GPIF Working Paper

Analysis for the integrated risk management between J-REIT and traditional assets

August 24, 2021
Kazuhiro Shimada
Koichi Miyazaki
Tetsuya Oishi

EXECUTIVE SUMMARY

- Government Pension Investment Fund (hereafter referred to as GPIF) invests in three alternative asset classes: infrastructure, private equity and real estate. As of the end of March 2021, the market value of those alternative assets was 1.3419 trillion JPY.
- GPIF manages alternative assets by classifying them into four traditional asset classes (domestic bonds, domestic equities, foreign bonds and foreign equities) according to their risk-return profiles for risk-management purposes.
- In this working paper, we regard “J-REIT” as alternative assets for the sake of convenience as a first step for the integrated risk management between alternative assets and traditional assets, and consider the degree of necessity to manage separately "J-REIT" as an independent asset class.

1. Introduction

In fiscal 2013, GPIF began managing alternative assets by using a joint investment vehicle with institutional investors. In general, alternative assets include a wide variety of assets, including infrastructure, private equity, real estate, private debt, commodities and hedge funds, while GPIF invests in three assets: infrastructure, private equity and real estate. GPIF has been deploying capital to alternative assets while sophisticating investment capabilities, and the total market value of alternative assets as of the end of March 2021 was 1.3419 trillion JPY, representing 0.70% of the total pension reserve. Under the fourth medium-term management plan, alternative assets are permitted to be invested up to 5% of GPIF's total assets under management. However, needless to say, due attention should be paid to market conditions and investment risks. Given the increasing value of the alternative assets, we are at the stage of evaluating the way to manage the risk.This point will be elucidated in this working paper.

The risk-return characteristics of alternative assets differ from those of traditional assets such as equities or bonds. In “Chapter 8: Alternative Investment”, edited by The Securities Analysts Association of Japan (2020), Ogishima stated the following characteristics are commonly seen in alternative assets: (1)

(NOTE)This working paper summarizes the research results of GPIF staffs, and the content and opinions expressed in the text do not represent GPIF's official views.

Low liquidity compared with traditional assets; (2) Diversification effects obtained by combining them with traditional assets; (3) High valuation costs (i.e., complex strategies and schemes, less transparent reporting, etc.); and (4) Difficulty of performance evaluation. Among them, (3) and (4) are the characteristics that make it very difficult to manage the risk of alternative assets. It is necessary to overcome these issues eventually and refine risk management methods. This working paper, as a first step, attempts to examine the integrated risk management with traditional assets by regarding J-REIT as an alternative asset.

J-REIT is a Japanese version of REIT (Real Estate Investment Trust), and the market was opened in March 2001. REIT had become an important asset class in the United States and Australia at that time, as a financial instrument which enables real estate investment while maintaining liquidity. The market value of J-REIT has increased steadily since it opened, reaching about 17.7 trillion JPY at the end of July 2021, 20 years after its opening.

Ohashi, Kamita and Mori (2003) is one of the earlier preceding studies on J-REIT. They found that J-REIT was middle-risk, had low correlations with other assets, generated expected returns on a CAPM standard, and during its investment horizon, had specific periods to increase the linkage with equities or with bonds by analyzing J-REIT's risk-return from a variety of perspectives based on weekly data from the opening of the market to March 2003. After their study, numerous studies have been made to analyze J-REIT markets. Ishijima, Takano and Taniyama (2006) estimated risk premiums of J-REIT based on Regime Switching Model for asset pricing. Ito (2013) found that increase of stock prices caused a positive effect and increase of interest rates caused a negative one on J-REIT market by analyzing the impact of stock prices and interest rates on J-REIT market. Jin (2015) verified the prevailing view that "REIT is a financial product which is middle-risk and middle-return, in the middle between equities and bonds," by using monthly data from March 2003 to February 2015 and found that it was high-risk and high-return when measured in the whole period. Jin also showed that there was not much that can be explained by using market variables for equities, government bonds and real estate, because the returns of J-REIT indices fluctuated independently. Tsuji (2016) examined the historical trend of dynamic correlation coefficients between J-REIT indices and equities indices by using DCC-GARCH modelled in Engle (2002) and stated that both indices showed strong correlations as a whole, but the correlations declined during economic downturns.

In this way, studies on analysis of J-REIT market have been well accumulated, however, few academic studies are seen which have approached from the perspective of integrated risk management with traditional assets, the good characteristics of alternative assets, as stated by Ogishima, "(2) Diversification effects that obtained by combining them with traditional assets." One of those few studies is Ohashi's presentation material "Analysis of REIT Product Characteristics Using Financing Methods" attached as the reference materials of Ohashi, Kamita and Mori (2003) that presented the efficient frontier structured by the data of equities, bonds and J-REIT for only two years. Also, Kawaguchi (2004) described in detail necessity and challenges of classifying the alternative assets, particularly real estate and real estate securitization products as a new asset class. Furthermore, as the circumstance after entering Reiwa period, in "Chapter 3: Expanding

Alternative Asset Investment" under the supervision of Tokyo Marine Asset Management Co., Ltd. (2020), Hama introduced the opinion of a domestic pension fund that alternative assets had been managed within the framework of traditional assets, partly due to the small amount of allocation, but according to the increase of the allocation we started to manage it separately as an independent asset classes after the global financial crisis.

