2003

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Acknowledgement: We thank Kazuhiko Fujiki and Kazuo Sato for helpful comments.

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This paper examines the benefits of diversifying into real estate and other assets that typify the wealth held by Japanese investors by examining movements in mean variance frontiers. We employ spanning tests to assess statistical significance of frontier shifts without specifying a benchmark asset pricing model. We also examine the impact of shifts in mean variance frontiers before and after the precipitous decline in Japanese real estate and stock market values in the 90s. Spanning tests show that real estate, short, and long-term bonds provide diversification benefits while domestic and US equities do not. Significant shifts in mean variance frontiers are detected during the 90s. Residential property as opposed to commercial and industrial properties proves to be a more robust diversifier. Statistically significant shifts are also economically significant as measured by Sharpe ratio changes. Although significant, the portfolio weights on real estate are small compared to their composition in nations' wealth.

I. Introduction

Real estate is a large and growing portion of nations' wealth. Ibbotson, Siegel and Love (1985) who examine real estate, equities, bonds, cash, and commodities find real estate comprises the largest share of World (37%) and U.S. (40%) wealth. More recently, Heaton and Lucus (2000) document that U.S consumers hold 55% of their wealth in real property and only 20% in equities. The share of real estate in representative investor portfolios suggests an immense diversification demand for these assets yet empirical asset pricing models typically ignore real estate. Ignoring the largest component of wealth has potentially serious consequences for asset pricing predictions as they heavily depend on the set of assets under consideration. An Ill-defined benchmark made solely of stock indices makes for an unreliable metric to measure systematic risks.

This paper assesses the diversification demand for Japanese real estate. Japan is a country characterized by heavy real estate investment and has the second largest stock market in the world. Over 40 years of land values are examined in our endeavor, constituting the longest time series ever used in such an investigation. We evaluate the benefit of diversifying into Japanese real estate in a general asset-pricing framework that does not rely on a specific benchmark model such as the Capital Asset Pricing Model. We use spanning tests and Sharpe ratios to assess statistical and economic significance of adding real estate to well diversified portfolio of a representative Japanese Investor. Our results provide insight into whether this huge component of nations' wealth is diversification driven and the prospects for growth of the recently created securitized real property market in Japan.[1]

[1] Although introducing securitized real estate in Japan was discussed during the 90's (Suzuki, 1998), Japan Real Estate Investment Trusts (J-REITs) were not allowed to form prior to a May 2000 change in the Investment Trust

Research on the diversification benefits of real estate, both in the US and internationally is mixed (Wilson and Zurbruegg, 2003); most studies conclude that real estate is an important diversifier due to its low correlation with equities and other financial assets. These studies include, Fistenberg, Ross and Zisler (1988), Webb (1990), Hudson-Wilson, Elbaum (1995), Grauer and Hakansson (1995), Eichholtz (1996a), Lui and Mei (1998), and Ling and Naranjo (2002). On the other hand, Rubens, Louton and Yobaccio (1998) conclude that there are no real estate diversification benefits available to US investors. Ziobrowski, Ziobrowski, Rosenburg (1997) find that international diversification into US real estate is also of no benefit. Investigations into the portfolio benefits of real estate can be broadly categorized into the analysis of securitized real estate (REIT) and other real estate related equities, and those that examine direct property investment.

REIT studies use easily observed asset returns from a broad range of countries.[2] REITs and real estate related securities are liquid and do not entail any of the management duties incumbent on parties who directly invest in real estate. However, REITs do not typically cover all types of real property, representing only high-grade commercial properties, and the availability of these time series are limited. REITs may not represent the underlying properties they hold as evidence indicates REITs and real estate related securities behave more like equities with much higher correlations to equity prices than their direct investment counterparts. Gordon, Canter and Web (1998) based on a 1984-1997 sample report intra country real estate related equity with market

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Law. The first two J-REITs listed on the Tokyo Stock Exchange September 10, 2001. Matsumura (2002) reported as many as 20 new funds were ready for listing.

