Geographic Concentration and Diversification Strategies in Japanese REITs: The Tokyo Concentration Measure and Its Impact on REIT Stock Return Volatility

Yusho KAGRAOKA [a]

Abstract

This study investigates the concentration of Japanese Real Estate Investment Trusts (J-REITs) in Tokyo and examines their internal diversification strategies across property sectors, locations, and acquisition prices. The primary objectives are to analyze how Tokyo concentration affects REIT stock return volatility and to assess the effectiveness of diversification strategies in mitigating this volatility.

A new metric, the Tokyo Concentration Measure (TCM), is introduced to quantify the hierarchical geographic concentration within Tokyo. The TCM is straightforward to calculate and captures multi-level classifications from regions down to specific wards. The empirical analysis utilizes detailed property portfolio data and panel data models to examine the relationship between the TCM, diversification measures—including property sector entropy and acquisition price diversification—and stock return volatility.

Key findings reveal a gradual decline in Tokyo concentration since 2019. Moreover, higher Tokyo concentration is associated with increased REIT stock return volatility, indicating that concentration in a single metropolitan area amplifies investment risk. In contrast, greater diversification in acquisition prices reduces REIT stock return volatility, suggesting that investing across a range of property values enhances portfolio stability. Notably, diversification across property sectors does not impact stock return volatility.

Keywords : Tokyo Concentration measure; diversification; REIT

JEL : G11, R12, R32

1. Introduction

Real Estate Investment Trusts (REITs) play a significant role in Japan's financial and real estate markets, offering both individual and institutional investors exposure to real estate without the need for direct property ownership. The Japanese REIT (J-REIT) market has experienced steady growth, with the total market capitalization of listed J-REITs reaching 15.4 trillion yen by the end of 2023, complemented by an additional 6 trillion yen in private REITs. Collectively, REITs manage real estate assets valued at 28.7 trillion yen.[1]

REITs provide portfolio diversification across various sectors of real estate, such as commercial, residential, and office buildings, thereby helping to mitigate investment risk (Chan et al., 2002). Understanding the composition of a REIT's holdings and its diversification strategies—both within individual REITs and across multiple REITs—is essential for effective risk management and optimizing returns (Anderson et al., 2015). The diversification benefits of REITs lie in offering investors access to multiple properties, reducing risks associated with reliance on a single property sector or regional location (Eichholtz et al., 1995; Gyourko and Nelling, 1996). This paper distinguishes two main forms of REIT diversification:

- Internal Diversification: This involves diversifying a single REIT's assets across different property

a Professor, Faculty of Economics, Musashi University

[1] The Association for Real Estate Securitization (ARES). https://www.ares.or.jp/

sectors or locations. For example, a diversified REIT might hold office buildings, shopping centers, and residential apartments in various regions, thus reducing exposure to potential downturns in any single sector or area (Mueller, 1993; Anderson et al., 2015).

- External Diversification: This entails diversifying across multiple REITs, each specializing in different sectors or locations. For instance, holding shares in both a healthcare REIT and a commercial REIT can spread risk and provide exposure to varying market dynamics. Likewise, holding shares in REITs with properties on both the East Coast and the West Coast of the United States can spread risk and provide exposure to varying regional market dynamics.

Internal diversification can be further categorized into three key strategies:

1. Geographic Diversification: REITs may invest in properties across different regions or cities to minimize exposure to location-specific risks, such as natural disasters, economic downturns, or policy changes. By distributing properties across diverse locations, REITs can effectively mitigate these risks.
2. Property Sector Diversification: Investments may span a variety of property sectors, including residential, commercial, industrial, or retail. Each property sector possesses a unique risk-return profile, contributing to a REIT's ability to maintain stability throughout economic cycles. For example, office spaces may face challenges during a recession, whereas residential demand might remain relatively steady.
3. Property Price Diversification: Diversifying across a range of property values can also affect a REIT's risk profile. Managing properties of varying sizes and values may introduce complexities and administrative costs, however investing in both high-value and lower-value properties can potentially stabilize rental income streams.

Several studies have examined the link between REIT stock returns and internal diversification. Capozza and Seguin (1999) found that diversification across property sectors negatively affected REIT value. Benefield et al. (2009) reported superior performance for specialized REITs[2] compared to diversified ones, while Ro and Ziobrowski (2011) observed increased stock volatility in specialized REITs. More recently, Beracha et al. (2019) found that for U.S. REITs, property sector diversification is not associated with REIT stock return volatility, whereas greater geographical diversification is. Feng et al. (2021) explored how geographic diversification influences the value of equity REITs and found that REITs with more geographically diversified portfolios tended to exhibit lower return volatility, suggesting that diversification helps mitigate location-specific risks.

In the United States, REITs typically specialize in a specific property sector, such as office buildings, shopping centers, industrial properties, residential complexes, or niche areas like data centers or healthcare facilities. This specialization enables investors to target specific segments based on their risk tolerance, market outlook, or investment strategy. Consequently, investors often construct diversified portfolios by investing in multiple specialized REITs, aligning their investments with broader macroeconomic trends or growth sectors.