Accordingly, the purpose of this study is to discuss the necessity of managing alternative assets separately as an independent asset class when its allocation become greater in the future, by assuming J-REIT as an alternative asset, although presently GPIF manages alternative assets by classifying them into bonds or equities according to their risk-return profiles. This paper is structured as follows. In Section 2, we clarified the risk-return profiles of J-REIT, equities and bonds based on monthly data for about 20 years since the opening of J-REIT market. Section 3 presented the results of empirical analysis on the current approach to managing J-REIT within the framework of traditional assets such as equities and bonds. In Section 4 we discussed the necessity of managing J-REIT separately as an independent asset class when the allocation of J-REIT increased. In Section 5, we verified the efficient frontier consisting of J-REIT, equities and bonds. In the final Section, we summarized the study and raised future issues.

2. Risk-return profiles of J-REIT, equities and bonds

2.1 The settings of data and analysis

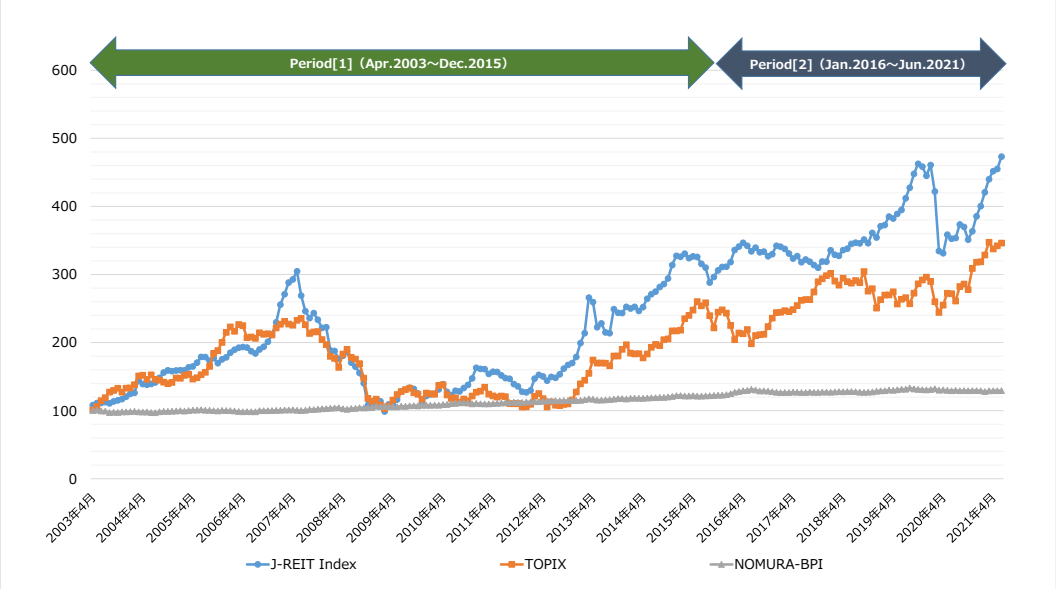
The data used in the empirical analyses are monthly data from April 2003 to June 2021 for the three indices of Tokyo Stock Exchange REIT Index (incl.dividends, hereafter referred to J-REIT Index), Tokyo Stock Price Index (incl.dividends, hereafter referred to TOPIX) and Nomura Bond Performance Index (hereafter referred to NOMURA-BPI).

As the settings of analysis, the data period is set into three terms: i) the entire period (April 2003 to June 2021), ii) the period [1] (April 2003 to December 2015), and iii) the period [2] (January 2016 to June 2021). The entire period covered almost 20 years from the opening of J-REIT market to present, the period [1] covered all the period in the preceding study of Jin (2015), and the period [2] covered the corresponding period of the BOJ's quantitative and qualitative monetary easing policy with a negative interest rate. The analysis has been made through the following steps: first, we examined how three indices moved over for each period, second, we calculated the rolling one-year volatility of each index and examined its change, and third, based on these analyses we understood the returns and volatilities of the three assets over each period.

2.2 The results of the analysis and its implications

Figure 1 shows the historical trends of the three indices, with setting the end of March 2003 as 100. In June 2021, J-REIT Index, TOPIX and NOMURA-BPI were around 470, 350 and 130, showing that the returns are high, middle and low, respectively.

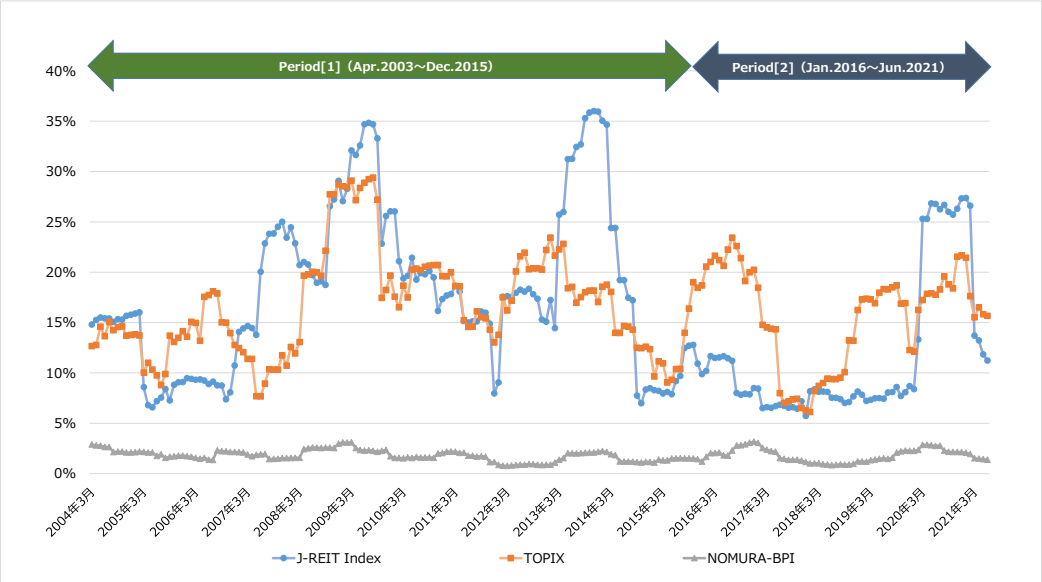
Figure 1: Monthly Cumulative Returns



(Source: Prepared by the authors from FactSet data)