[2] A recent comprehensive study of real estate related securities by Ling and Naranjo (2002) covered a sample from 1984 to 1999 of 600 companies in 28 countries.

equity index correlations of 14 countries ranging from .96 in Hong Kong to .24 in Germany: Japan and the US have correlations of .86 and .54 respectively.[3]

Direct investment studies use a combination of appraisal and transactions data to assess the benefits of real property. Even though the popularity of securitized property is growing, private investment still dominates real estate transactions (Wilson and Zurbruegg, 2003). Indices based on direct investment reflect asset prices of both privately and publicly held real property. These studies document returns to real property exhibit much lower correlation with equities than REITs. Quan and Titman (1999) use appraisal prices from prime office buildings in selected cities (e.g., Tokyo) of 17 countries from 1984 to 1996. They show that correlations with stock indices are no different than zero except in Japan where its .62 correlation is significant. Case, Goetzman, and Rouwenhorst (2000) find across 22 counties from 1987 to 1997 correlations ranging from .34 to .44 depending property type.

Although direct investment indices represent a broader range of properties, the accuracy of this data in representing *true* market value is subject to debate. Quan and Titman (1999) point out that the lower correlation of appraisal based series with equities may be an artifact of the data. Appraisal smoothing, low liquidity and the estimation of income and rents could potentially understate volatility and induce an upward bias in return. In general, only portions of properties in an index trade each survey period while the others are inferred through appraisal methods. Appraisals can contain estimation errors that will not be represented in index values thus understating true volatility. Another explanation for low equity correlations, conjectured here, is

[3] Chandrashekaran (1999) report the correlation of US REITs and the S&P500 ranges from .48 to .79 depending on the sample period.

that appraisals by their nature represent expected prices which are necessarily less volatile than realized prices.

The Gold standard in the US real estate industry is the National Council of Real Estate Investment Fiduciaries (NCREIF) index. The NCREIF index is a collection of members' self-reported property values. As such, it is also subject to self-reporting and audit biases. Fischer, Miles and Webb (1999) conclude that while estimation error on individual properties is high, it is much less severe for property aggregates where the average appraisal overstated transactions by 2.8 percent. Geltner (1998) discuss usefulness of NCREIF index as well as the potential random errors of appraisal processes and assessing the magnitudes of these errors. However, Rubens, Louton and Yobaccio (1998) find that correcting for appraisal smoothing in the NCREIF data do not alter their results.

The property indices used in this study come from the Japan Real Estate Institute (JREI) that compiles the longest and broadest collection of Japanese land prices. The JREI continuously updates values from approximately 2,230 appraisal sites in the largest 223 cities. While not free of potential appraisal biases, the JREI appraisal methods are uniform; they are not self-reported valuations and avoid estimating rents by assessing land-as-vacant value only. We find much lower correlation of equity and property values than Quan and Titman (1999), only .22 over 40-year sample, which is not stable in sub-samples.

The case for diversification depends on more than a point estimate of an equity correlation and will ultimately be predicated upon the set of assets in an investor's portfolio, the temporal stability and significance of these assets' correlation structure, and the feasibility of a particular diversification strategy. If the market portfolio is not mean variance efficient, one can incorrectly conclude real assets are “good” diversifiers. If asset correlations are not stable, but vary widely, then diversification benefits are questionable as an optimized portfolio becomes expensive or impossible to maintain in the face of uncertain correlations. Eichholtz (1996b) argues against real estate diversification on the grounds that correlations are not stable, and at least internationally, diversification strategies are very expensive to execute for the gain received. Rubens, Louton and Yobaccio (1998) using a broader collection of assets than the equity market alone find that no diversification benefits are present in the US.

We address the shortcomings of an ill-defined benchmark and the changing nature of asset correlations in our empirical tests. As part of this research we develop a new spanning test that allows for shifts in the composition of frontier portfolios. Unlike standard empirical tests, our spanning tests are not subject to benchmarking error, as they do not rely on a specific benchmark asset pricing model.[4] In our analysis we use a long sample of semi-annual time-series data from 1957 to 2001 on five assets that typify the wealth of the Japanese investor: real estate, domestic and US equities, short and long term bonds. As real estate is a broad heterogeneous asset class, we also break out our analysis by commercial, residential an industrial property.