In contrast, J-REITs are generally more diversified. Rather than focusing on a single sector, many J-REITs invest across a range of property sectors. This internal diversification offers investors exposure to a variety of asset classes within a single REIT. In Japan, the responsibility of creating a balanced and diversified portfolio typically falls to the REIT manager, who actively manages risk and return. This approach allows individual investors to access a wide range of real estate assets without the need to select specialized REITs individually.

Diversification is often seen as the opposite of concentration. While standard deviation is commonly used as a measure of diversification, it fails to adequately capture geographic diversification. Alternative measures, such as entropy—a concept from physics (Salinas, 2001) and information theory (Cover and Thomas, 2006)—and the Herfindahl-

2 Specialized REITs invest exclusively in real estate assets within a single property sector.

Hirschman Index (HHI), used to measure market competition (Hannah and Kay, 1977), can evaluate diversification but do not incorporate geographic patterns.

This study examines the relationship between internal diversification in REITs and their stock price volatilities. It analyzes internal diversification in three dimensions: property sector, location, and acquisition price. By shifting the focus to concentration rather than diversification, this study enhances the analysis of geographic diversification. To achieve this, a new metric is proposed—the Tokyo Concentration Measure (TCM)—to assess the geographic concentration of REITs in Tokyo, considering regional, prefectural, and ward level concentration. The TCM is compared against two other diversification metrics: entropy and the HHI. The TCM's application is particularly relevant for J-REITs, which often concentrate their holdings in offices, commercial buildings, and residential properties in the Tokyo Metropolitan Area.

The remainder of this paper is organized as follows. Section 2 introduces the TCM, while section 3 discusses the internal diversification of J-REITs. Section 4 applies the TCM to assess REIT stock return volatility. Section 5 concludes the paper, and the Appendix provides an overview of Japan's geography, including regions, prefectures, and the wards within Tokyo.

2. The Tokyo Concentration Measure

2.1. Tokyo Concentration and Diversification Measures

Over recent decades, the Tokyo Metropolitan Area has attracted significant attention due to its high concentration of real estate properties, population, businesses, capital, and other entities. This raises the question of how to quantify the degree of this concentration. Constructing such a measure requires careful consideration, given the varying scales and hierarchical levels involved. The concentration of entities—such as individuals, companies, and real estate assets—within the Tokyo Metropolitan Area is observed at multiple scales and should be modeled using a hierarchical framework.

Concentration in the Tokyo Metropolitan Area is not simply characterized by entities moving into the region; it also exhibits complex fine structures. Certain districts have extremely high densities, while others are more sparsely populated. Furthermore, some wards serve as hubs, attracting a disproportionately large number of entities. This concentration often extends beyond the borders of Tokyo, resulting in increased densities in adjacent prefectures due to overflow from Tokyo.

To date, no specific concentration measure has been developed to capture this phenomenon. Commonly used measures, such as entropy and the Herfindahl-Hirschman Index (HHI) are typically employed to evaluate diversification. Previous research by Batty (1976) and Batty et al. (2014) has explored entropy from a spatial perspective, while Hirschman (1945) and Herfindahl (1950) developed the HHI to measure market competition. These measures are defined as follows.

Let n_i represent the number of entities in category $i \ (i = 1, \cdots, m)$, such that $\sum_{i=1}^{m} n_i = n$ and let $p_i = \frac{n_i}{n}$.

- Entropy: The entropy E is given by

$$E = -\sum_{i=1}^{m} p_i \log(p_i). \tag{1}$$

- HHI: The HHI is defined as

$$HHI = \sum_{i=1}^{m} (p_i)^2. \tag{2}$$

Lower values of entropy indicate that entities are concentrated within a single category, Similarly, a higher HHI (approaching 1) signifies greater concentration. Conversely, when entities are distributed more evenly across categories, entropy increases, and the HHI approaches $\frac{1}{n}$. However, neither entropy nor the HHI accounts for spatial relationships or hierarchical structures.

2.2. The Tokyo Concentration Measure (TCM)

The Tokyo Concentration Measure (TCM) is developed to quantify the geographic concentration of real estate assets within Tokyo. Recognizing that such concentration manifests at multiple geographic scales—regional, prefectural, and ward levels—the TCM adopts a hierarchical structure to reflect this multi-layered classification. For this study, Japan is divided into the following five hierarchical layers:

1. First layer: Japan and foreign countries. Japan is divided into ten regions: Hokkaido, Tohoku, Minami-Kanto, Kita-Kanto and Koshin, Hokuriku,

Tokai, Kinki, Chugoku, Shikoku, and Kyushu.
2. Second layer: The Minami-Kanto region is subdivided into four prefectures: Saitama, Chiba, Tokyo, and Kanagawa.
3. Third layer: Tokyo is further divided into two areas: the 23 special wards and the remaining areas. The 23 wards represent the city's core business districts.
4. Fourth layer: The Five Major Wards—Chuo, Chiyoda, Minato, Shinjuku, and Shibuya—constituting the primary central business districts.
5. Fifth layer: The Three Major Wards—Chuo, Chiyoda, and Minato—representing the most densely concentrated business districts.

This hierarchical segmentation reflects the standard classifications used in Japan's real estate industry. Detailed maps corresponding to each layer are provided in the Appendix.