Regarding risks, Figure 1 shows that NOMURA-BPI barely fluctuates and its risk is low, but it is difficult to find the magnitude of the risks associated with J-REIT Index and TOPIX. Figure 2 shows the volatilities of the indices, and in the period [1] the volatility of J-REIT Index is often extremely higher than that of TOPIX, which indicates the risk of J-REIT Index is generally higher than that of TOPIX. On the other hand, in the period [2] although the volatility of J-REIT Index is higher than that of TOPIX during the period after the COVID-19 shock in March 2020, in the period from 2016 up to the COVID-19 shock, the volatility of J-REIT Index is lower and more stable than that of TOPIX.

Figure 2: Volatility of monthly returns <Annualized>



(Source: Prepared by the authors from FactSet data)

In comparing the returns and volatilities in period [1], period [2] and the entire period in Table 1, the returns and volatilities of NOMURA-BPI are 0.9% to 1.7% per annum and 1.9% to 2.0% per annum, respectively, thus the both risk and return are low in all three periods. Comparing J-REIT Index and TOPIX, both return and volatility of J-REIT Index was about 1%-2% higher than those of TOPIX over the period [1] and the entire period, showing that both risk and return of J-REIT Index was slightly higher. This result is consistent with the preceding study by Jin (2015). It is interesting to note the results of the analysis for the period [2], which was not observed in any of the preceding studies. In this period, the volatility of J-REIT Index was around 2% lower than that of TOPIX, meanwhile the return of the J-REIT Index was around 1% higher than that of TOPIX, showing risk is slightly lower and return is higher. The risk-return profile of J-REIT Index is considerably more attractive in the period of the BOJ's QQE policy with a negative interest rate, if there are no contingencies such as COVID-19 shock, since the results of the period [2] analysis includes the impact of COVID-19.

Table 1 Risk-Return Characteristic Value

	Period [1] Apr 2003 to Dec 2015		Period [2] Jan 2016 to Jun 2021		Whole period Apr 2003 to Jun 2021	
	Returns	Volatilities	Returns	Volatilities	Returns	Volatilities
J-REIT Index	10.9%	20.0%	8.6%	13.8%	10.2%	18.3%
TOPIX	8.6%	18.0%	7.7%	15.7%	8.3%	17.3%
NOMURA- BPI	1.7%	1.9%	0.9%	2.0%	1.4%	1.9%

(Source: Prepared by the authors from FactSet data)

3. Approach of managing the risk of J-REIT within the flamework of the traditional asset

3.1 Method of analysis

To manage risk of J-REIT within the framework of traditional assets, the balances of J-REIT need to be allocated to equities (TOPIX) and bonds (NOMURA-BPI). The balances of J-REIT are allocated to equities or bonds depending on the risk-return profiles, if the risk-return profiles are close to those of equities it is allocated more to equities, on the other hand if these profiles are close to bonds then it is allocated more to bonds, with making the sum of the allocations equal to the original balance. This method to determine the amount of allocation is shown in pp.121 of Ang, Brandt and Denison (2014). (Constrained estimation equation that allocates one unit of J-REIT to β_E unit of equity and β_B unit of bond)

$$r_t^{JREIT} = \alpha + \beta^E r_t^E + \beta^B r_t^B + \varepsilon_t \quad (1)$$

$$\beta^E + \beta^B = 1,\ \beta^E \geq 0,\ \beta^B \geq 0 \quad (2)$$

Here, r_t^{JREIT}, r_t^E , $r_t^B and\ \varepsilon_t$, each represents the returns of J-REIT Index, TOPIX and NOMURA-BPI,

and the regression error at time t. α represents the extent to which J-REIT Index outperforms a portfolio of β_E units of TOPIX Index and β_B units of NOMURA-BPI. The parameters, α, β_E and $\beta_{B,}$ are estimated by minimizing the sum of squared errors in the data period under the constraint equation (2).

3.2 The settings of data and analysis

The data used in the empirical analyses are monthly data from April 2003 to June 2021 for Tokyo Stock Exchange REIT Index (incl.dividends), Tokyo Stock Price Index (incl.dividends), and Nomura Bond Performance Index (*). In the analysis of individual securities in J-REIT Index, considering that there is a sufficient data period and there is no bias in the sectors to which the securities belong to, 28 securities for which the data for the last 10 years from July 2011 to June 2021 are included.

The analysis has been made in the following manner: Firstly, we divided the data period into i) the entire period (April 2003 to June 2021), ii) the period [1] (April 2003 to December 2015) and iii) the period [2] (January 2016 to June 2021), and estimated the parameters by using the explanatory variables as TOPIX and NOMURA-BPI, and the explained variable as J-REIT Index in regression equation (1). Secondly, we examined whether J-REIT Index have more similar characteristics of equities or bonds in each period to be analyzed. In addition, the performance of J-REIT Index was compared to the portfolios consisting of β_E units of TOPIX and β_B units of NOMURA-BPI, by using the results of the first step, which includes the estimated parameter α, the weights of TOPIX β_E and the weights of the NOMURA-BPI β_B. Thirdly, through empirical analyses of individual securities in J-REIT Index, we estimated the parameters by using the explanatory variables as TOPIX and NOMURA-BPI (excluding ABS) and the explained variable as returns for individual securities in the regression equation (1).

