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Dynamics of Diversification Benefits of Real Estate within a Minimum-Variance Portfolio: the Case of Japan

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This research evaluates dynamics of diversification benefits of real estate within a minimum-variance portfolio, assuming different holding periods: 3 years and 7 years. Real estate showed constant risk diversification benefits through all the holding periods, and the variability in allocation ratio tends to be smoothed as the portfolio is held longer.
[Key Words] Real Estate Finance, Moving Window Minimum Variance Portfolio Model Multi-Asset Portfolio

1. Introduction

Modern Portfolio Theory (MPT) has significantly progressed thanks to Markowiz's great contribution. A number of literature focuses on analyzing diversification benefits of combining different asset classes in a portfolio, looking at relationship of one asset class with another asset class. This sort of research is also done to real estate as an asset class for its diversification benefits; especially a lot is done in other countries but not many in Japan. As understanding relationship of real estate with other asset classes is important for portfolio managers and investors to manage their multi-asset portfolio that includes real estate, this research thus discusses about the diversification benefits of Japanese real estate allocation in a context of MPT.

1.1 Literature Review

Early research in US revealed a fundamental role of real estate investment within a multi-asset portfolio. Ibbotson & Siege, (1984) reported that from 1960 to 1982 real estate did not have much correlation against equities and government bonds while it was well-correlated with inflation, suggesting that real estate was a good diversifier against those asset classes except for treasury bills, also was a good inflation hedger. The research indicates usefulness of real estate addition to a multi-asset portfolio.

Lee (2003) tested timing of real estate diversification benefits when it improved performance of a multi-asset portfolio, with UK data ranging from 1977 to 2002. It was reported that in almost 70% of occasions, real estate lowered portfolio returns but it did also improve the performance in downside.

Lee & Stevenson (2006) focused on consistency of real estate allocation within optimal portfolio over periods from 1977 to 2002 in U.K.. They pointed that, assuming holding periods of 5 to 25 years; real estate was consistently included within optimal portfolio. There was discovered a tendency that as longer period real estate was held the more improved the impact of real estate was on the portfolio. Real estate switched its role as a risk diversifier and as a return enhancer within optimal portfolio under different periods. Real estate played a role as a risk diversifier rather than as a return enhancer. The research suggests

that inclusion of real estate is strategically beneficial to multi-asset portfolio in a long term.

Furthermore, it was reported that diversification benefits of real estate inclusion within multi-asset portfolio depends on existing asset allocations of the portfolio (Lee, 2005). Based on an idea that actual portfolios in the actual market do not necessarily have efficient structure, Lee analyzed the impact of real estate on inefficient multi-asset portfolios with U.S. data of large cap equities, mid cap equities, small cap equities, long term government bonds, long term corporate bonds and real estate from 1952 to 2003. The results were, that in most cases diversification benefits of real estate was was not particularly remarkable, and that the level of the impact varied depending on existing portfolio structures.

Real Estate Investment Trusts (REITs) are recognized as listed real estate, and relationship between REITs and real estate also has long been focused. Giliberto (1990) reported a pure real estate factor between real estate and REITs, and Clascock *et al* (2000), Clayton & MacKinnon (2001) also analyze dynamics of relationships between multi-assets including real estate and REITs.

The empirical evidences obtained from the above researches are important for anyone who operates and manages multi-asset portfolios with real estate inclusion; however, it is also true that the knowledge is all based on data outside Japan and not many of these real estate investment-focused researches have been done in Japanese academia. The most likely reason for this research absence is, firstly evaluation of multi-assets with an idea of "total returns" is still not common in Japan, and secondly a real estate investment index in Japan did not have sufficient dataset to conduct this sort of research.

This paper discusses the impact of real estate inclusion on a multi-asset portfolio as the case of Japan.