Results indicate bonds are the most important to a well-diversified Japanese investor portfolio both statistically and economically. Real estate is also an important diversifier, but this effect is not uniform across property types. Residential property is more robust to our tests and is more economically meaningful than commercial or industrial property. We find spanning inferences are affected by allowing differences in mean variance frontier pre and post the precipitous declines in Japanese equity and real estate prices starting in 1990. Domestic equities now become an important diversifier and all real estate property types become significant. US equity, which does not significantly contribute diversification opportunities, is economically meaningful in the 90s. Our computed portfolio weights are too low to match the even most conservative estimates of real estate in Japanese national wealth. This evidence indicates it is unlikely that the diversification demand for assets alone can explain the large proportion of a national wealth held in real estate.

II. Method

[Figure 1]

Spanning tests, Huberman and Kandel (1987), reveal whether an asset or set of assets offers additional diversification opportunities to a portfolio. Spanning tests measure the difference between two mean variance frontiers. There are p benchmark assets common to both frontiers and the other q test assets are only included in the construction of one of the frontiers. As shown in Figure 1, the frontier MV_{p+q} will always encompass MV_p because it contains more assets used in its construction. As mechanics dictate, the Sharpe ratio S_{p+q} is necessarily greater than S_p. The null hypothesis of spanning states that both frontiers statistically coincide,

$$H_0:\ MV_{p+q} = MV_p\ . \tag{1}$$

It is sufficient to measure the distance between frontiers at two points, as all other points are convex combinations[5]. A confirmation of the spanning hypothesis implies that additional test assets q will not offer diversification opportunities relative to those already included in the

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[4] A number of researchers have used spanning tests including Huberman and Kandel (1987), De Santis (1994), Dahlquist and Soderlind (1999), and Maroney and Protopapadakis (2002). DeRon and Nijiman (2001) provide extensive survey of this literature.
[5] A mean-variance frontier is a parabola therefore fully describe by two points in mean-variance space.

portfolio of benchmark assets *p*. In other words, the set of benchmark assets prices the broader set of assets. Evidence against the spanning hypothesis means the inclusion of test assets takes advantage of diversification opportunities not available in the benchmark assets, thus these test assets should be included in any well-diversified portfolio.

Spanning-like tests can be conducted with a variety of asset pricing models. For example, the Capital Asset Pricing Model restriction that constant term in the CAPM regression of excess returns be zero is the less restrictive intersection hypothesis that tests the distance at one point (test to see if $S_{p+q} = S_p$). This approach is problematic as this is a joint test of the specific discount factor created by the CAPM and the intersection hypothesis. The claim that the market portfolio is on the efficient frontier of all assets is dubious at best.

The proper implementation of spanning tests requires measuring the distance between frontiers at two points. The advantage of the Stochastic Discount Factor SDF approach to spanning tests is that it guarantees portfolios used in spanning tests lie on the mean variance frontier of assets used in their construction. These tests are based on Hansen and Jagannathan (1991), HJ, volatility bounds that give a lower boundary on the volatility of all stochastic discount factors SDFs such that the Law of One Price (LOP) is not violated. HJ bounds have a dual relationship to the mean variance frontier because SDFs are portfolios constructed to have the lowest variance possible for a given return. Spanning tests exploit the mean variance efficiency of the HJ bounds: selecting two points on the mean variance frontier is the same as selecting two points on the HJ bounds. HJ bounds are model free in the sense they do not require one to specify a specific benchmark model and therefore avoid the joint hypothesis problem inherent in using CAPM or Multifactor benchmarks.

HJ (1991) use the LOP to derive the bound on admissible discount factors. The LOP is the minimum restriction on asset prices that assets which have the same set of payoffs sell for the same price. The LOP is the present value relation at the heart of asset pricing:

$$E(X_{t+1}m_{t+1}) = P_t \text{, or equivalently } E(R_{t+1}m_{t+1}) = 1, \qquad \text{(2a, 2b)}$$

where *X*, and *R* are a *t+1* payoffs and gross returns on *N* assets, *m* is the SDF and *P* is vector of today's asset prices. The SDF *m* is commonly called the intertemporal marginal rate of substitution, which places additional restrictions on its construction. If there is no such restriction, it is straightforward to derive the SDF *m* as an algebraic exercise.