3.3 The results of the analysis and its implications

The result with J-REIT Index being used as the explained variable is shown in Table 2. In the whole period, the ratio of the weight of TOPIX to the weight of NOMURA-BPI is approximately 6:4. In the period [1], the weight of TOPIX was 0.663 and the weight of NOMURA-BPI was 0.337, which shows that J-REIT Index had more similar characteristic to equities than bonds. Meanwhile in the period [2], the weight of TOPIX was 0.343 and the weight of NOMURA-BPI was 0.657, which showed the completely opposite results.

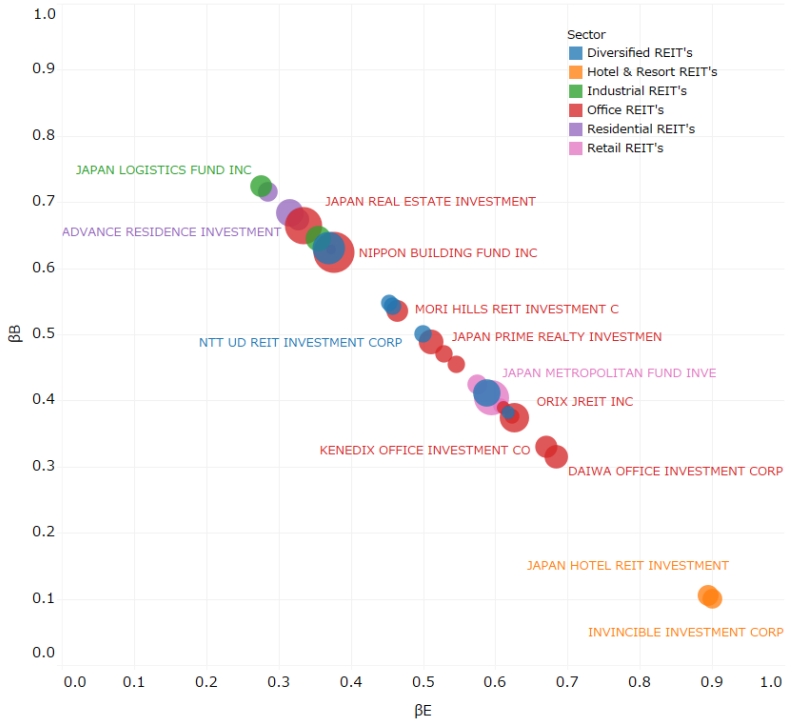
Table 2: Parameters by Analysis Period

Analysis Period		α	β^E	β^B
Period [1]	Apr 2003 to Dec 2015	0.004	0.663	0.337
Period [2]	Jan 2016 to Jun 2021	0.005	0.343	0.657
Whole period	Apr 2003 to Jun 2021	0.004	0.582	0.418

(Source: Prepared by the authors from FactSet data)

The empirical analysis of individual securities of J-REIT Index shown in Figure 3 also shows that the ratio of equity to bond varies widely depending on the securities, from 7:3 to 3:7, and the ratio for some securities in hotel industry is as much as 90% equity. In this way, the characteristics of J-REIT as equities or bonds varies widely depending on each period. Therefore, it is difficult to accurately evaluate the total risk by using the risk management method of allocating J-REIT between equities and bonds at a certain ratio when the percentage of J-REIT in a portfolio increases.

Figure 3 Results of the parameters for individual securities



(Source: Prepared by the authors from FactSet data)

(*)

Nomura Bond Performance Index (Nomura-BPI) is used for Domestic bond index data, as in the initial analyses, to acquire data from April 2003 when data for J-REIT Index began to be available, instead of using NOMURA-BPI (excluding ABS) which is GPIF's evaluation benchmark for domestic bond investment. NOMURA-BPI (excluding ABS) is used for individual securities since the analysis period is limited to the past 10 years.

4. Necessity of managing the risk of J-REIT independently

4.1 Issues in managing the risk of J-REIT within the framework of traditional assets

Variance-covariance matrix for the two assets of equities (TOPIX) and bonds (NOMURA-BPI) can be applied to measure the risk amount associated with J-REIT within the framework of traditional assets, after

the balance of J-REIT per unit is allocated to β_E units of equity and β_B units of bond. The amount of that allocation is estimated by the regression equation described in Section 3.1. The first practical problem is that the allocation tends to be the same through the investment horizon in many cases. However, as confirmed in Section 3.3, this allocation varies widely depending on the periods. The second practical problem is that the variance arising from the error term in the regression equation (1) is ignored. Specifically, the variance of the regression error term σ_ε^2 is ignored in equation (3), which is obtained by calculating the variance of both sides of the regression equation (1). The impact of this omission on the portfolio's estimated risk is examined in the following section.

$$Var\left(r_t^{JREIT}\right) = Var(\alpha + \beta^E r_t^E + \beta^B r_t^B + \varepsilon_t) = Var(\beta^E r_t^E + \beta^B r_t^B) + Var(\varepsilon_t)$$
$$= (\beta^E)^2(\sigma_E)^2 + 2\rho_{E,B}\beta^E\beta^B\sigma_E\sigma_B + (\beta^B)^2(\sigma_B)^2 + \sigma_\varepsilon^2 \quad (3)$$

Here $\sigma_E, \rho_{E,B,}\sigma_B$ and σ_ε^2, each represents the volatility of the equity, the correlation coefficient between the equity and the bond, the volatility of the bond and the variance of the regression error term, respectively.

