Impacts of Real Estate Securitization on Land Price Changes in the Inner City of Tokyo since 2001: A Geographically Weighted Regression Analysis

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Abstract: This study examined the relationship between land price changes and the Japanese Real Estate Investment Trust (J-REIT) in the inner city of Tokyo by using global and local regression techniques. In the beginning of the 21st century, as a reaction to economic depression, the Japanese Government implemented policies that encouraged structural reforms. These policies included real estate securitization that primarily intended to solve the issue of massive bad loans held by financial institutions. With the support of the Bank of Japan in terms of the easing of money supply, affluent liquidities flew into the real estate market through real estate securitization. The J-REIT is the only scheme of real estate securitization that offers shares to the public. A total of 64% of all the properties invested by the J-REIT are located in the inner city of Tokyo. Conventional multivariate regression analysis revealed that the J-REIT had a significant influence on land price changes every year. Affluent liquidities invested through the J-REIT have made positive impacts on the deflation of land prices. Geographically weighted regression (GWR) analysis was applied to clarify whether or not the relationship between land price changes and the J-REIT varied in the study area. The results of the GWR analysis indicated that the relationship between land price changes and the J-REIT showed a significant, spatial non-stationarity. Areas that benefited from the positive impacts of the J-REIT were limited to business districts such as Hibiya, Shinjuku, and Shibuya.

Key words: real estate securitization, J-REIT, land price, geographically weighted regression (GWR), Tokyo

Introduction

Globalization of finance is undoubtedly an obvious phenomenon in the contemporary world with respect to either its quantity or quality. According to Sassen (2001: 65–84), cross-border transactions in the financial industry underwent transformations during the 1980s. In other words, the key financial institutions of the cross border transactions were banks, and until the 1970s, many transactions comprised bank loans. However, in the 1980s, securities firms and investment banks became the key institutions, and there was a massive increase in the international securities transactions that were closely related to the growth of the financial industry. Deregulation and innovations of financial products were the two major aspects of the growth in securities transactions. The most important innovation in the financial industry is securitization that transforms various types of financial assets into marketable instruments. Securitization has been the vehicle for the massive expansion of the securities market and transformed assets that were considered illiquid until recently.

Real estate securitization has made real estate as well as other financial instruments highly liquid and accessible. According to the modern portfolio theory introduced by Harry Markowitz who received the Nobel Prize in 1990, diversification of a portfolio could improve risks and returns. Therefore, institutional investors usually build up their investment portfolios in the light of diversification. Real estate is considered as an alternative asset for the diversification of a portfolio, although stocks and bonds are conventional assets as well. Institutional investors recognized
real estate as a tertiary asset after stocks and bonds (Kitamura 2006). Weber (2002) stated that recent investors preferred securitized real estate to real estate because real estate securitization could realize short-term returns.

It was not until the late 1990s that real estate securitization experienced a sharp growth in Japan. As a reaction against a prolonged economic depression, the Council on Economic and Fiscal Policy headed by the Prime Minister proposed an emergency economic package in April 2001; the package included the establishment of Administration Task Force on Urban Renewal and promotion of real estate securitization. These policies were attributed to an expansion of real estate securitization: the volume of real estate securitization per year increased from 1.9 trillion yen (16 billion dollars) in 2000 to 6.9 trillion yen (58 billion dollars) in 2005 (Ministry of Land, Infrastructure and Transport 2006b: 47-48). Moreover, real estate securitization accounted for 64% of the transactions of land between listed companies, based on transaction prices during the second half of 2005 (Ministry of Land, Infrastructure and Transport 2006b: 46-47).

However, thus far, the impacts of the expansion of real estate securitization on urban spaces are not evident. Yamada (1999) studied appraisal land prices in the inner city of Tokyo and observed that land price changes were not uniform over the inner city, but regionally polarized since 1997. In other words, the variance in land price changes over the inner city increased. The observation provoked a question regarding the cause of spatial polarization of land price changes. The land value is usually presented at least two prices; the appraisal land price and the actual transaction price. The gap between these two prices becomes narrow after the sharp growth of real estate securitization in the late 1990s. The appraisal land price is now closely linked to the actual transaction price through real estate securitization. Therefore, it is possible that real estate securitization is attributed to the polarization of land price changes in the inner city of Tokyo.

This study examines the impacts of real estate securitization on land price changes, particularly on the spatial polarization of land price changes in the inner city of Tokyo. This contributes to a better understanding of the role of real estate securitization as an actor which creates urban spaces. The impacts of real estate securitization are analyzed in the following two ways: using conventional multivariate regression analysis and geographically weighted regression (GWR) analysis.

The dataset and methods employed in this study are described in the second section. The first part of the second section provides a reason for the Japanese Real Estate Investment Trust (J-REIT) being considered as a representative case of real estate securitization. The development processes of the J-REIT are discussed in the third section while focusing particularly on the allocation of assets. Finally, the impacts of the J-REIT are investigated in the fourth section. The first part of the fourth section presents the procedures of the GWR analysis by comparing them with the conventional multivariate regression analysis. Then multivariate regression and GWR analyses are performed to clarify the relationship between the J-REIT and land price changes in the inner city of Tokyo.