Given a real estate asset portfolio, the TCM should range from 0 to 1 and satisfy the following criteria:

- TCM = 0 when no asset is located in the Minami-Kanto region.
- TCM = 1 when all assets are located in the Three Major Wards.
- The TCM increases as a larger share of assets is located in:
  - the Minami-Kanto region (relative to other parts of Japan or foreign countries),
  - Tokyo Prefecture (relative to other Minami-Kanto prefectures),
  - the 23 special wards of Tokyo (relative to the rest of Tokyo),
  - the Five Major Wards (relative to other special wards),
  - and the Three Major Wards (relative to the remaining major wards).

Given a real estate asset portfolio, the TCM satisfying the criteria is calculated through the following steps, based on these hierarchical layers:

1. Compute the total acquisition price of the portfolio.
2. Determine the proportion of real estate acquisition price in the Minami-Kanto region, to the total acquisition price, denoted as p_1.
3. Focus on the real estate within Tokyo Prefecture and determine its proportion relative to the total acquisition price, denoted as p_2.
4. Evaluate the real estate acquisition price in the 23 special wards and calculate its proportion relative to the total acquisition price, denoted as p_3.
5. Consider the real estate assets in the Five Major Wards and calculate their acquisition price proportion relative to the total acquisition price, denoted as p_4,.
6. Narrow down to the Three Major Wards and calculate their proportion relative to the total acquisition price, denoted as p_5.
7. Finally, the TCM is computed as the arithmetic average of these five proportions[3] :

$$TCM = \frac{1}{5}\sum_{m=1}^{5} p_i \tag{3}$$

This new concentration measure can be extended to other hierarchical classifications. Let a_i $(i = 1, \cdots, n)$ denote the entities forming a set $\Omega = \{a_1, a_2, \cdots, a_n\}$. Introduce hierarchical categories $\{C_1, \ldots, C_M\}$ with M levels, where each category C_m consists of subsets $C_{m,k} (k = 1, \ldots, K_m)$. Each entity belongs to one of the subsets $C_{m,k} \in \{C_{m,1}, C_{m,2}, \ldots, C_{m,K_m}\}$, and the following conditions are satisfied:

$$C_{m,k} \cap C_{m,l} = \emptyset \text{ when } k \neq l \tag{4}$$

$$\bigcup_{k=1}^{K_m} C_{m,k} = \Omega \tag{5}$$

For every k, there exists an l such that

$$C_{m,k} \subset C_{m-1,l} \text{ for } m = 2, \ldots, M. \tag{6}$$

Let the i-th entity have a scalar attribute v_i and belong to $C_{m,k}$. Denote the number of entities in $C_{m,k}$ by $n_{m,k}$, and the total scalar value of entities in $C_{m,k}$ by $V_{m,k}$. The total number and scalar are given by

$$n = \sum_{k=1}^{K_m} n_{m,k} \text{ and } V = \sum_{k=1}^{K_m} V_{m,k} \ (m = 1, \ldots, M). \tag{7}$$

Given the sets $C_{1,k_1}, C_{2,k_2}, \ldots, C_{M,k_M}$ which satisfy $C_{M,k_M} \subset C_{M-1,k_{M-1}} \subset \cdots \subset C_{1,k_1}$, the equally weighted and the value-weighted concentration measures for $C_{1,k_1}, C_{2,k_2}, \ldots, C_{M,k_M}$ are defined as:

$$\phi(C_{1,k_1}, C_{2,k_2}, \ldots, C_{M,k_M}) = \frac{1}{M}\sum_{m=1}^{M} \frac{n_{m,k_m}}{n}, \tag{8}$$

[3] A simple weighed average of the proportions at each hierarchical level is considered in this case; however, arbitrary weights are possible.

$$\psi(C_{1,k_1}, C_{2,k_2}, \dots, C_{M,k_M}) = \frac{1}{M}\sum_{m=1}^{M}\frac{V_{m,k_m}}{V}. \qquad (9)$$

These measures range between 0 and 1, with values closer to 1 indicating a higher concentration of entities.

3. Internal Diversification of J-REITs

An examination of the internal diversification strategies of J-REITs is essential for understanding their investment behaviors and risk management practices. This section explores how J-REITs diversify their property portfolios across different property sectors, geographic locations, and acquisition prices. By analyzing detailed data from the Association for Real Estate Securitization (ARES), insights are gained into the patterns and implications of these diversification strategies on REIT performance and REIT stock return volatility.

ARES provides detailed data on the property portfolios of J-REIT, including property sector classification, geographic location, and acquisition prices. In the ARES database, property size is represented by acquisition price, as appraisal values are unavailable. This dataset spans 54 months, from December 2018 to May 2023, and covers 65 REITs. During this period, four new REITs were listed, while five were delisted, resulting in some missing values in the panel data. On average, around 60 J-REITs were listed throughout this period, collectively holding about 4,300 properties, resulting in 232,936 observations. Over time, the total acquisition price of these properties increased from 18.0 trillion yen to 22.2 trillion yen, as depicted in Figure 1.