2. Methodology and Data

2.1 Methodology: Moving Minimum Variance Portfolio Model

This paper focuses on dynamic diversification benefits of real estate inclusion within a minimum-variance portfolio, by observing time-varying differences in asset allocations and risk return characteristics before and after the real estate inclusion. The methodology is as follows: we suppose that there are total return data of several asset classes from time 1 to time t. We first estimate a mean variance portfolio from 1 to t with the model below (t<T). Here we prepare a hundred of return figures ranging from maximum returns to minimum returns ($E(R_{Port})$), and solve a quadratic programming to achieve the sliced hundred returns. By doing this, we draw a portfolio diagram and find out a minimum variance portfolio.

$$\sigma_{Port}^2 = \sum_{i=1}^{N} w_i^2 \sigma_i^2 + 2 \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} w_i w_j \sigma_{ij} \rightarrow \min_{w}$$

$$s.t.\ E(R_{Port}) = \sum_{i=1}^{N} w_i E(R_i)\,, 0 \leq w_i, \sum_{i=1}^{N} w_i = 1$$

w_i : weights of asset i, σ_i^2 : variance of asset i, σ_{ij} : covariance between asset i and asset j, N : the number of assets, $E(R_i)$: expected return of asset i, $E(R_{Port})$: expected return of a portfolio

Secondly, we do the same analysis for a period of τ from n to n+1 ($n = 2,3,4 \cdots$). Thirdly, regarding the period τ as a period window, we move the analysis window one month by one month with the mean-variance model, in order to see difference in results of minimum variance portfolios with and without real estate. Fourthly, n represents one month in the following analysis and assumes several period windows of τ. In this paper, this method will be called as the window-moving minimum variance portfolio model.

Government bonds tend to be regarded as risk-free assets; however, the bonds have liquidity and are traded in actual markets, thus there are risks of price variability. Hence this paper treats government bonds as risk assets and includes in the analysis.

There have been set two period windows in this research: three-year as a short-term, a seven-year as a mid-term. Each analysis first constructs multi-asset portfolio without real estate, and adds real estate in it so that an impact of the inclusion can be visualized. Given that the low liquidity of real estate, we assume no short selling. Therefore, weights of quadratic programming always lie between 0 to 1.

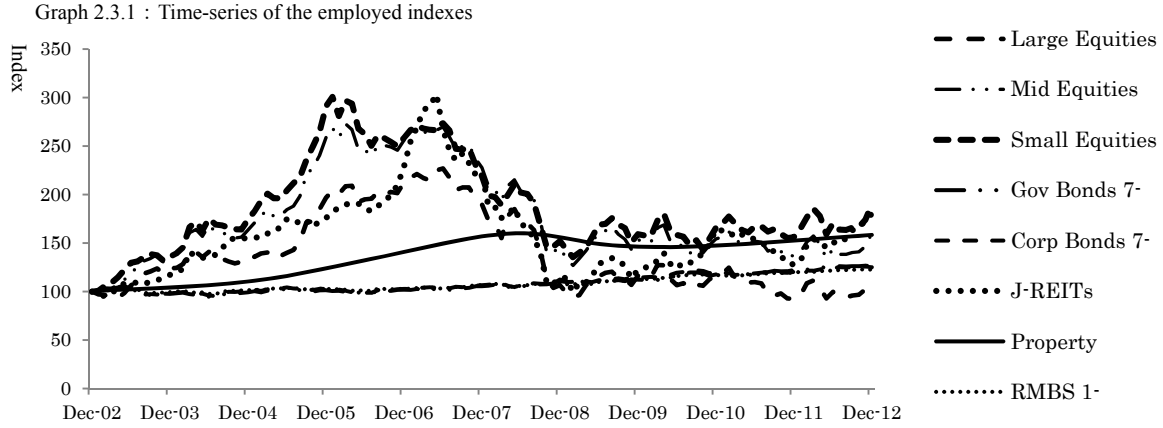
2.2 Implications and Limitations of the methodology

The aim of this research is to seek a way to construct a multi-asset portfolio with real estate inclusion, in other words, to evaluate value of real estate investment. An idealistic approach for this aim may be to construct a forward-looking model that captures future expectation of investors based on historical return time-series; however, this paper adopted rather a backward-looking approach as a first step for developing the forward-looking model. By doing so, we can clarify the difference in results between backward-looking perspective and forward-looking perspective in future research. The construction of the forward-looking model will not be addressed in this paper and should be assessed in future research.