Data and Methods

Data

It is critical that information pertaining to real estate securitization is available. Olds (1995) has reported some cases of urban development projects that were fund-raised through real estate securitization. However, due to insufficient information on real estate securitization, his attempt was not very successful with respect to describing the reality of real estate securitization. It is necessary to select a real estate securitization scheme that adopts a positive approach toward information disclosure. Thus, private funds of real estate securitization that do not disclose their information are excluded from this study. This study focuses on the J-REIT that is listed on the Tokyo Stock Exchange (TSE) because of its guaranteed disclosure of information. The J-REIT has disclosed various types of information: addresses, floor area and purchased prices of owned buildings, attributes of balance sheets, financiers of debt and equities, and so on. The data were collected from annual secu-
This study uses appraisal land price information known as Published Land Price (PLP) as land prices that are probably affected by the J-REIT. The PLP is based on the published land price survey that is conducted by the Ministry of Land, Infrastructure and Transport every year. The PLP is an appraisal land price estimated by qualified appraisers throughout Japan. Incidentally, Shimizu and Nishimura (2006) pointed out that there was a time lag between the PLP and actual transaction prices. The time lag in the PLP is treated in the following analysis. This study defines the inner city of Tokyo as the office area of 23 Wards. PLP observation points within the area of which Ikoma Data Service System (IDSS) reported the rent of office buildings are selected for analysis.

Methods

Although the primary concern of this study is the impacts of the J-REIT on land price changes in the inner city of Tokyo, it is also necessary to understand its impacts in a broader context. Matsubara (1982, 1984, 1985, 1988) showed the importance of understanding the development processes of real estate capital. In particular, the position of the Tokyo metropolitan area is apparent by examining the processes on a nationwide scale. Unfortunately, he could not take into account real estate securitization because the first case of real estate securitization occurred in 1987. Hence, an effort is required to study the development processes of the J-REIT throughout Japan and to clarify the role of the Tokyo metropolitan area. In this study, the allocation of the buildings purchased by the J-REIT is of interest—whether or not they are concentrated in the Tokyo metropolitan area. Furthermore, factor analysis on time series data is performed to describe the dynamic processes of the allocation.

The GWR analysis is an effective tool for exploring the mechanisms of land price changes. According to Yamada (1999), land price changes in the inner city of Tokyo started fluctuating locally after 1997. This polarization of land price changes is probably due to the local differential processes that work simultaneously in the inner city. The local regression model including the GWR analysis premises on spatial non-stationarity: the relationship between independent and dependent variables exhibits local variation (Nakaya 2003). Meanwhile, the global regression model, namely conventional multivariate regression analysis, premises on spatial stationarity: the relationship between independent and dependent variables is uniform. Thus, a local model rather than a global model represents the polarization of land price changes more effectively if spatial non-stationarity exists in the study area. The GWR analysis has been applied to commuting patterns between cities (Lloyd and Shuttleworth 2005) and locations of air toxic release facilities (Mennis and Jordan 2005). Furthermore, semi-parametric GWR combined with both spatially varying and spatially uniform parameters has been introduced (Nakaya et al. 2005).

Development Processes of the J-REIT

Overview of the J-REIT

Background of real estate securitization in Japan In March 1997, a bulk sale of bad loans offered by the Tokyo Mitsubishi Bank triggered the rapid expansion of real estate securitization in Japan. The buyers of the bulk sale were overseas funds, particularly U.S.A. funds; their aim behind the transaction was to securitize the collateral real estate of bad loans. The overseas funds evaluated the prices of bad loans by discounted cash flow (DCF)—income gains that would be produced from real estate. On the contrary, the Japanese investors had paid less attention to DCF because the prices of real estate in Japan had been rising from the 1950s to the late 1980s. This upward trend of land prices had made Japanese investors blind to evaluation based on income gains. In fact, DCF had an impact on the evaluation of real estate; further, it has been used in real estate securitization since the late 1990s (Yamamoto et al. 2005). Therefore, the beginning of real estate securitization in Japan was closely linked to the globalization of finance, particularly, in that an idea of real estate securitization and evaluation based on DCF were introduced by overseas financial institutions.

Government’s policies on real estate securitization The disposition of bad loans has
been promoted by the Japanese Government since the late 1990s. The main purpose of the promotion is to recover confidence in the Japanese financial system. In 1997 and 1998, a financial system crisis was provoked by three Japanese banks with some banks becoming insolvent or temporarily nationalized. The Japanese Government decided to use public funds to resolve Japan’s banking turmoil and directed each bank to dispose the bad loans. Consequently, the bulk sales of bad loans were frequently offered by major Japanese banks in a sequential manner. These bulk sales have provided many opportunities to securitize collateral real estate. In other words, real estate securitization has enabled the restructuring of Japanese banks by creating demand for the bad loans of the banks.

Under Government monitoring, the major Japanese banks began selling mutual holding stocks as well as bad loans in order to improve earnings. Therefore, listed Japanese companies were exposed to the monitoring of markets as stocks were transferred from the major banks to the outsiders. In general, stock markets evaluate the corporate value mainly in terms of the returns on assets. Under the monitoring of markets, the listed companies were required to reduce idle assets and improve the returns on assets. Consequently, the idle assets including office buildings and company housing were sold to the funds and securitized in a sequential manner. Moreover, the financial service agencies declared an announcement regarding the application of accounting for impaired assets by 2005. The announcement has accelerated the trend of listed companies selling their properties.

In order to support the Government’s policies, the enactment of the legislation regarding real estate securitization began in the late 1990s. Since September 1998, the Law on Securitization of Specified Assets by Special Purpose Companies (SPC Law) was implemented. The SPC Law was expected to advance the disposition of bad loans by using real estate securitization. In November 2000, the SPC Law was amended for further use because it was not always convenient for practical purposes. The Investment Trust and Investment Corporation Act (Investment Trust Act) was also implemented in November 2000. The Investment Trust Act enabled the establishment of real estate investment trust. A legal basis was constructed for the Investment Corporation—the so-called J-REIT.