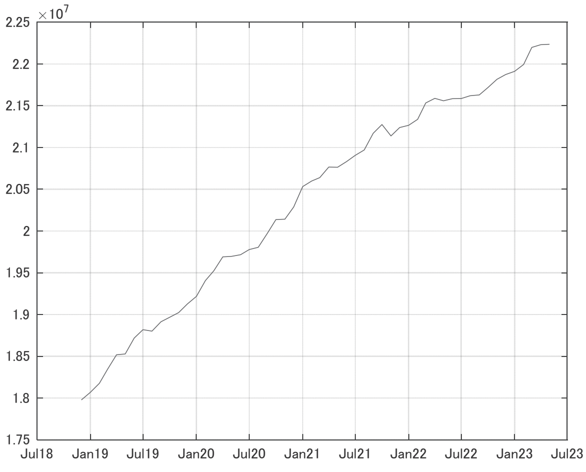

Figure 1. Total acquisition price of J-REITs (in million yen).

In Japan, properties are categorized into seven sectors based on their usage: office, commercial, residential, logistics, hotel, healthcare, and others. Figure 2 illustrates the proportion of total acquisition price by property sector.

REITs can be classified based on their investment strategy—whether they focus on a single property sector or diversify across multiple sectors. Single-sector REITs specialize in one specific property sector, while multi-sector REITs diversify their portfolio across two or more sectors, holding a mix of properties. As shown in Figure 3, the number of single-sector J-REITs declined from 25 in December 2018 to 20 in May 2023, indicating a trend toward diversification. This contrasts with the U.S. REIT market, where, as of April 2024,

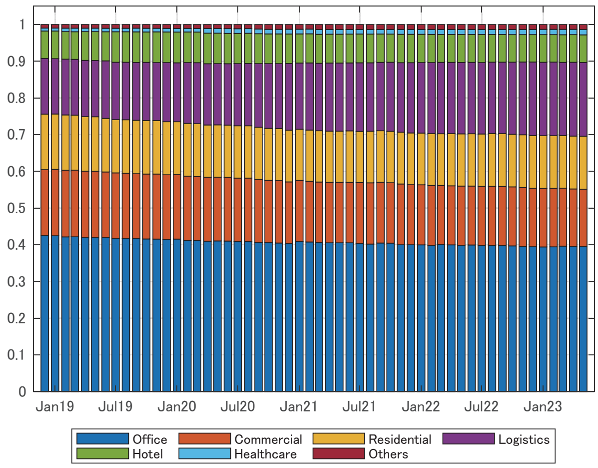

Figure 2. Proportion of total acquisition price by property sector.

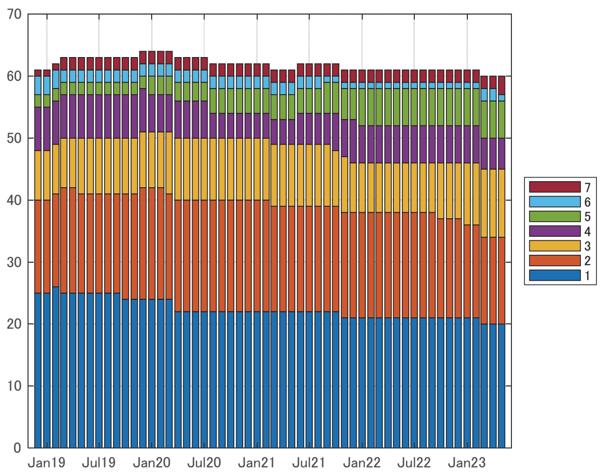

Figure 3. Number of J-REITs by the number of property sectors in which they invest.

125 out of 137 REITs focused on a single sector.[4] In the U.S., investors typically achieve diversification by investing in multiple single-sector REITs.

Many J-REITs prioritize properties in Tokyo due to the city's economic significance. As Japan's business hub, Tokyo is home to a high concentration of corporate headquarters, financial institutions, and multinational companies, which drives strong demand for commercial real estate, particularly office space. The city's stable occupancy rates and high property values make it an attractive market for J-REITs seeking consistent rental income and low vacancy rates. J-REIT portfolios often include properties located in central Tokyo districts, such as Chiyoda, Shibuya, and Minato. Figure 4 presents the proportion of total acquisition price by region, while Figure 5 provides a breakdown of total acquisition price within the Minami-Kanto region.

The office sector has traditionally been a significant part of the J-REIT market, particularly in major urban areas like Tokyo. Office-focused J-REITs tend to concentrate their portfolios in central business districts, such as Marunouchi, Shinjuku, and Shibuya, where corporate demand for office space is high. As shown in Figure 2, the office sector remains the largest, although its share has decreased slightly from 42.6% to 40.0%.

Office J-REITs are particularly sensitive to economic conditions. During periods of economic growth, demand for office space rises, driving up rents and occupancy rates. Conversely, during downturns, vacancy rates may rise, negatively affecting yields and property valuations. The COVID-19 pandemic accelerated the shift toward remote work, significantly reducing demand for office space. As companies reassess their office space needs, some office J-REITs have experienced a decline in tenant demand, leading to downward pressure on rents, especially for non-prime office buildings.