2.3 Research Data

Equities, Bonds and Real Estate are employed in this research. Equities indexes are divided into three by size: Tosho Ichibu Large (large equities), Tosho Ichibu Medium (mid equities) and Tosho Ichibu Small (small equities). For bonds two Daiwa Bond Indexes are employed: one is Government Bond (7 years -) and the other is Corporate Bonds (7 years -). For real estate, IPD Property Index is adopted. This research also includes two additional real estate-related assets so that characteristics of real estate can be more captured. The first asset is Japan Real Estate Investment Trusts (J-REITs) as a listed real estate vehicle. A number of literatures such as Clascock *et al* (2000), Clayton & MacKinnon (2001) include REITs in comparison analysis with other asset classes as well as with real estate. The other asset is Residential Mortgage Backed Securities (RMBS, 1 year-) as a real estate-related bond asset class. For the former SMTRI J-REIT Sogo Index, for the later Daiwa Bond Index RMBS are employed. Note that this research does not consider impacts of specific approaches that individual investors take such as debts.

Graph 2.3.1 : Time-series of the employed indexes



The indexes employed in this analysis represent total returns, i.e. a combination of income return and capital growth. The observation periods are from December 2002 to December 2012, on a monthly basis[2]. 1st difference of log is utilized as a monthly return.

$$\mathrm{dlog}\, x_i = \ln x_i - \ln x_{i-1} \fallingdotseq (x_i - x_{i-1})\,/x_{i-1}$$

dlog x_i: return of asset x for period i

The real estate investment index also represents total returns. A total return of real estate is also a combination of income return and capital growth. An income return of real estate is based on net operating income generated mainly from tenants, and a real estate capital growth comes from a movement of capital employed. Real estate returns can be expressed by the following formula (refer to IPD, 2012 for details):

$$\mathrm{TR}_t = \mathrm{IR}_t + \mathrm{CR}_t$$

TR(Total Return): total return of period t, IR(Income Return): income return of period t, CR(Capital Return): capital return of period t (capital growth)

$$\mathrm{IR}_t = \frac{NI_t}{CV_{t-1}+Cexp_t}$$

NI_t: net income of period t, CV_{t-1}: capital value of period t-1, $Cexp_t$: capital expenditure of period t

$$\mathrm{CR}_t = \frac{CV_t - CV_{t-1} - Cexp_t + Crec_t}{CV_{t-1}+Cexp_t}$$

CV_t: capital value of period t, $Crec_t$: capital receipt of period t

Hence a real estate total return can be expressedas below:

$$\mathrm{TR}_t = \frac{CV_t - CV_{t-1} - Cexp_t + Crec_t + NI_t}{CV_{t-1} + Cexp_t}$$

The real estate index is based on appraisals. While usefullness of the appraised-based index is widely recognized, there are also smoothing and time lag issue that are know not to promptly capture market volatility.

Clayton *et al* (2001) reported that U.S. valuations lag three quarters with the fact that appraisers tended to anchor their previous valuations. Shimizu & Nishimura (2006) also found a smoothing effect from 1975 to 1999 in Chika Kohji (地価公示), Japanese land appraisals published by Ministry of Land. There are several reasons for the matter, but McAllister *et al* (2003) revealed a tendency of appraisers that they behaved less actively until market evidence was received. The impact of the smoothing issue is small at individual asset level, but becomes significant at aggregate level for the purpose of index construction (Brown & Matysiak, 2000).