In March 2001, the TSE opened the market for the J-REIT. The Nippon Building Fund Inc. (NBF) and the Japan Real Estate Corporation (JRE) were listed as the first J-REITs in September 2001.

**Structure of the J-REIT** The J-REIT usually purchases buildings by using debt financing from financial institutions and equities from investors such as institutional, individual, and overseas investors (Figure 1). The rents paid by tenants are resources for the loan repayment to financial institutions and share dividends to investors. Contrary to ordinal companies, the J-REIT is a paper company; thus, almost all the assets comprise real estate.$^2$

The asset management businesses of the J-
REIT must be entrusted to asset management companies because the J-REIT is merely a paper company. For example, the NBF entrusted all asset management businesses to the Nippon Building Fund Management Ltd. (NBFM). The businesses of the NBFM include the selection of buildings and issues pertaining to shares. The major sponsors of the NBFM are the Mitsui Fudosan, which is one of the biggest real-estate companies in Japan, and the Sumitomo Life Insurance Company. When the NBF was established, these NBFM sponsors sold their buildings to the NBF. Similarly, the sponsors of asset management companies sold their buildings to the J-REIT, particularly during its establishment. The buildings from these interested parties accounted for 60.1% of the total assets of the J-REIT based on the purchased price in December 2005. The sponsors of asset management companies included real estate, life insurance, railway, and overseas asset management companies.

The J-REIT has some different features from the REIT in the U.S.A. The first REIT in the U.S.A. was established in 1960 and its aggregated market value of the listed REIT reached 350 billion dollars in 2005 (Association for Real Estate Securitization 2006: 160). The J-REIT can not develop buildings; on the other hand, the REIT in the U.S.A. can develop buildings. In addition, the J-REIT can not invest in buildings in other countries.

**Assets**

Both the number of listed J-REITs on the TSE as well as its total assets increased from 2 J-REITs and 500 billion yen in December 2001 to 26 J-REITs and 3.4 trillion yen in December 2005 (Figure 2). The following subsection describes the development processes of the J-REIT, with a particular focus on the building allocation throughout Japan.

**Allocation of buildings in December 2005**

The J-REIT purchased 329 office buildings (41%), 372 condominiums (46%), and 95 shopping centers (12%) all over Japan. Based on the purchased prices, the shares indicate changes to office buildings, 2 trillion yen (59%); condominiums, 600 billion yen (17%); and shopping centers, 800 billion yen (23%). This is because the unit cost of office buildings is higher than that of condominiums.

The allocation of buildings based on purchased prices is largely concentrated in urban areas, namely the Tokyo and Osaka metropolitan areas (Table 1). In the Tokyo metropolitan area, 2.6 trillion yen (75.7%) of the buildings were based on the purchased prices. Furthermore, the inner city of Tokyo Prefecture (23 Wards) comprised 2.1 trillion yen (64%) of buildings. It is indicated that the J-REIT had intensively invested in that area. The other areas that received investments are the regional center cities such as Nagoya, Fukuoka, Hiroshima, Sendai, and Sapporo.

It is evident that the J-REIT buildings are concentrated in the Tokyo metropolitan area. On the other hand, the original buildings that might have been purchased are also concentrated in the Tokyo metropolitan area. Therefore, it is necessary to compare the allocation of the buildings purchased by the J-REIT and all the potential...
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buildings of investment. Since office buildings had greater weightage in the portfolio of the J-REIT, these buildings are selected for comparison on the basis of leasable floor area statistics. The statistics of the leasable floor area of all potential investment targets in December 2005 are drawn from the Ikoma Data Service System (2006). Based on these statistics, the shares of all office buildings in Japan are calculated by prefecture. The results revealed that the share of the J-REIT in Tokyo Prefecture was 59.8%, and it is larger than that of all office buildings, which accounts for 52.5% (Table 2). This implies that the share of the J-REIT in Tokyo Prefecture is over-weighted by 7%. Other prefectures such as Kanagawa, Fukuoka, and Saitama are over-weighted as well. With the exception of Fukuoka, these prefectures belong to the Tokyo metropolitan area. Consequently, taking into account the allocation of all the potential buildings of investment, it is evident that the building allocation of the J-REIT is concentrated in the Tokyo metropolitan area, particularly, in the inner city of Tokyo.

Factor analysis In order to illustrate the dynamic processes of the allocation of buildings since 2001, factor analysis (principal components analysis with varimax rotation) was performed on data, which is the percentage shares of total assets in every month from May 2001 to December 2005. The data was broken down according to nine areas: (1) Hokkaido Prefecture, (2) Miyagi Prefecture, (3) Tokyo Prefecture, (4) Kanagawa/Chiba/Saitama Prefectures, (5) Aichi Prefecture, (6) Osaka Prefecture, (7) Kyoto/Hyogo/Shiga Prefectures, (8) Hiroshima Prefecture, and (9) Fukuoka Prefecture. Therefore, the data matrix comprises 56 rows (56 month) by 9 columns (9 areas).