J-REITs benefit from operational efficiencies by managing properties of similar sizes, as standardized management practices reduce complexity and

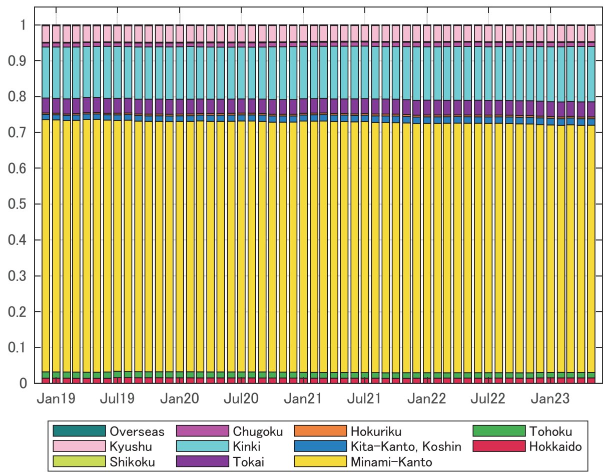

Figure 4. Proportion of total acquisition price by region.

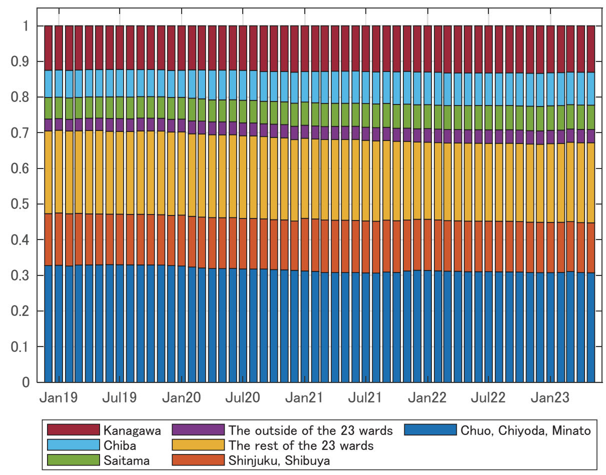

Figure 5. Proportion of total acquisition price within the Minami-Kanto region.

4 https://www.reit.com/sites/default/files/2024-09/MediaFactSheet_Aug-2024.pdf

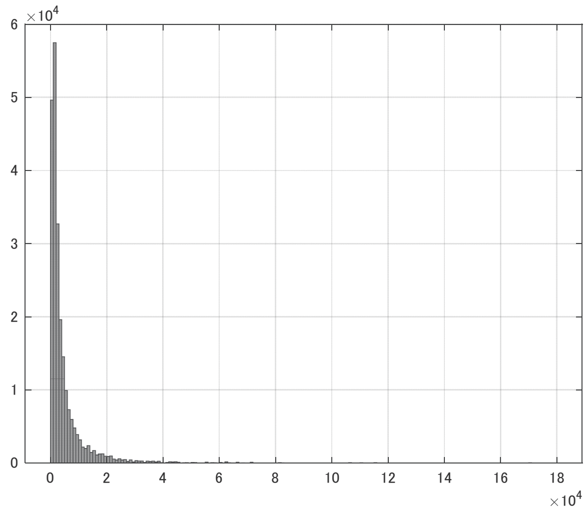

Figure 6. Histogram of acquisition prices.
Horizontal axis: price in million JPY.

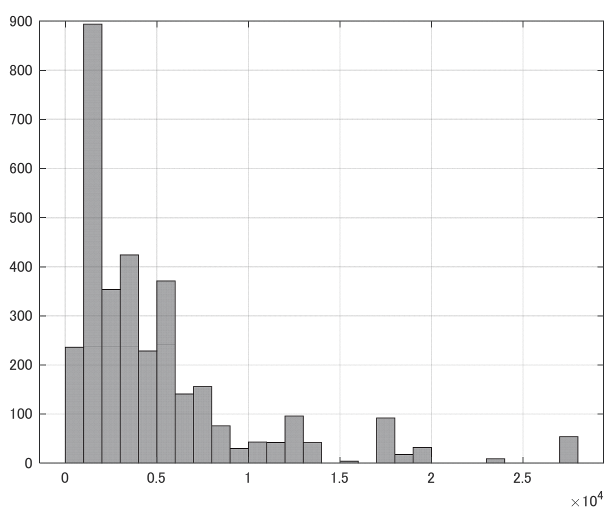

Figure 7. Histogram of median acquisition prices for J-REITs.
Horizontal axis: price in million JPY.

administrative costs. Figure 6 presents a histogram of property acquisition prices, which range from 86.7 million yen to 170 billion yen. Meanwhile, Figure 7 shows a histogram of the median acquisition prices for individual J-REITs, highlighting the significant variation in acquisition prices across different J-REITs.

4. Empirical Study

This empirical analysis utilizes daily REIT stock price data for J-REITs sourced from the Nikkei NEEDS Financial QUEST database. Monthly REIT stock returns are calculated as the average of daily relative log returns over the preceding three months. The daily relative log return is defined as the difference between the daily log return of a REIT stock and that of the REIT price index.[5] Similarly, monthly REIT stock return volatility is measured as the standard deviation of daily relative log returns over the same three-month period.

To demonstrate the usefulness of the TCM, an empirical study of J-REITs is conducted in two parts:

1. Analyzing the time series of the TCM for aggregated J-REITs.
2. Examining the relationship between property diversification measures of J-REIT property portfolios and J-REIT stock return volatility.

According to traditional portfolio theory, a more diversified portfolio tends to exhibit lower stock return volatility. This investigation explores whether higher levels of diversification in a REIT are associated with lower REIT stock return volatility.