4.2 The settings of analysis for the necessity of manage J-REIT as independent asset

A total of one unit of portfolio is analyzed with a non-negative weight consisting of J-REIT Index, TOPIX and NOMURA-BPI. The portfolio risk is measured in three ways, and defined as Risk I, Risk II and Risk III, respectively.

Risk I: The amount of risk in case that J-REIT is managed independently

This amount of risk is calculated by using a 3×3 variance-covariance matrix for a portfolio consisting of three assets. The percentages invested in J-REIT Index, TOPIX and NOMURA-BPI are shown as $w_R, w_{E,} and\ w_B$, respectively, then Risk I is calculated by the following equation:

$$\text{Risk I} = \sqrt{(w_R \quad w_E \quad w_B)\begin{pmatrix} \sigma_R^2 & \rho_{R,E}\sigma_R\sigma_E & \rho_{R,B}\sigma_R\sigma_B \\ \rho_{R,E}\sigma_R\sigma_E & \sigma_E^2 & \rho_{E,B}\sigma_E\sigma_B \\ \rho_{R,B}\sigma_R\sigma_B & \rho_{E,B}\sigma_E\sigma_B & \sigma_B^2 \end{pmatrix}\begin{pmatrix} w_R \\ w_E \\ w_B \end{pmatrix}}$$

$\sigma_R, \rho_{R,E}$ and $\rho_{R,B}$ are newly introduced notations and represent the volatility of J-REIT Index, the correlation coefficient between J-REIT Index and TOPIX, and the correlation coefficient between J-REIT Index and NOMURA-BPI, respectively.

Risk II: The amount of risk in case that J-REIT is managed within the framework of traditional assets

This amount of risk is calculated by allocating the percentage of investment in J-REIT Index w_R between TOPIX $\beta^E w_R$ and NOMURA-BPI $\beta^B w_R$, and then using a 2×2 variance-covariance matrix for the risk of the portfolio consisting of equities and bonds.

$$\text{Risk II} = \sqrt{(w_E + \beta^E w_R \quad w_B + \beta^B w_R) \begin{pmatrix} \sigma_E^2 & \rho_{E,B}\sigma_E\sigma_B \\ \rho_{E,B}\sigma_E\sigma_B & \sigma_B^2 \end{pmatrix} \begin{pmatrix} w_E + \beta^E w_R \\ w_B + \beta^B w_R \end{pmatrix}}$$

Risk III: The amount of risk calculated using the same equation to measure the risk as in the Risk II, while keeping the parameter β_E, β_B the same as it was determined initially

Here it needs to be pointed out that the variance from the error term in the regression equation (1) described in Section 4.1 is equal to the Risk I calculated by substituting $(w_R \quad w_E \quad w_B) = (1 \quad -\beta^E \quad -\beta^B)$.

In the next section, the analysis has been made in the following manner: Firstly, we measured the magnitude of the variance arising from the error term in the regression equation (1). Secondly, when calculating the risk of J-REIT within the framework of traditional assets, we measured the risk measurement error arising from omitting the variance of the error term (hereafter referred to as risk measurement error I), by calculating Risk I minus Risk II, and also measured the risk measurement error arising from not only omitting the variance of the error term but also from using the parameter $\beta_{E,}\beta_B$ as originally calculated and unchanging this parameter (hereafter referred to as risk measurement error II), by calculating Risk I minus Risk III.

4.3 The results of the analysis and its implications

Table1 shows volatilities of returns of J-REIT Index, TOPIX and NOMURA-BPI over period [1] and [2], and Table 3 shows the correlation matrices in addition to the volatilities of returns in Table 1. Table 3 shows that in period [1], the correlation coefficient between J-REIT Index and TOPIX was 0.61, but in period [2] it declined to 0.39. On the other hand, in period [1], the correlation coefficient between J-REIT Index and NOMURA-BPI was 0.07 but rose to 0.22 in period [2]. In Section 3.3, from the viewpoint of the regression coefficient β^E *and* β^B of regression equation (1), we found that J-REIT Index had stronger characteristics as equities in the period [1] and showed stronger characteristics as bonds in the period [2]. We also found that the similar change in characteristics from equities to bonds from the viewpoint of the correlation coefficient that eliminates the impact of volatility.

The variance-covariance matrix in Risk I, Risk II can be applied by using the parameters in Table 3. When the weights are set as $(w_R \quad w_E \quad w_B) = (1 \quad -\beta^E \quad -\beta^B)$ to calculate Risk I, it matched the variance resulting from the error term in the regression equation (1) and was 0.156 and 0.123 for the period [1] and [2], respectively. This indicates that the risk of one unit of J-REIT in long position, and β^E unit of TOPIX and β^B unit of NOMURA-BPI in short potion is 15.6% and 12.3% on an annualized basis. The analysis here, the percentage invested in J-REIT Index is set in 1% increments ranging from 1% to 30%, and the remainder is equally allocated to TOPIX and the NOMURA-BPI. Figures 4 and 5 show the risk measurement error I (= Risk I-Risk II) in period [1] and [2], respectively. Figures 4 and 5 take the percentage of J-REIT Index in the portfolio on the horizontal axis, and the magnitude of the risk measurement error I on the vertical axis. It indicated that the magnitude of the risk measurement error I relative to J-REIT Index weight is not as large as the error calculated from the standard deviation of the error term in the regression

equation (1), and is almost the same in the period [1] and [2]. When the percentage of investment in J-REIT is 5%, the effects of the error term in the regression equation (1) in the period [1] and [2] are simply calculated as follows: 15.6% × 0.05 = 0.78%, 12.3% × 0.05 = 0.615%, respectively. However, the actual risk measurement error I was considerably smaller than the effects of the simple error term, which was around 0.1%, as shown in Figures 4 and 5. This was due to the reduction of the impact of the error term in equation (1) through the diversification effect between the investment ratio of the 5% of J-REIT which has difference in the risk measurement, $0.05 \times (w_R \quad w_E \quad w_B) = (0.05 \quad -0.05\beta^E \quad -0.05\beta^B)$, and the investment ratio of the remaining 95 % which is equally allocated to TOPIX and NOMURA-BPI, $(w_R \quad w_E \quad w_B) = (0 \quad 0.475 \quad 0.475)$. As stated above, the standard deviation of the regression error term in period [1] and period [2], and the volatility of each asset and the correlation coefficient between assets are interrelated, and the risk measurement error I in period [1] and period [2] turned out to be almost the same.