Expand (2b) using the definition of covariance and suppressing time subscripts for clarity yields,

$$E[Rm] = E[R]E[m] + Cov[R, m] = 1\ . \qquad (3)$$

HJ prove *m* is linear in returns:

$$m = E[m] + r'\beta\ , \qquad (4)$$

where *r'=R-E[R]* is vector of *N* return deviations from their times series means, β is a vector of weights on *N* assets, and *E[m]* is the expected value of the discount factor. Now solve for the set of weights such that the solution satisfies (3). Substituting (4) into (3) and simplifying gives,

$$E[R]E[m] + E[rr'\beta] = \iota \quad . \qquad (4)$$

Solving for β we see,

$$\beta = \Sigma^{-1}(\iota - E[R]E[m])\ , \qquad (5)$$

where Σ is the covariance matrix of returns. The discount factor has variance,

$$Var[m] = \beta' \Sigma \beta \tag{6}$$

which has the lowest variance of any candidate discount factor because the SDF is constructed to satisfy (2b) with a linear projection on the payoffs (refer to Campbell, Lo and MacKinlay (1997), or Cochrane (2001) for proofs of propositions related to the SDF).[6] This is similar to the BLUE property in Ordinary Least Squares. Given the first and finite second moments of returns and a nonsingular covariance matrix, an SDF with *E[m]* as its expectation can be constructed solely from returns data. The SDF will have the lowest variance of any candidate SDF with the same expectation. The expectation of *E[m]* has the property of being the price of the risk free asset.

To form the parabola that is the HJ volatility bound, HJ treat *E[m]* as an unknown parameter c, and the standard deviation of the SDF with expectation c, $\sigma(m_c)$ is plotted against c. This forms the lower bound on all SDFs constructed from a set of returns that satisfy the LOP. Any other SDF must have higher variance than the one along the bound to price all the assets.

Spanning tests use two SDFs with expectations $E(m_1)$, and $E(m_2)$ chosen in a reasonable range to measure the difference between frontier portfolios at two points. Following Maroney and Protopapadakis (2002), the empirical form of spanning tests is:

$$\begin{aligned} R - E(R|m_1) &= \varepsilon_1, \quad E(\varepsilon_1) = 0, \\ R - E(R|m_2) &= \varepsilon_2, \quad E(\varepsilon_2) = 0, \end{aligned} \tag{7}$$

where,

$$E(R|m_j) = \frac{1 - \text{cov}(Rm_j)}{E(m_j)}, \text{ and } m_j = E(m_j) + r_p' \beta_{pj} + r_q' \beta_{qj}; \; j = \{1,2\}.$$

[6] The dual relationship between mean variance and HJ bounds is easily proved by noticing equation (4) has an identical form (up to a normalization) to the FOCs derived from maximizing a Sharpe ratio. Benninga (2002) shows that any sets of portfolio weights satisfying the FOCs are of this form and therefore give portfolios that lie on a mean variance frontier.

With N assets there are $2N$ orthogonality conditions and without restrictions the system is just identified and linear with coefficients $\{\beta_{p1}, \beta_{q1}, \beta_{p2}, \beta_{q2}\}$. Without restrictions all orthoga1ity conditions are satisfied and sample averages are replicated using either SDF--by construction. The restriction given by spanning implies the two SDFs produced from p benchmark assets will replicate the averages of the q test assets not used in its construction. Spanning implies $2q$ overidentifying conditions positing that there is no need to include test assets in the construction of the SDFs: $\{\beta_{q1} = \beta_{q2} = 0\}$. Overidentifying conditions reveal how well the SDF produced from p assets replicates the sample averages of the broader set. We estimate the system using GMM with a Newly and West (1987) correction for first order autocorrelation. The Hansen (1982) *J*-Statistic based on the criterion from GMM and distributed $\chi^2(2q)$ will evaluate the goodness of fit of the overidentifying conditions.