4.1. The TCM for aggregated J-REITs

To assess the degree of Tokyo concentration, the TCM for the aggregated REITs is calculated. Figure 8 presents a monthly plot of the TCM, showing a downward trend from 0.457 to 0.432 over the study period. The TCM exhibits fluctuations due to the listing of new REITs and the delisting of older ones.

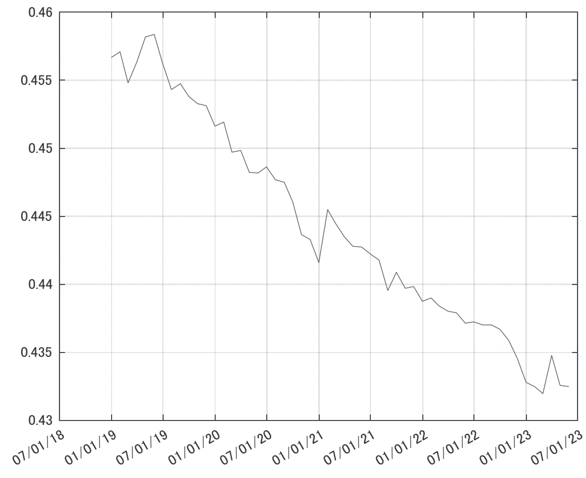

Figure 8. Tokyo concentration measure for aggregated REITs.

[5] Due to the COVID-19 pandemic, J-REIT stocks depreciated significantly. The J-REIT stock price index plummeted from 2,250.65 on February 20, 2020 to 1,145.53 on March 19, 2020. To evaluate REIT stock performance based on diversification of REIT real estate portfolio, the relative log return is examined.

Overall, the plot indicates that Tokyo concentration has been gradually decreasing since 2019. Notably, the impact of the COVID-19 pandemic does not appear to have accelerated the pace of this deconcentration.

4.2. Panel Data Analysis

To investigate whether property diversification reduces REIT stock return volatility, a panel data analysis is conducted using REIT stocks as the cross-sectional variable and applying a fixed-effects model. Property diversification is evaluated from four perspectives:

1. Tokyo concentration.
2. Regional location diversification of REIT real estate assets.
3. Property sector diversification.
4. Acquisition price diversification.

In Japan, property sectors are classified into seven sectors: office, commercial, residential, logistics, hotel, healthcare, and others. Diversification in property sector and regional location is measured using entropy,[6] while acquisition price diversification is calculated as:

$$\text{Price Diversification} = \left(\left(97.5^{\text{th}}\ \text{percentile}\right) - \left(2.5^{\text{th}}\ \text{percentile}\right)\right) / \left(\text{median price}\right). \quad (10)$$

This metric represents the 95% range normalized by the median price. The dependent variable in the regression models is the logarithm of monthly REIT stock return volatility. Summary statistics for the dependent and explanatory variables are presented in Table 1, and Table 2 lists the correlation coefficients of the explanatory variables. Notably, there is a strong negative correlation coefficient between entropy of location and TCM at −0.648. Due to this strong negative correlation, Tokyo concentration and location diversification are not used as explanatory variables in the same model.

Four models are estimated, with the Hausman test supporting the use of a fixed-effects model. The results are summarized in Table 3.

- Model I: Uses the entropies of property sector and regional location as explanatory variables.
- Model II: Uses the entropy of property sector and TCM as explanatory variables.
- Model III: Extends Model I by incorporating price diversification.
- Model IV: Extends Model II by incorporating price diversification.

First, Model I is analyzed. The coefficient for the entropy of property sector is 0.432278 and is statistically significant at the 10% level, indicating that sector diversification may increase REIT stock return volatility, contrary to REIT managers' intentions.

Next, Model II is considered. The coefficient for the TCM is 1.425674 and is statistically significant at the 1% level, suggesting that Tokyo concentration increases REIT stock return volatility.

Subsequently, Model III is assessed. The coefficient for diversification of acquisition prices is −0.039998

Table 1. Summary Statistics.

	ln(volatility)	Entropy of property sector	Entropy of location	TCM	Price diversification
Mean	−4.7543	0.1879	0.3886	0.3869	5.5135
Median	−4.8367	0.1044	0.3529	0.3391	4.6690
Maximum	−2.9182	0.6742	0.8962	0.9641	24.1054
Minimum	−5.6811	0.0000	0.0000	0.0000	1.2082
Std. Dev.	0.4345	0.2065	0.2326	0.2522	3.4665
Skewness	0.9784	0.7271	0.2157	0.2643	2.2742
Kurtosis	3.7778	2.1644	2.3571	1.9470	10.2672

Table 2. Correlation Coefficients.

	Entropy of property sector	Entropy of location	TCM	Price diversification
Entropy of property sector	1.000			
Entropy of location	−0.100	1.000		
TCM	0.076	−0.648	1.000	
Price diversification	0.202	0.105	0.061	1.000

[6] Similar estimation results are obtained when using the HHI.

and is statistically significant at the 1% level, implying that diversification of acquisition prices decreases REIT stock return volatility. This suggests that rents from large properties (properties with high acquisition prices) and those from small properties may vary inversely, resulting in stability of the aggregated rents and REIT stock returns.