In fact, Suzuki & Takatsuji (2013) pointed out that a real estate index, which also is employed in this research, had stronger autocorrelation in its

stochastic process, compared to other asset classes.

As discussed above, appraisal-based indexes have intrinsic issues, and particularly the smoothing effect is known to exaggerate real estate allocation within a multi-asset portfolio, suggesting it needs extra care when interpreting the obtained results.

There are also several desmoothing ways to tackle the issue; however it is also true that discussion for the desmoothing techniques are still under discussion (Key & Marcato, 2007, Bond *et al*, 2012). Therefore, this paper decides not to apply any desmoothing techniques, while focusing on reviewing fundamentals of diversification benefits that real estate has for future research.

3. Results

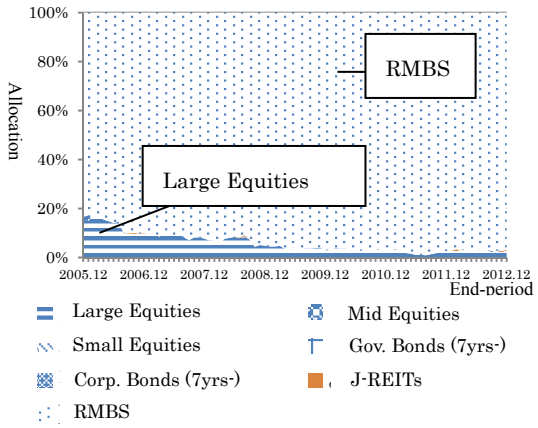
3.1 Shot-term investment of 3 years

First of all, let us assume 3-year holding to see a short-term dynamics of asset allocation.

Excluding real estate, a portfolio with 3-year showed high allocation of average 94.03% to bonds over time. While government bonds tend to be regarded as a risk free asset, they were not included in the minimum variance portfolio. RMBS significantly accounted for the portfolio since the volatility of the asset was smaller than the other assets.

An average return of the portfolio was 0.09% and standard deviation was 0.29% on average. Next, with the inclusion of real estate into the portfolio, the average allocation of RMBS decreased down 23.60%, instead, real estate was included with an average allocation of 75.14%. While large equities had 17.03% allocation at maximum, it became 2.19% with the real estate inclusion. The average volatility of the portfolio was pushed down to 0.13%, despite the average return that rose to 0.17%. A level of the real estate allocation had a standard deviation of 13.83%.

Graph 3.1.1 : Portfolio Allocation Time-series (3yrs, exclusive of real estate)



Graph 3.1.2 : Portfolio Allocation Time-series (3yrs, inclusive of real estate)

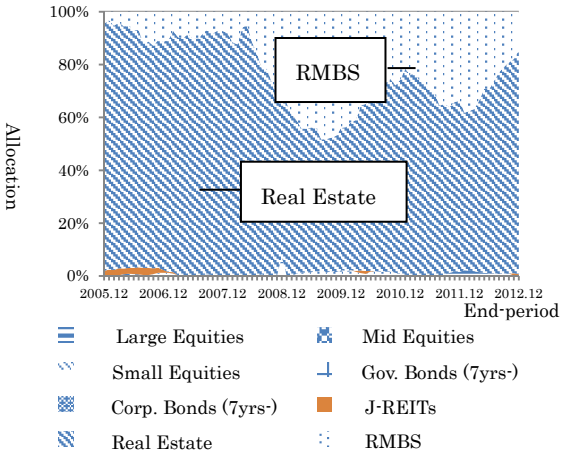


Table 3.1.3 : Portfolio Allocations (3yrs, exclusive of Real Estate)

	Ave.	Std.dev.	Min.	Max.
Large Equities	5.86%	4.10%	0.90%	17.03%
Mid Equities	0.04%	0.27%	0.00%	2.19%
Small equities	0.04%	0.13%	0.00%	0.68%
Gov. bonds(7-)	0.00%	0.00%	0.00%	0.00%
Corp. bonds(7-)	0.00%	0.00%	0.00%	0.00%
J-REITs	0.04%	0.12%	0.00%	0.69%
RMBS(1-)	94.03%	4.20%	82.75%	99.10%