The results of spanning tests will ultimately depend on the first two moments of returns data. Hansen and Richard (1987) show that spanning results using unconditional moments do not inform the findings of using conditional moments (frontier portfolios will differ in composition). As we study a long sample period, it is likely that spanning results will change when conditioning on sub-samples. We split the sample in two parts to explore this possibility. The most significant event in Japanese stock and real estate market histories occurred in 1990 with the declines of the equity and real estate prices shortly thereafter. In this paper we modify the spanning framework to capture the before and after 1990 shifts in frontiers:

$$
\begin{gathered}
R - E(R|m_1(I)) = \varepsilon_1, \quad E(\varepsilon_1) = 0, \quad E(\varepsilon_1 I) = 0, \\
R - E(R|m_2(I)) = \varepsilon_2, \quad E(\varepsilon_2) = 0, \quad E(\varepsilon_2 I) = 0, \\
\text{where,} \\
E\left(R|m_j(I)\right) = \frac{1 - \operatorname{cov}\left(Rm_j(I)\right)}{E\left(m_j(I)\right)}, \text{ and}
\end{gathered}
\tag{8}
$$

$$m_j(I) = E(m_j(I)) + r'_p(\delta_{pj} + \phi_{pj} I) + r'_q(\delta_{qj} + \phi_{qj} I);\ j = \{1,2\}.$$

The new coefficients are $\{\delta_{pj}, \delta_{qj}\}$, $\{\phi_{pj}, \phi_{qj}\}$, I is an indicator variable that is zero before 1990 and one thereafter, and $r' = R - E(R|I)$. The covariance of returns and the SDFs is allowed to change to fit two sets of average returns instead of the one set, as in the unconditional case. Spanning hypotheses are also amended for various combinations.

III. Data

We consider an extensive sample of returns data of semi-annual observations (September and March) from September 1957 to September 2001. We use data on short and long term bonds, domestic and US stocks, and Japanese real estate. Availability of real estate prices and International Financial Statistics (IFS) data governs the frequency and sample period.

The Japan Real Estate Institute (JREI) assembles the longest and broadest collection of Land price data. These national indices are comprised of appraised values collected from approximately 2,230 appraisal sites in the largest 223 cities.[7] The JREI assess value "land-as-vacant" and compiles indices according to property use: Commercial (LD-C), Residential (LD-R), and Industrial (LD-I).[8] The JREI also reports a composite of all properties (LD-A). The short-term bond (RF) is the IFS Japanese Call Money rate compounded into six-month holding period returns. The Call Money rate is the end of month average lending rate for transactions maturing in less than one month.[9] The longer term bond return (BD) is based on the IFS lending rate. The six month holding period is obtained by assuming a newly issued bond, paying a

[7] *Urban Land Price Index* published by the (JREI) outlines the construction of their land indices.
[8] Even though the housing component is not considered part of the real property, Noguchi (1994) reports that land component can be as high as 98% in some areas of Tokyo.
[9] This IFS (15860B..ZF…) series is spliced together with the Gensake rate after November 1991.

coupon every six-months, and having seven years to maturity.[10] The coupon from the bond issued six months before is discounted for six and half years at the new yield to arrive at its price. The return is then the bond price appreciation plus coupon.

The domestic equity market is represented by the Nikkei 225 index (NK) from the Japan Economic Newspaper (i.e., the Nihon Keizai shinbun).[11] The Standard and Poor's composite index (US) characterize the foreign equity market; from Robert Shiller's web site, www.econ.yale.edu/~shiller. The US dollar total returns index is converted into yen using the end of month spot rate obtained from IFS.[12]

IV. Results

[Table 1]

Table 1 Panels A and B document sample moments of our five assets for the entire sample and sub-periods. In the grand sample, the returns to bonds are less than equities, but much less volatile (values plotted in Figure 1). Real estate overall (LD-A) has the third highest return and the third highest standard deviation. The return to residential real estate (LD-R) is the highest among property types and is slightly higher than domestic equity return. Before 1990, domestic equity and real estate returns are huge; however, during the 90s real estate and domestic equity returns are negative.[13] Commercial property suffers the most among property types. As

[10] The IFS Handbook states that the lending rate we use (15860p..ZF…) is the weighted arithmetic average of contracted interest rates charged by all banks on both short- and long-term loans. Data originates from *Economics Statistics Monthly* published by the Bank of Japan. Seven years maturity is chosen based on this description. This series is the longest available for longer term debt.
[11] The Nikkei 225 does not include dividends and dividend series are not available for this long sample period. The Japan Securities Research Institute (1996) documents the lack of propensity of listed Japanese firms to pay dividends. Dividend yields average less than 1% over much of the 80s and 90s.
[12] IFS series (158..AE.ZF…).
[13] Ueda (1990), French and Poterba (1991), and Ito and Iwaisako (1996) investigate the factors that underlie the run-up in equity prices prior to 1990.

characteristic of the 90s, US equities did very well even in yen terms. The average appreciation of the yen against the dollar is nearly zero during this period, but the exchange rate does increase the volatility of yen denominated US equity returns. Although there are changes in the average returns between the two samples, volatility remains roughly the same.