Factor analysis produced three factors that have an eigenvalue that is greater than 1, and their cumulative variance is 81.7% of the total variance. Varimax rotation on three factors produced a simple structure (Table 3). Tokyo, Osaka and Kanagawa/Chiba/Saitama Prefectures have high factor loadings on the first factor. Note that Tokyo Prefecture has a negative loading; therefore, the process of Tokyo Prefecture is opposite to those of the other two areas. The standardized factor scores of the first factor are positive since the first half of 2002 and then become negative from the second half of 2003 to 2004 (Figure 3). This transition of factor scores is due to the extensive provision of office buildings to the inner city of Tokyo in 2003. The provision of office buildings was expected to have cooled down the office building market. With the forecast of a weak office building market in Tokyo Prefecture, the J-REIT set the weight of allocation to

Table 2. Shares of the leasable floor area of office buildings by prefecture

<table>
<thead>
<tr>
<th>Prefecture</th>
<th>Share of buildings owned by the J-REIT (%)</th>
<th>Share of all buildings (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokyo</td>
<td><strong>59.8</strong></td>
<td>52.5</td>
</tr>
<tr>
<td>Osaka</td>
<td>11.6</td>
<td>17.5</td>
</tr>
<tr>
<td>Kanagawa</td>
<td><strong>6.9</strong></td>
<td>4.5</td>
</tr>
<tr>
<td>Fukuoka</td>
<td><strong>4.4</strong></td>
<td>3.3</td>
</tr>
<tr>
<td>Aichi</td>
<td>4.2</td>
<td>5.4</td>
</tr>
<tr>
<td>Saitama</td>
<td><strong>2.0</strong></td>
<td>0.9</td>
</tr>
<tr>
<td>Hokkaido</td>
<td>1.6</td>
<td>2.5</td>
</tr>
<tr>
<td>Miyagi</td>
<td>1.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Hiroshima</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Chiba</td>
<td>1.1</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Source: Annual security reports, Ikoma Data Service System (2006).
Note: Over-weighted prefectures are denoted with bold letters and underbars.
other areas from 2002 (Hashimoto 2006). Factor analysis shows that the alternative areas of investment are Osaka Prefecture and suburbs of the Tokyo metropolitan area (Kanagawa/Chiba/Saitama Prefectures); this is because these two areas show positive scores since 2002. In other words, the J-REIT recognized Osaka Prefecture and the suburbs of the Tokyo metropolitan area as alternatives for the diversification of portfolios because of their weak correlation with the office market in Tokyo Prefecture. Meanwhile, the transition of the standardized factor scores after the second half of 2003 proves the resurgence of investment in Tokyo Prefecture. The transitions of standardized factor scores of the second and the third factors demonstrate that the investment in the local region increased since 2002 or 2003 (see Figure 3). Aichi, Hiroshima, and Fukuoka Prefectures have positive factor loadings on the second factor. In contrast, Miyagi Prefecture has negative factor loadings on the second factor; hence, the process of Miyagi Prefecture is opposite to those of the other three prefectures. The standardized factor scores of the second factor were negative until the second half of 2003. In other words, Miyagi Prefecture has positive factor scores until the second half of 2003, which implies that the J-REIT also perceived Miyagi Prefecture as an alternative area for investment. However, Miyagi Prefecture is different from Osaka Prefecture and the suburbs of the Tokyo metropolitan area in that it does not show resurgence of investment after the second half of 2003. This is because the real estate market of Miyagi Prefecture is smaller than the sum of the markets of the other three prefectures; buildings that were deemed investment-worthy had probably been saturated. Since the second half of 2003, the standardized factor scores of the second factor are positive. This implies that the J-REIT continued purchasing buildings in Aichi, Hiroshima, and Fukuoka Prefectures.

Hokkaido Prefecture has positive factor loadings on the third factor, whereas the suburbs of the Osaka metropolitan area (Kyoto/Hyogo/Shiga Prefectures) have negative factor loadings on the third factor. The standardized factor scores of the third factor are suggested to be positive until the second half of 2005; in other words, the J-REIT had purchased buildings in Hokkaido Prefecture before the second half of 2005. The standardized factor scores of the third factor turned negative since the second half of 2005. This transition of the factor scores indicates that the J-REIT purchased buildings in the suburbs of the Osaka metropolitan area although Hokkaido Prefecture was not as attractive as before. The real estate market in both Hokkaido and Miyagi Prefectures is small; therefore, the number of buildings for potential investment is limited. Once the J-REIT purchased buildings having good occupancy and/or commanding higher rental rates in prefectures such as Hokkaido and Miyagi, the resurgence of investment became difficult in those prefectures due to their small real estate market. The J-REIT always seeks buildings having good occupancy and/or commanding higher rental rates with the exception of those in saturated real estate market areas.

Impacts of the J-REIT on land Price Changes in the Inner City of Tokyo

In this chapter, the impacts of the J-REIT on land price changes are examined using regression analysis. The procedures of the GWR analysis are described in the first section. Then conventional multivariate regression and GWR analyses are performed to clarify the impacts of the J-REIT on land price changes.