Table 3.1.4: Risk Return Profile of Portfolios (3yrs, exclusive of real estate)

	Ave.	Min.	Max.
Return	0.09%	0.02%	0.18%
Risk (Std.Dev.)	0.29%	0.16%	0.38%

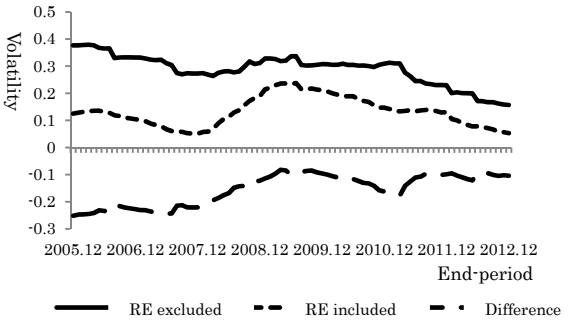
Table3.1.5: Portfolio Allocations (3yrs, inclusive of Real Estate)

	Ave.	Std.dev.	Min.	Max.
Large Equities	0.25%	0.52%	0.00%	2.19%
Mid Equities	0.04%	0.17%	0.00%	0.93%
Small equities	0.47%	0.65%	0.00%	2.14%
Gov. bonds (7-)	0.09%	0.78%	0.00%	7.24%
Corp. bonds (7-)	0.01%	0.06%	0.00%	0.50%
J-REITs	0.40%	0.82%	0.00%	2.73%
Real Estate	75.14%	13.83%	49.67%	95.00%
RMBS(1-)	23.60%	13.73%	3.22%	48.31%

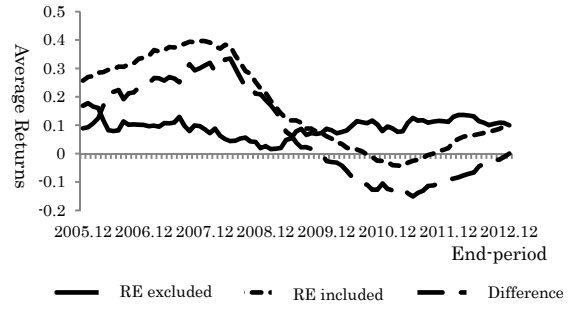
Table 3.1.6: Risk Return Profile of Portfolios (3yrs, inclusive of real estate)

	Ave.	Min.	Max.
Return	0.17%	-0.04%	0.40%
Risk (Std.Dev.)	0.13%	0.05%	0.24%

Graph3.1.7：Difference in Volatility with Real Estate Inclusion



Graph3.1.8：Difference in Returns with Real Estate Inclusion



However, it is also worth looking at time-varying changes. It is clear that, since January 2009, an average return of portfolio with real estate inclusion is lower than it of portfolio exclusive of real estate. Since the data includes a period after 2007 when the financial crisis took place, this can be interpreted as an impact of the crisis. In other words, real estate has been included within a minimum variance portfolio even after the financial crisis, although the average return has been pushed down.

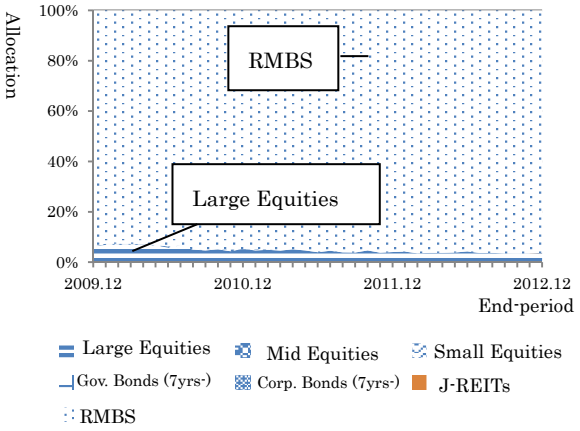
3.2 Mid-term investment of 7 years

The above 3-year investment period may not be representative of cyclicality of real estate that tends to be longer than of other assets. To take the cyclicality into account, let us assume a longer 7-year investment period.