Finally, Model IV is evaluated. The coefficients for TCM and diversification of acquisition prices are 1.581847 and −0.042885, respectively, and are statistically significant at the 1% level. This implies that higher TCM increases REIT stock return volatility, while greater diversification of acquisition prices decreases it.

Among these models, Model IV is superior based on the adjusted-R^2. The TCM coefficient is positive, indicating that higher Tokyo concentration increases REIT stock return volatility. Conversely, the price diversification coefficient is negative, suggesting that greater price diversification reduces REIT stock return volatility. Notably, the entropy of property sector is not statistically significant, indicating that diversification by property sector does not lower REIT stock return volatility, despite REIT managers acquiring a variety of property sectors with the aim of reducing volatility.

Model V uses the average REIT stock return as the dependent variable, and explanatory variables are the same as Model IV. The empirical result is also given in Table 3. Although the model shows a lower adjusted-R^2, it is noteworthy that both the TCM and price diversification are statistically significant. The coefficient for the TCM is 0.003284, suggesting that higher TCM (greater Tokyo concentration) leads to higher REIT stock returns, while the coefficient for price diversification is −0.000148, meaning that higher price diversification leads to lower REIT stock returns.

5. Conclusion

This study finds that J-REITs tend to invest across multiple property sectors, whereas U.S. REITs typically specialize in single sectors. The empirical analysis indicates that greater Tokyo concentration increases REIT stock return volatility, while price diversification reduces it. Notably, diversification by property sector does not impact volatility. The newly introduced TCM provides a valuable tool for assessing geographic concentration, with potential applications in other cities worldwide. These findings contribute to a deeper understanding of how internal diversification strategies affect REIT performance, offering valuable insights for REIT managers and investors in optimizing portfolios and managing risk. Further research may explore sector-specific concentration within Tokyo.

Acknowledgements: The author would like to extend thanks to Masayuki Ishihara for invaluable discussions.
Disclosure statement: The authors report there are no competing interests to declare.

References

Anderson, R.I., Benefield, J.D., & Hurst, M.E. (2015). Property-type diversification and REIT performance: an analysis of operating performance and abnormal returns. *Journal of Economics and Finance*, 39, 48-74. https://doi.org/10.1007/s12197-012-9232-0

Batty, M. (1976). Entropy in spatial aggregation. *Geographical Analysis*, 8, 1-21. https://doi.org/10.1111/j.1538-4632.1976.tb00525.x

Batty, M. Morphet, R., Masucci, P., & Stanilov, K. (2014). Entropy, complexity, and spatial information. *Journal of Geographical Systems*, 16, 363-385. https://doi.org/10.1007/s10109-014-0202-2

Benefield, J.D., Anderson, R.I., & Zumpano, L.V. (2009). Performance differences in property-type diversified versus specialized real estate investment trusts (REITs).

Table 3. Regression Results.

Model		I			II			III			IV			V	
intercept		−4.803005	***		−5.375122	***		−4.633166	***		−5.196323	***		−0.000226	
Entropy of property sector		0.432278	*		0.368411			0.434620	*		0.353678			−0.000008	
Entropy of location		−0.083725						0.045587							
Tokyo concentration measure					1.425674	***					1.581837	***		0.003284	**
Price diversification								−0.039998	***		−0.042885	***		−0.000148	***
Adjusted R^2		0.149088			0.152054			0.153116			0.156770			0.013007	

The asterisks indicate the statistics significance levels, where * denotes significance at the 10% level. ** at the 5% level, and *** at the 1% level.

Review of Financial Economics, 18, 70-79. https://doi.org/10.1016/j.rfe.2008.04.001

Beracha, E., Feng, Z., & Hardin III, W.G. (2019). REIT operational efficiency: Performance, REIT stock return volatility, and return. *The Journal of Real Estate Finance and Economics*, 58, 408-437. https://doi.org/10.1007/s11146-018-9655-2

Capozza, D.R. & Seguin, P.J. (1999). Focus, transparency and value: the REIT evidence. *Real Estate Economics*, 27, 587-619. https://doi.org/10.1111/1540-6229.00785

Chan, S.H., Erickson, J., & Wang, K. (2022). Real Estate Investment Trusts: Structure, Performance, and Investment Opportunities, Oxford University Press.

Cover, T.M. & Thomas, J.A. (2006). Elements of Information Theory, 2nd Edition. John Wiley & Sons, Inc., Hoboken, New Jersey.

Eichholtz, P.M.A., Hoesli, M., MacGregor, B.D., & Nanthakumaran, N. (1995). Real estate portfolio diversification by property type and region. *Journal of Property Finance*, 6, 39-59. https://doi.org/10.1108/09588689510101676

Feng, Z., Pattanapanchai, M., Price, S.M., & Sirmans, C. F. (2021). Geographic diversification in real estate investment trusts. *Real Estate Economics*, 49, 267-286. https://onlinelibrary.wiley.com/doi/abs/10.1111/1540-6229.12308

Gyourko, J. & Nelling, E. (1996). Systematic risk and diversification in the equity REIT market, *Real Estate Economics*, 24, 493-515. https://doi.org/10.1111/1540-6229.00701

Hannah, L. & Kay, J.A. (1977). Concentration in Modern Industry: Theory, Measurement and the U. K. Experience. The Macmillan Press Ltd, London and Basingstoke.