The procedures of the GWR analysis

In conventional multivariate regression analysis, spatially uniform parameters \((\beta_0, \beta_1, \beta_2, \ldots)\) are estimated:
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\[ Y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \varepsilon_i \] (1)

On the other hand, in the GWR analysis, parameters \((\beta_{0(i)}, \beta_{1(i)}, \beta_{2(i)}, \ldots)\) are locally estimated at each observation point \(i\):

\[ Y_i = \beta_{0(i)} + \beta_{1(i)} x_{1i} + \beta_{2(i)} x_{2i} + \varepsilon_i \] (2)

The calibration of the GWR analysis is carried out by weighting neighborhood observations according to distance decay function away from observation point \(i\). In this study, the GWR 3.0 software package has been used for the GWR analysis. The GWR 3.0 implements a weighting function:

\[ w_{ij} = \begin{cases} 1 - \left( \frac{d_{ij}}{b}\right)^2 & \text{when } d_{ij} \leq b \\ 0 & \text{when } d_{ij} > b \end{cases} \] (3)

where \(w_{ij}\) determines the weight of an observation point \(j\) for the GWR calibration centered on observation point \(i\), \(d_{ij}\) denotes the distance between observation point \(i\) and neighborhood data point \(j\), and \(b\) is referred to as the bandwidth.

The GWR analysis can estimate parameters in two types of bandwidth: the fixed bandwidth in which the number of samples is varied and the adaptive bandwidth in which the number of samples is fixed. The adaptive bandwidth can reduce the problem of small samples when data are sparse; it can produce reliable results rather than those of the fixed bandwidth. According to Fotheringham et al. (2002: 44-51), therefore, if observation points are not equally distributed, it is better to use the adaptive bandwidth. The number of samples for the adaptive bandwidth is decided upon by selecting the number of samples that minimizes the corrected Akaike Information Criterion (AICc). With regard to the information on the AICc, see Sugiura (1978), Hurvich and Simonoff (1998), and Fotheringham et al. (2002: 61). The AICc for the GWR takes the following form:

\[ \text{AICc} = \log(\hat{\sigma}^2) + 1 + \frac{2(\text{tr}(H) + 1)}{n - \text{tr}(H) - 2} \] (4)

where \(n\) is the sample size, \(\hat{\sigma}\) is the estimated standard deviation of the error term, and \(\text{tr}(H)\) denotes the trace of the hat matrix, which maps \(\hat{y}\) on to \(y\) in the following manner:

\[ \hat{y} = Hy \] (5)

While calibrating a GWR model, it is worth considering whether the local model offers an improvement over the global model. One procedure to assess the improvement is to determine whether any of the local parameter estimates is significantly non-stationary. The Monte Carlo significance test (Hope 1968) is employed to test spatial non-stationarity. In this test, an observed value of the variance of local parameter estimates is compared with \(n-1\) simulated ones (\(n\) is the number of simulations: for example, 100 or 1,000). The geographical coordinates are randomly permuted for \(n-1\) with a set of variables, and \(n-1\) sets of variances are obtained. It should be noted that independent variables were not permuted against dependent variables. The results are sorted, and the rank of the observed variance is determined. The \(p\)-value for the test is obtained by subtracting the ratio rank/\(n\) from unity.

**Variables**

The dependent variable of regression analysis is land price changes—calculated yearly changes in the land price of the commercial area points using Published Land Price (PLP) data. Although the PLP survey is conducted every year, some observation points are replaced. When computing yearly changes, these replaced points are excluded. The land price changes were computed on each observation point within the IDSS area. The land price changes in 2005-2006 indicated large increase rates in Marunouchi, Akasaka, Aoyama, and Shibuya (Figure 4). These land price changes are denoted as LPCHANGE in the regression analysis.

The independent variables of regression analysis must include a variable that represents the impacts of the J-REIT; this is because the impacts are a primary concern of this study. The appraisers of the PLP survey reference a transaction price of real estate in the neighborhoods to appraise the value of observation points. Therefore, the purchase price of the J-REIT probably affects the appraisal value of the PLP in the neighborhood. In the regression analysis, the purchase price of the J-REIT has to be standardized in an area unit; this is because the PLP is the price per square meter. Hence, purchased prices and leasable floor areas of the J-REIT are...
aggregated within the 1 km radius area from the PLP observation points. The independent variable that represents the impacts of the J-REIT is purchase prices divided by leasable floor areas; this variable is denoted as **REITPRICE**. Incidentally, the sponsors of asset management companies and private funds under the control of the sponsors often sold their buildings to the J-REIT. The buildings transferred from those interested parties are different from its evaluation of transactions in markets. Therefore, **REITPRICE** is twofold—one including the transactions of interested parties and the other excluding the transactions of interested parties. The distribution of purchased price floor area ratio (including the transactions of interested parties)
in 2004–2005 shows that the transactions of the J-REIT are active in the western part of the inner city (Figure 5). Areas such as Shibuya and Aoyama show a high value of purchased price floor area ratio.

The other independent variables are (1) street distance from the nearest railway station to the observation points: STATION, (2) railway distance from Tokyo Station to the nearest station of the observation points: TOKYO, (3) railway distance from Shinjuku Station to the nearest station of the observation points: SHINJUKU, and (4) dummy variable of the urban regeneration area: URAREA. URAREA is 1 if the observation points are in the urban regeneration area and 0 otherwise. There are eight urban regeneration areas in the inner city of Tokyo in 2005 (see Figure 5).

Figure 5. Purchased price floor area ratio of the buildings of the J-REIT, 2004–2005.
Source: Annual security reports, Press releases.
The period of study targets is from 2001 when the two J-REIT corporations were listed on the TSE. Shimizu and Nishimura (2006) point out that the PLP has a time lag of one year reflecting the neighborhood transaction prices. Hence, the model was constructed as follows: REITPRICE in \(t-1\) corresponds to LPCHANGE in \(t\). Precisely, if the independent variable is the REITPRICE of 2001–2002, then the dependent variable is LPCHANGE of 2002–2003. The LPCHANGE can be calculated up to 2005–2006 because the latest PLP available is that of 2006. Due to this data condition, the period of study targets are 2002–2003, 2003–2004, 2004–2005, and 2005–2006. The regression analysis was performed in each of these four periods.