Assuming a 7-year term portfolio with no real estate inclusion, RMBS also showed considerably high allocation of average 91.18% over the periods. This asset allocation ratio deviated with 1.25% variability, suggesting that the asset class was consistently included in the portfolio. The other assets were not much included.

Next, with real estate inclusion, the allocation of RMBS decreased from an average of 95.18% and maximum of 96.63%, down 40.70% and 47.46% respectively. The volatility of the minimum-variance portfolio became 0.19% from 0.30% on average, improving the return volatility over the observation periods. Also average return of 0.07% was pushed up to 0.13%.
Also, average real estate allocation was estimated 58.25%, but variability of the allocation was small at 5.74%, suggesting real estate was stably included in the minimum-variance portfolio. Government bonds again were not included in the portfolio.

Graph 3.2.1 : Portfolio Allocation Time-series (7yrs, exclusive of real estate)



Graph 3.2.2 : Portfolio Allocation Time-series (7yrs, inclusive of real estate)

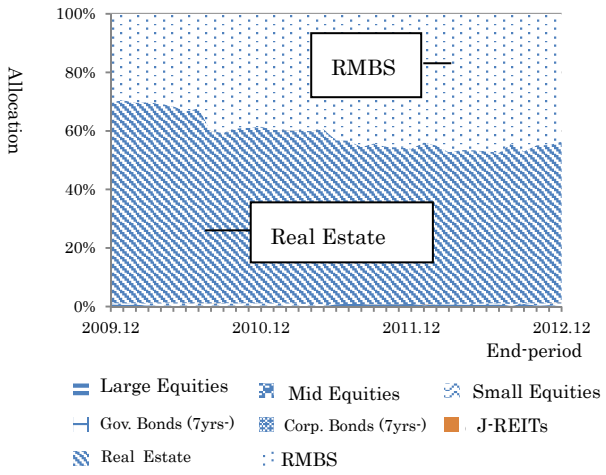


Table 3.2.3 : Portfolio Allocations (7yrs, exclusive of Real Estate)

	Ave.	Std.dev.	Min.	Max.
Large Equities	4.73%	1.17%	3.37%	7.10%
Mid Equities	0.05%	0.13%	0.00%	0.49%
Small equities	0.04%	0.14%	0.00%	0.72%
Gov. bonds(7-)	0.00%	0.00%	0.00%	0.00%
Corp. bonds(7-)	0.00%	0.00%	0.00%	0.00%
J-REITs	0.00%	0.00%	0.00%	0.00%
RMBS(1-)	95.18 %	1.25%	92.66 %	96.63 %

Table 3.2.4 : Risk Return Profile of Portfolios (7yrs, exclusive of real estate)

	Ave.	Min.	Max.
Return	0.07%	0.05%	0.09%
Risk (Std.Dev.)	0.30%	0.26%	0.37%

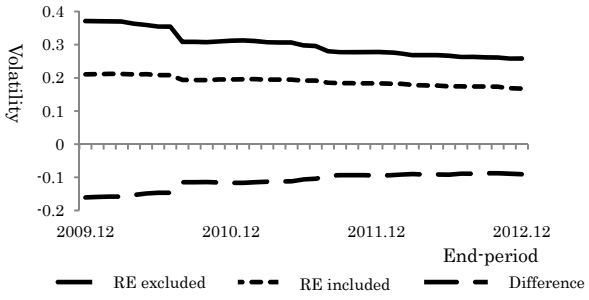
Table 3.2.5 : Portfolio Allocations (7yrs, inclusive of Real Estate)