Figure 4: Risk Measurement Error I in Period [1]

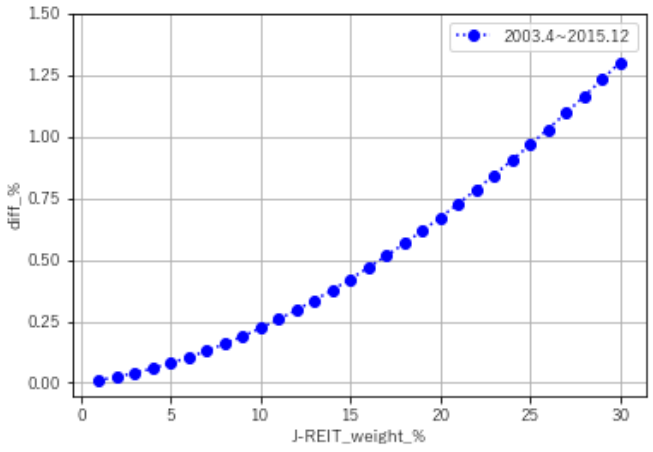
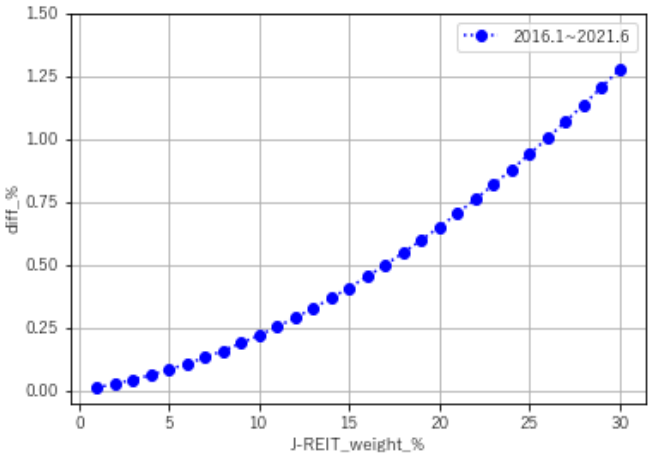


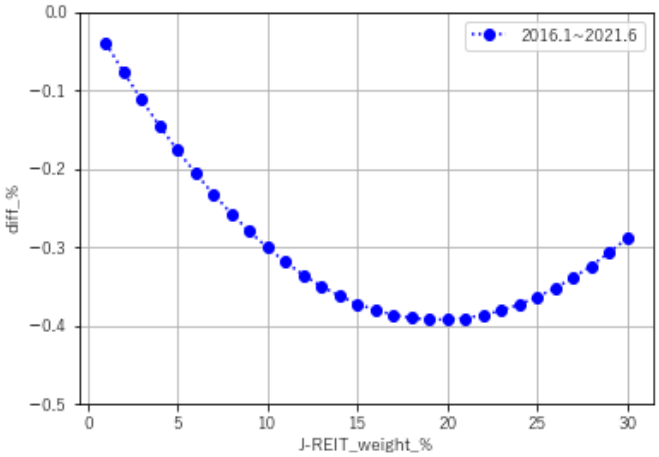
Figure 5: Risk Measurement Error I in Period [2]



(Source: All figures are compiled by the authors from FactSet data.)

Figure 6 shows that the risk measurement error II in period [2] is negative in the range of 1% to 30% of the investment ratio of J-REIT on the horizontal axis, which indicates that the amount of risk of portfolios including J-REIT measured within the framework of traditional assets resulted in a larger estimate of the amount of risk than measuring the risk regarding J-REIT as an independent asset. As mentioned in Section 3.3, the weights of TOPIX and NOMURA-BPI were completely inverse in period [1] and [2], so this would cause a large impact and lead to the miscalculation of the risk in the opposite direction in case the same weights have been used.

Figure 6: Risk Measurement Error II in Period [2]



(Source: Prepared by the authors from FactSet data)

Here focusing on the measurement of risk in GPIF. In Chapter 1, it was noted that the total value of GPIF's alternative assets is 0.70% of the total pension reserve as of the end of March 2021, and GPIF is allowed to invest up to 5% of its total assets under management in alternative assets. If J-REIT is considered as an alternative asset, the impact to the portfolio is nominal as the minimum percentage of investment in J-REIT is 1% and this is considered as a substitute for the 0.70% at the end of March 2021, shown in Figures 4 and 5. However, considering the maximum percentage of alternative assets of 5%, the risk measurement error I for both period [1] and period [2] would be around 0.1%, and the amount would be 100 billion JPY, which is calculated by 100 trillion JPY (assuming the amount of domestic assets) x 0.1%. This is the reason why we stated " Given the increasing value of the alternative assets, we are at the stage of evaluating the way to manage the risk." in Chapter 1.