**Multivariate regression analysis**

The estimated parameters of REITPRICE including the transactions of the interested parties are not stable in the period of study targets (Table 4). In particular, in 2002–2003, the parameter of REITPRICE is negative, implying that higher purchase prices cause negative land price changes. According to the interview with the person involved in the JRE\(^9\), sponsor companies had a tendency to sell buildings having poor occupancy and/or commanding lower rental rates to the JRE in 2001 because the real estate market had cooled down during that time. The interviewee also said that tough negotiations regarding the building transactions took place between the sponsors and the JRE. Consequently, REITPRICE is difficult to interpret when only the transactions of interested parties are included.

On the other hand, the estimated parameters of REITPRICE excluding the transactions of interested parties show a constant relation between the J-REIT and land price changes (Table 5). The parameters of REITPRICE are positive and statistically significant at the 1% level over four periods; this implies a temporal stationarity of REITPRICE. Moreover, REITPRICE has the highest impact on land price changes among independent variables in all the study target periods. The coefficient of determination represents a better fit than that of the former analysis including the transactions of interested parties. Positive parameters of REITPRICE imply that positive land price changes arise from higher purchase prices of the J-REIT. It is clear that the J-REIT played a vital role as a buyer of buildings in the real estate market and supported land prices against the deflation of land prices. The other independent variables such as TOKYO and

<table>
<thead>
<tr>
<th>Number of samples</th>
<th>Standardized partial regression coefficients</th>
<th>(R^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STATION</td>
<td>REITPRICE</td>
</tr>
<tr>
<td>2002–2003</td>
<td>389</td>
<td>-0.097</td>
</tr>
<tr>
<td>2003–2004</td>
<td>389</td>
<td>-0.117*</td>
</tr>
<tr>
<td>2004–2005</td>
<td>383</td>
<td>-0.125*</td>
</tr>
<tr>
<td>2005–2006</td>
<td>381</td>
<td>-0.153**</td>
</tr>
</tbody>
</table>

Note: **: Significant at the 1% *: Significant at the 5%

<table>
<thead>
<tr>
<th>Number of samples</th>
<th>Standardized partial regression coefficients</th>
<th>(R^2)</th>
<th>Moran’s I (residuals)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STATION</td>
<td>REITPRICE</td>
<td>TOKYO</td>
</tr>
<tr>
<td>2002–2003</td>
<td>389</td>
<td>-0.090</td>
<td>0.429**</td>
</tr>
<tr>
<td>2003–2004</td>
<td>389</td>
<td>-0.117*</td>
<td>0.494**</td>
</tr>
<tr>
<td>2004–2005</td>
<td>383</td>
<td>-0.082</td>
<td>0.497**</td>
</tr>
<tr>
<td>2005–2006</td>
<td>381</td>
<td>-0.126**</td>
<td>0.469**</td>
</tr>
</tbody>
</table>

Note: **: Significant at the 1% *: Significant at the 5%
URAREA are statistically significant in three periods; the parameters of SHINJUKU are statistically significant in all the periods. It is also evident that the urban regeneration policy had a positive effect on land price changes since 2003 because URAREA becomes significant from 2003–2004.

Nevertheless, the coefficients of determination of the multivariate regression analysis are as low as less than 30%. Furthermore, Moran's Is of standardized residuals are positive and statistically significant at the 1% level in all the periods (see Table 5). It is indicated that spatial autocorrelation remains in residuals. As pointed out by Tsutsumi et al. (1999), spatial auto-correlation of residuals challenges the significance of the estimated parameters. An application of GWR could be a remedy for these indicators if spatial non-stationarity is a feature of the study area.

The GWR analysis

In addition to the multivariate regression analysis, the GWR analysis was conducted for the following four periods: 2002–2003, 2003–2004, 2004–2005, and 2005–2006. In the GWR analysis, only the variable of REITPRICE excluding transactions of the interested parties was used.

The GWR analysis shows a better performance than that of the conventional multivariate regression analysis. The coefficients of determination of the GWR increased as compared to those of the multivariate regression analysis (Table 6). Taking into account the degree of freedom, the reduction of AIC suggests that the GWR is preferable to conventional multivariate regression. Moran's I of standardized residuals is not significant in all the periods; the issue that Tsutsumi et al. (1999) stated is resolved by applying the GWR. The Monte Carlo significance test indicates that the coefficients of STATION are not significant in the period of the study target (Table 7). On the other hand, the other variables suggest spatial non-stationarity because the Monte Carlo significance test is statistically significant. In particular, REITPRICE is significant at the 0.1% or the 1% level for the study target period; therefore, the relationship between REITPRICE and LPCHANGE is proved to be locally different.

