−429.

Gabriel, S.A. and Nothaft, F.E. (2001), Rental Housing Markets, the Incidence and Duration of Vacancy, and the Natural Vacancy Rate, *Journal of Urban Economics*, 49, 1, 121−129.

Hozumi, Y., Fujii, K., and Tsutsumi, M. (2014), Relationship between Vacancy Duration and Change Rate of Rent: Evidence from the Rental Apartment Market in Tokyo's 23 Wards, The AsRES 19th International Conference.

Smith, L.B. (1974), A Note on the Price Adjustment Mechanism for Rental Housing, *The American Economic Review*, 63, 3, 478−481.