Table 3: Risk-Return Characteristics

	Period [1] Apr 2003 to Dec 2015		Period [2] Jan 2016 to Jun 2021		Whole period Apr 2003 to Jun 2021	
	Returns	Volatilities	Returns	Volatilities	Returns	Volatilities
J-REIT Index	10.9%	20.0%	8.6%	13.8%	10.2%	18.3%
TOPIX	8.6%	18.0%	7.7%	15.7%	8.3%	17.3%
NOMURA- BPI	1.7%	1.9%	0.9%	2.0%	1.4%	1.9%

Period [1] Apr 2003 to Dec 2015

	J-REIT Index	TOPIX	NOMURA- BPI
J-REIT Index	1.00	0.61	0.07
TOPIX	0.61	1.00	-0.31
NOMURA- BPI	0.07	-0.31	1.00

Period [2] Jan 2016 to Jun 2021

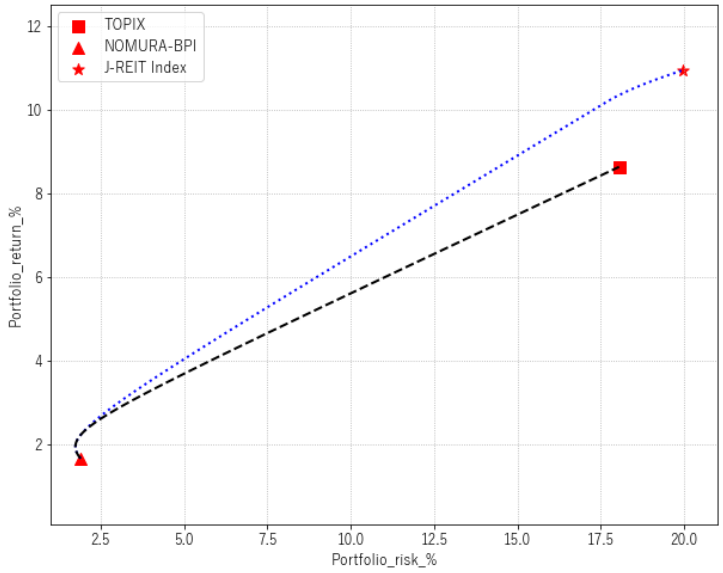
	J-REIT Index	TOPIX	NOMURA- BPI
J-REIT Index	1.00	0.39	0.22
TOPIX	0.39	1.00	-0.45
NOMURA- BPI	0.22	-0.45	1.00

(Source: Prepared by the authors from FactSet data)

5. Efficient frontier portfolios consisted of J-REIT, equities and bonds

This Chapter examines the efficient frontier of portfolios consisted of J-REIT, equities and bonds, for which preceding studies are scarce. Figure 7 shows the efficient frontier for only two assets, TOPIX and NOMURA-BPI for the period [1] shown in Table 3, based on the returns of J-REIT Index, TOPIX and NOMURA-BPI, the volatility and the correlation matrix, and the efficient frontier when three assets are available including J-REIT, with the portfolio's risk on the horizontal axis and the portfolio's return on the vertical axis. In addition to the two efficient frontiers shown in Figure 7 in period [2], Figure 8 also shows the efficient frontier when four sub-sector indices of J-REIT Index can be invested as well as the three assets mentioned earlier. Figure 7 reconfirms that J-REIT has higher risk and higher return than TOPIX in period [1]. Furthermore, it shows that the portfolio including three types of assets is superior in terms of risk-return since the efficient frontier of three assets lies on the upper left-hand side, compared to the portfolio of only two assets, TOPIX and NOMURA-BPI. In particular, focusing on the risk amount of 10% since the risk (standard deviation) of GPIF's basic portfolio is 12.32% according to p.36 of FY2020 Annual Report, the optimized return of the portfolio including only two types of assets of TOPIX and NOMURA-BPI is 5.7%, while the optimized return of the portfolio including three type of assets with J-REIT Index added is 6.5%, approximately 80BP higher than the portfolio of two types of assets.

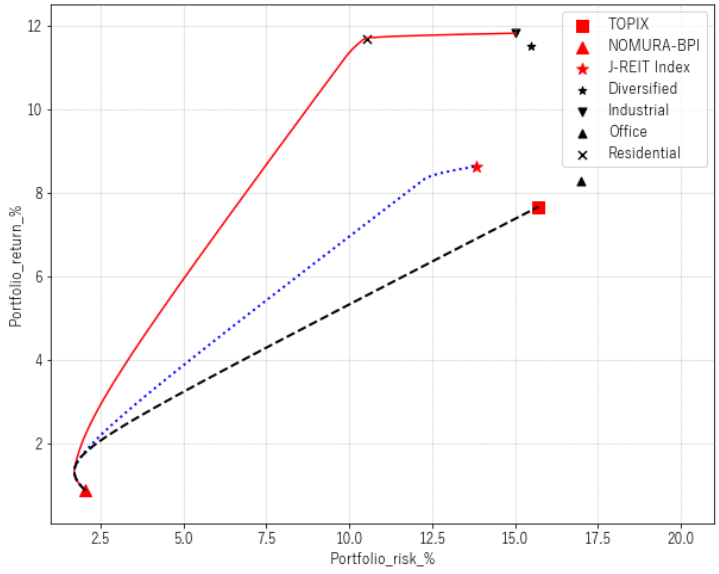
Figure 7: Effective Frontier (Period [1]: Apr 2003 to Dec 2015)



(Source: Prepared by the authors from FactSet data)

Furthermore Figure 8 shows that J-REIT has lower-risk and higher-return than TOPIX in period [2]. Therefore, in period [2], the move of the efficient frontier to the upper left is larger by adding J-REIT to the two assets of TOPIX and the NOMURA-BPI than in period [1]. Focusing on the risk amount of 10% similarly to period [1], the optimized return of the portfolio including only two types of assets of TOPIX and NOMURA-BPI is 5.4%, whereas the optimized return of the portfolio including three types of assets with J-REIT Index added is 7.0%, and the portfolio's return is improved as much as approximately 160BP. In addition, the appropriate selection of funds within J-REIT Index that invest in high-performance sectors will raise the optimized return to 11.5 %, an approximate 450BP improvement in portfolio returns. Thus, the risk-return efficiency of the portfolio could increase to a considerable degree by adding J-REIT to the portfolio.