The distribution of the parameter REITPRICE was examined to clarify the spatial non-stationarity of the relation between REITPRICE and LPCHANGE. Like conventional regression analysis, t-value was computed for the parameters of each observation point in order to test the significance of the parameter estimates. In order to eliminate potential problems caused by the multiple hypothesis tests, Bonferroni correction was applied. Bonferroni correction adjusts

<table>
<thead>
<tr>
<th>Number of samples</th>
<th>$R^2$</th>
<th>GWR AIC</th>
<th>Global model AIC</th>
<th>Moran's I (residuals)</th>
<th>The number of samples for the adaptive bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002–2003</td>
<td>389</td>
<td>0.623</td>
<td>1718.27</td>
<td>1954.20</td>
<td>0.004</td>
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<tr>
<td>2003–2004</td>
<td>389</td>
<td>0.548</td>
<td>1672.48</td>
<td>1805.34</td>
<td>-0.002</td>
</tr>
<tr>
<td>2004–2005</td>
<td>383</td>
<td>0.605</td>
<td>1502.83</td>
<td>1674.93</td>
<td>-0.001</td>
</tr>
<tr>
<td>2005–2006</td>
<td>381</td>
<td>0.731</td>
<td>2011.73</td>
<td>2309.35</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STATION</th>
<th>REITPRICE</th>
<th>TOKYO</th>
<th>SHINJUKU</th>
<th>URAREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002–2003</td>
<td>0.16</td>
<td>0.00***</td>
<td>0.00***</td>
<td>0.04***</td>
</tr>
<tr>
<td>2003–2004</td>
<td>0.07</td>
<td>0.00***</td>
<td>0.00***</td>
<td>0.02***</td>
</tr>
<tr>
<td>2004–2005</td>
<td>0.58</td>
<td>0.01**</td>
<td>0.00***</td>
<td>0.01***</td>
</tr>
<tr>
<td>2005–2006</td>
<td>0.78</td>
<td>0.00***</td>
<td>0.00***</td>
<td>0.01***</td>
</tr>
</tbody>
</table>

Note: ***: Significant at the 0.1% **: Significant at the 1% *: Significant at the 5%
the critical value of the test upwards by setting a new significance level equal to the original significance level divided by the number of samples in the GWR model (Fotheringham et al. 2002: 135).

With regard to 2002-2003, the positive and statistically significant observation points are located in Shinjuku, Shibuya, and Marunouchi (Figure 6a). A few observation points in Shintomicho indicate negative and statistical significance. Shintomicho is one of the areas that are characterized by the congestion of small office buildings. A building purchased by the J-REIT in 2001 in the neighborhood of Shintomicho was a

Figure 6. Results of the t-test of parameter REITPRICE with Bonferroni correction.
large office building; therefore, the person who appraised the observation points might consider Shintomicho as an area of potential disinvestment. During 2003-2004, the observation points that showed statistical significance are scarce except for Shinjuku because the investment of the J-REIT was evacuated from Tokyo as described above (Figure 6b). The number of positive observation points of statistical significance increased in 2004-2005 by resurgence of the investment to Tokyo (Figure 6c). In 2005-2006, observation points of statistical significance further increased, particularly in the western parts of the inner city such as Akasaka, Shinjuku, and Shibuya (Figure 6d).

It is evident that the impacts of the J-REIT on land price changes are not uniform over the target areas and periods of this study. The areas that benefit from the investment of the J-REIT are limited spatially. However, areas such as Shinjuku, Shibuya, and Hibiya are the main targets of investment because they frequently have positive and significant points.

In addition to REITPRICE, the distributions of the parameters of the other three variables (TOKYO, SHINJUKU, and URAREA), which show significant, spatial non-stationarity are examined. In order to map spatial non-stationarity, $t$-value was computed for each parameter estimate of the three variables, and $t$-test was performed by applying Bonferroni correction as well as REITPRICE.

With regard to 2002-2003, the observation points that are located in Marunouchi, Hibiya, Ginza, and Shinbashi are negative and statistically significant for TOKYO (Figure 7a). These points of negative significance are located approximately within the 2 km radius from Tokyo Station. The distance from Tokyo Station is an important factor for land price changes, particularly in these areas. It is interesting that these observation points indicate a negative parameter for TOKYO, contrary to the results of the multivariate regression analysis (see Table 5). These trends of 2002-2003 are similar to those of 2003-2004; in addition, a negative and statistically significant point is also located in Shibuya (Figure 8b). During 2004-2005, the observation points of negative and statistical significance increased in Shibuya and Ginza (Figure 8c). Furthermore, the observation points of negative and statistical significance increased in Shibuya during 2005-2006 (Figure 8d). The land price changes in these areas are affected by the distance from Shinjuku Station. It is suggested that people from the western part of the Tokyo metropolitan area are important customers for these areas; this is because Shinjuku Station is the railway terminal for the western part of the Tokyo metropolitan area.

As compared with the other variables, the distribution of parameter URAREA is more difficult to interpret. In multivariate regression analysis, URAREA shows positive and statistically significant parameters (see Table 5). Nevertheless, the parameters of GWR analysis show negative and statistically significant parameters during three periods (2002-2003, 2003-2004, and 2005-2006). Negative and statistically significant observation points are located in Marunouchi during the first two periods (Figures 9a and 9b). These negative parameters are inconsistent with the results of multivariate regression analysis. In order to resolve the inconsistency between the
global model and GWR, the semi-parametric GWR (Nakaya et al. 2005) may be an effective tool. In semi-parametric GWR, which is a combination of the global model and GWR, each variable is automatically determined whether the parameters are spatially varying or uniform over the study area. If the semi-parametric GWR proves that URAREA is spatially uniform, the parameters of URAREA are not locally computed; therefore, the inconsistency between the global model and GWR is resolved. During 2004–2005, positive and statistically significant observ-
vation points are located in Marunouchi and Ginza (Figure 9c). These positive parameters conform to the results of the multivariate regression analysis. During 2005-2006, positive and statistically significant observation points increased in the Ginza area (Figure 9d). However, negative and statistically significant observation points are located in Shibuya. The urban regeneration area of Shibuya was designated in December 2005. Hence, it may be very early to assign the value of 1 to the Shibuya area for URAREA because appraisers cannot reflect the
impact of designation on land prices.