	Ave.	Std.dev.	Min.	Max.
Large Equities	0.43%	0.33%	0.00%	0.95%
Mid Equities	0.00%	0.00%	0.00%	0.00%
Small equities	0.62%	0.45%	0.00%	1.30%
Gov. bonds(7-)	0.00%	0.00%	0.00%	0.00%
Corp. bonds(7-)	0.00%	0.00%	0.00%	0.00%
J-REITs	0.00%	0.00%	0.00%	0.00%
Real Estate	58.25 %	5.74%	51.42 %	69.36 %
RMBS(1-)	40.70 %	5.83%	29.55 %	47.46 %

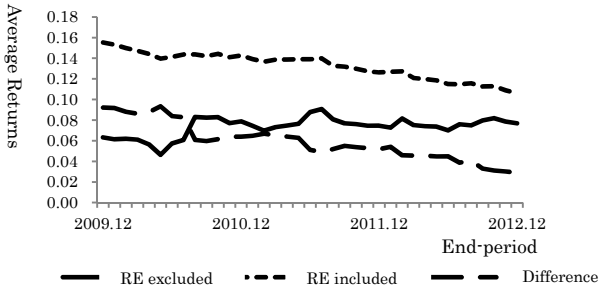
Table 3.2.6 : Risk Return Profile of Portfolios (7yrs, inclusive of real estate)

	Ave.	Min.	Max.
Return	0.13%	0.11%	0.16%
Risk (Std.Dev.)	0.19%	0.17%	0.21%

Graph 3.2.7 : Difference in Volatility with Real Estate Inclusion



Graph 3.2.8 : Difference in Returns with Real Estate Inclusion



4. Conclusion

This research analyzed dynamics of diversification benefits that real estate has in a multi-asset portfolio (minimum-variance portfolio), assuming a short-term 3 year and a mid-term 7-year investment periods. The results are as follows:

① Real estate inclusion showed improvement in risks at any assumed investment periods; hence

real estate can be regarded as a good risk diversifier.

② Real estate was consistently included in a minimum-variance portfolio, but the asset allocation ratio had time-varying nature and the variability became smaller with longer investment period. In other words, short-term investment requires active asset rebalance.

③ The results suggested high weights of RMBS and real estate among the all asset classes in a minimum-variance portfolio. Therefore, a minimum-variance portfolio that literally seeks minimum risk, can base real estate-focused assets. If an investor prefers higher risk, the portfolio can include risk assets like equities and so on.

④ As the resulted significant allocation to real estate and RMBC, the analysis happened to be like adding real estate into a RMBC-focused portfolio and could not seek many characteristics of equities, J-REITs, government bonds and corporate bonds. However, this also can be interpreted that diversification benefits of real estate still exist even in RMBS-focused portfolio. While RMBS is a real estate-related bond asset and real estate is a direct investment to properties, diversification benefits still can be achieved even with the combination of both assets.

⑤ Under the impacts of the financial crisis, diversification benefits were observed with real estate, the average returns were pushed down. Hence real estate more takes a role as a risk diversifier than as a return enhancer.

There remain challenges for future research. This research does not consider transaction costs, although real estate is known to have higher transaction costs compared to other asset classes. Real estate has lower liquidity and strong heterogeneity. Appraisal-based indexes contain issues like smoothing effect and time lag. The research focused purely on dynamics of minimum-variance portfolio, but there is also an important concept of cumulative returns of investment operation, that represent returns achieved over operation periods of real estate portfolio. Future research should address these issues and points.

Notes

(1) Other than RMBS, CMBS (commercial mortgage backed securities) also should be included in this analysis; but the research does not due to limited CMBS data available. Also this research assumes domestic investment markets thus no consideration about foreign equities. These should be addressed in future research.

(2) It should be noted that the pas literatures (Lee (2003), Lee & Stevenson (2006), Lee (2005)) assume much longer observation periods, so extra care should be taken when comparing the results with the past literatures.

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