Figure 8: Effective Frontier (Period [2]: Jan 2016 to Jun 2021)



(Source: Prepared by the authors from FactSet data)

6. Summary and future challenges

This study firstly analyzed the risk-return profiles of J-REIT, equities and bonds based on monthly data for about 20 years since the opening of J-REIT market and found that J-REIT has characteristics of high-risk and high-return, or low-risk and high-return compared to equities. Secondly, the risk measurement error would arise when J-REIT is allocated between equities and bonds at a certain fixed ratio since the degree of equity and bond characteristics inherent in J-REIT varies significantly depending on the period. Thirdly, the risk measurement error will be too large to be overlooked when the percentage of J-REIT in the portfolio increases. Finally, if the efficient frontier is figured with accurately measured risk level, the efficient frontier with J-REIT added to the portfolio will move to the upper left, showing that the portfolio's performance improves in terms of risk-return profiles.

As the risk-return profile of traditional assets moves toward low-risk and low-return in the long-term trend, J-REIT's returns are attractive as mentioned earlier, and alternative assets that has less liquidity than J-REIT are expected to have even higher returns. On the other hand, it is difficult to measure the risk of alternative assets compared to traditional assets, and it takes longer time to realize the return on alternative assets than traditional assets. Moreover, when investing in alternative assets, it is necessary to thoroughly examine whether it is desirable compared to the risk-return profile of traditional assets and how risk-return profiles improve when the portfolio is structured in combination with traditional assets and alternative assets. As the first step, this working paper elucidated the necessity of managing the J-REIT separately as an independent asset class, considering J-REIT as an alternative asset. The future challenges are to establish more sophisticated and advanced risk-management methods for private REIT which have relatively high frequency of price updates among alternative assets, and for private equity, infrastructure, real estate, and other funds that have less liquidity.

References

Ang, A., Brandt, M and D. Denison (2014)"Review of the Active Management of the Norwegian Government Pension Fund Global," Commissioned by the Norwegian Ministry of Finance. pp.1-161.

Engle, R. (2002) "Dynamic Conditional Correlation: A Simple Class of Multivariate

Generalized Autoregressive Conditional Heteroskedasticity Models", Journal of Business and Economic Statistics 20: pp.339-350.

Hiroshi Ishijima, Eriko Takano, Tomohiko Taniyama (2006), "Estimating Risk Premiums for J-REIT Based on a Regime-Switching Asset Pricing Model," JAREFE journal (The Japanese Association of Real Estate Financial Engineering (JAREFE)) 2006, Development of Real Estate Financial Engineering," pp. 85-115, Toyo Keizai Inc. *(published in Japanese)*

Takayoshi Ito (2013), "Empirical Analysis of Japanese REIT Markets-Examination of the Impact of Stock Prices and Interest Rates and Its International-Linkage," Trust Research Incentive Fee Theory No.34, Vol.11,

pp.144-162. *(published in Japanese)*

Kazuhiko Ohashi, Junko Kamita, and Seiji Mori (2003), "Risk-Return Analysis of J-REIT: Analysis Based on Weekly Data from the Opening of the Market to March 2003,"Policy Research for land, infrastructure, transport and tourism" Land, Infrastructure, Transport and Tourism Policy Research," No. 27. *(published in Japanese)*

Yuichiro Kawaguchi (2004), "Current Status and Challenges of Real Estate Investment: From Alternative Assets to New Basic Assets," "Security Analyst Journal," 2004. 11, pp.6-19. (published in Japanese)

Jingzhi Jin (2015), " Empirical analysis on the performance of J-REIT: perspective of comparison among stock market, bond market and real estate market," " The Doshisha University Academic Repository " *(published in Japanese)*

Doshisha University's website (http://doi.org/10.14988/pa.2017.0000014278)).

Takashi Tsuji (2016) " Dynamic Correlation Analysis of Japanese Real Estate Investment Trusts Market," Aichi University Economic Review No. 201, pp. 29-46. *(published in Japanese)*

Supervised by Tokyo Marine Asset Management Co., Ltd., Kenichi Hirayama (2020) "Implementation of Alternative Investment," Chuokeizai-sha holdings, inc., *(published in Japanese)*

Edition by the Securities Analysts Association of Japan/Supervised by Yukihiro Asano and Shigeki Sakakibara/Keisuke Ito, Seiji Ogishima and Takashi Suwabe (2020), "New - Securities Investment Theory II: Practical Edition," Nikkei Business Publications, Inc. *(published in Japanese)*

Government Pension Investment Fund (GPIF) (2019,2020) "Annual Report" *(published in Japanese)*

Mitsubishi UFJ Trust and Banking, Corporation Trust and Banking Dept. (2013) "J-REIT Return Characteristics" website of Mitsubishi UFJ Trust and Banking Corporation (http://www.tr.mufg.jp/houjin/jutaku/pdf/u201301_1.pdf)) *(published in Japanese)*