**Concluding Remarks**

This study has examined the development process of the J-REIT and its impacts on land price changes in the inner city of Tokyo. The results are summarized as follows. Buildings owned by Japanese corporations were sold since the late 1990s; this is because the Japanese Government promoted the deposition of bad loans, and corporations were required to increase the re-
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turns on assets. Real estate securitization has played a vital role in buying these buildings by collecting funds not only from investors living in Japan but also from investors around the world. It is evident that the buildings purchased by the J-REIT were concentrated in the inner city of Tokyo. In order to explore the impacts of the J-REIT on land price changes in the inner city of Tokyo, conventional multivariate regression analysis and GWR analysis were applied. The multivariate regression analysis revealed positive relations between the purchase prices of the J-REIT and land price changes over the period of study targets. The GWR analysis indicated that the impacts of the J-REIT showed significant, spatial non-stationarity; in other words, the relations between the J-REIT and land price changes are locally different. The areas that benefited from investments of the J-REIT are limited to Hibiya, Shinjuku, and Shibuya.

This study reveals that the investments of the J-REIT resulted in spatial polarization of land price changes in the inner city of Tokyo. The multivariate regression analysis shows that among other variables, the J-REIT has had the highest and positive impacts on land price changes. This result implies that real estate securitization has become the key player in land price formation since the late 1990s. Due to the Bank of Japan's monetary policy, affluent liquidities flew into the real estate market through real estate securitization. These affluent liquidities enabled real estate securitization as the key players of land price formation. In addition, the GWR analysis shows the spatial non-stationarity of the J-REIT. This spatial non-stationarity of the J-REIT contributed to the spatial polarization of land price changes. Some areas in the inner city of Tokyo benefited from investment of the J-REIT and experienced positive land price changes; in contrast, the other areas did not benefit from the investment of the J-REIT. If the impacts of the J-REIT are spatial stationarity, land price changes are relatively uniform over the study area.

The impacts of the J-REIT suggest clues regarding the effect of real estate securitization on urban spaces. Under the evaluation standard of real estate securitization, areas that yield constant cash flow are of interest. Investments can be made in these areas to produce further cash flow. In the case of the J-REIT, office buildings have been reformed to produce higher rent. On the other hand, areas that provide less cash flow are exposed to the risk of disinvestment. Therefore, a value gap between the areas of investment and disinvestment widens. The development processes of real estate securitization in Japan are processes of spatial unbundling of urban spaces.

Since the late 1990s, the Japanese Government has been administrated by the Prime Minister who advocated structural reforms. Due to a series of structural reforms, the direct finance system through market displaced the indirect finance system through bank loans. The direct finance system resulted in the sharp expansion of the securities market. The real estate securitization market is no exception in that it benefited from expansion of the securities market. Smith (2002) points out that many developed countries in the world implement urban regeneration policies. Real estate securitization is used for financing the tools of urban regeneration policies, which intend to expand domestic demand. Hence, it seems that the growth of domestic demand is a common interest among the developed countries. Contrary to the J-REIT on which this study has focused, the private funds of real estate securitization purchased diversified properties. The private funds purchased properties such as resort hotels and golf courses in the local regions of Japan. These properties recall a distant memory of the 1980s. The cause of the bubble economy in the late 1980s was extravagant bank loans, which were lent to development projects of office buildings in urban areas and resort facilities in local regions. In the 21st century, the financiers of these properties were no longer bank loans but funds through evaluation of the market.

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YABE N.

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Notes

1. Nishimura (1995), Watanabe (2003), Wada (2003, 2004), and the Association for Real Estate Securitization (2006a) were used as a reference for the description in this section.

2. One of the conditions to list the Investment Corporation on the TSE is that at least 75% of the assets comprise real estate. The remaining assets are allowed only for cash and cash equivalents.

3. The price-based statistics of all office buildings are not available in Japan.

4. In the first half of 2003, many office buildings were constructed in the inner city of Tokyo, in particular, the Shinagawa, Shiodome, and Roppongi areas. It was believed that this provision of office buildings would cool down the office building market in Tokyo.

5. Purchase prices of buildings by the J-REIT are determined by DCF. Income gains that would be produced from buildings are estimated and are discounted by interest rate.

6. The PLP survey does not define the objective standard of the neighborhood in which a transaction is referenced for appraisal. Based on an interview with an appraiser conducted on August 8, 2006, this study defines the neighborhood of observation points as an area that is within 1 km radius from the observation points.

7. Variables like population density and agglomeration of retail stores are excluded because these variables are not necessarily appropriate for the analysis of the office area. Significant correlations between these variables and TOKYO or SHINJUKU are another reason for the exclusion to avoid multicollinearity.

8. The urban regeneration area is designated by the Law on Urban Regeneration that was enacted in June 2002. The urban regeneration area is characterized by deregulations of city planning and financial supports by the Government.

9. The interview was conducted on September 5, 2006.

10. One of the other corrections to the multiple hypothesis testing problems is based on false discovery rate (Benjamini and Hochberg 1995).

References


Matsubara, H. 1988. Real estate capital and urban...
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(J): written in Japanese

(JE): written in Japanese with English abstract