Herfindahl, O.C. (1950). Concentration in the U.S. Steel Industry. Ph.D. dissertation. New York, Columbia University.

Hirschman, A.O. (1945). National Power and the Structure of Foreign Trade. University of California Press, Berkeley.

Mueller, G.R. (1993). Refining Economic Diversification Strategies for Real Estate Portfolios. *The Journal of Real Estate Research*, 8, 55-68. https://doi.org/10.1080/10835547.1993.12090694

Ro, S. & Ziobrowski, A.J. (2011). Does focus really matter? Specialized vs. diversified REITs. *Journal of Real Estate Finance and Economics*, 42, 68-83. https://doi.org/10.1007/s11146-009-9189-8

Salinas, S.R.A. (2001). Introduction to Statistical Physics. Springer Science+Business Media, New York.

Appendix

An understanding of Japan's geography is essential for comprehending the hierarchical concentrations in Tokyo. At the national level, Japan is divided into ten regions (Figure A1). Among these, the Minami-Kanto region comprises four prefectures: Tokyo, Kanagawa, Saitama, and Chiba (Figure A2). Tokyo Prefecture is further subdivided into 23 wards, 26 cities, five towns, and eight villages (Figure A3). Within the 23 wards, the central business districts—Chiyoda, Chuo, Minato, Shinjuku, and Shibuya—serve as the city's commercial and financial hubs.

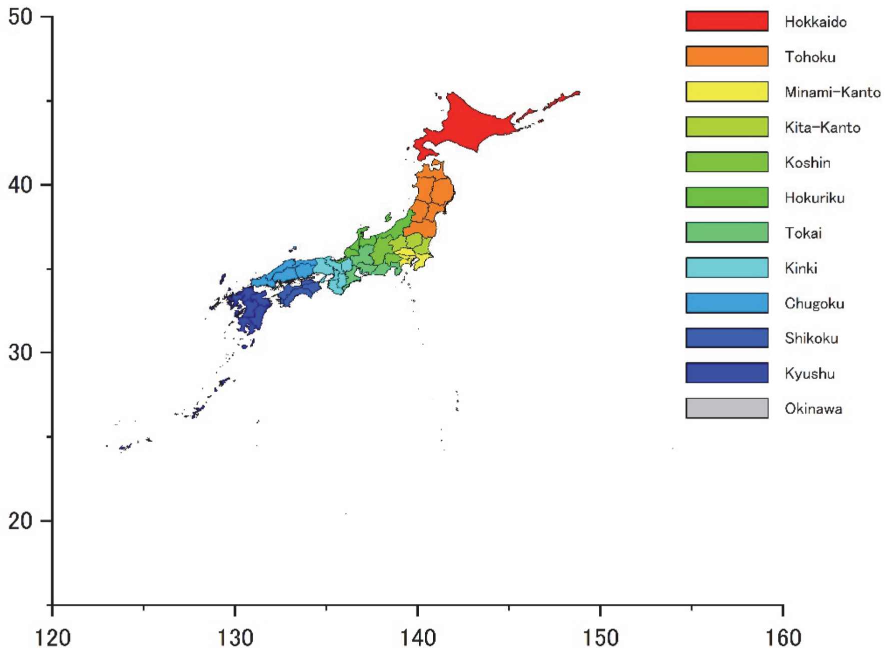

Figure A1. Regions in Japan.

Figure A2. Prefectures in the Minami-Kanto region.

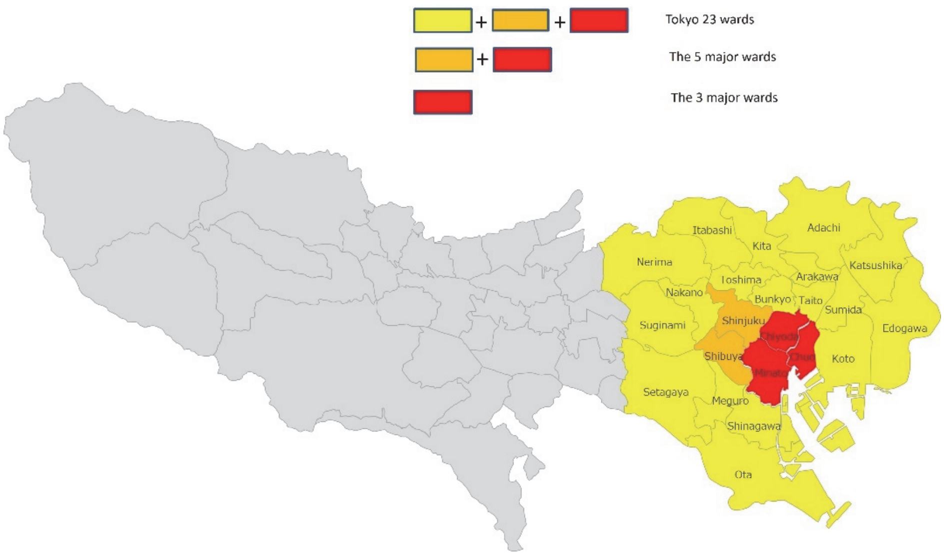

Figure A3. Wards in Tokyo prefecture.