Panel B of Table one depicts the asset correlation structure. The correlations between assets are markedly different in the 90s with some even changing sign. The correlation of real estate and short-term bond returns is positive and strengthens in the 90s. The correlation of real estate and longer-term bond returns is negative and strengthens in the 90s. The expected negative correlation between long term bond returns and real estate is apparent in the 90s. The correlation structure is similar across property types, as the correlation between property types is extremely high; exceeding 93% (not reported). The positive connection between Japanese and US equity markets intensifies in the 90s although average returns are much different. From the first two moments of the data, average returns and asset correlations change in the 90s and therefore may impact spanning tests as the mean-variance frontier changes from sample to sample.

[Table 2]

Spanning test results are presented in Panels A-D of Table 2. The unconditional spanning tests (*i*) places restrictions on equations (7) hypothesizing that sets of four benchmark assets can form frontiers that span the remaining test asset not used in their construction. These tests are unconditional in the sense that the SDFs in equations (7) use the unconditional moments of our data. Each panel has five entries on a row because each asset in the five-asset set has the opportunity to become a test asset. There are four panels because we examine the effect of each real estate index measure separately in different asset sets. For our purposes, we assign significance at the 5% level. Across panels tests of (*i*) indicate that excluding short or long-term bonds from a frontier with the other four assets statistically leaves exploitable diversification opportunities. Diversifying into real estate or equities only materially adds to a well-diversified portfolio if residential real estate (Panel C) is used. Results thus far suggest that the type of real property is an important consideration in achieving a well-diversified portfolio, and diversifying into bonds in indispensable.

The next set of spanning tests concentrate on restrictions imposed on equations (8) that allow for a change in the mean variance frontier during the 90s. The sets of tests (*ii*)-(*iv*) employ the same methodology as in the unconditional case where we rotate each asset out to become a test asset. Of the remaining tests, (*ii*) is more important. The restriction imposed in (*ii*) is the conditional frontier equivalent to the unconditional case. Results indicate that bonds are still important to both frontiers, but unlike the unconditional case both domestic equities and all types of real estate are now important to well-diversified portfolios of each sub-sample! Tests (*iii*) and (*iv*) examine this finding further. Tests (*iii*) indicate whether an asset is important to the earlier pre-90s frontier. As in (*ii*), domestic equities and real estate, except industrial property, are important to a well-diversified portfolio during the 9/57-9/89 sample. Tests (*iv*) indicate whether each asset contributed to the change in the frontier during the 90s. Results of tests (*iv*) largely depend property type. The composite and commercial indices in Panels A and B both suggest that call money and US equities do not contribute to the changes in frontier. Results for residential property in panel C suggest marginal contributions to frontier changes from any of the five assets. Results for industrial property in Panel D are much like the first two panels. Test (*v*) confirms a significant frontier change in the 90s period. This test the restriction that the change in discount factor weights ϕ=0 for all assets. Surprisingly US equity is not significant in any of tests, but it may have economic relevance. A subject we turn to next.

A test asset may be statistically significant to a well diversified portfolio but not economically meaningful. Although not common, the converse may also be true. To examine economic significance we look at Sharpe ratio losses in Table 3. We compare the Sharpe ratio before and after deleting an asset from the frontier to measure the change. Geometrically, we examine the change from SR_{p+q} to SR_p in Figure 1. As is the problem with intersection tests, Sharpe ratios are affected by the reference return (e.g., the choice of risk rate in a mean-variance context). For this reason, Table 3 examines a range of semi-annual reference returns with corresponding Sharpe ratio, mean, and standard deviation of the frontier portfolios (using the Land composite return, LD-A, in the set of assets) for our three periods are to the left. The frontier portfolios contain all five assets. Holding the reference return constant, the percentage Sharpe ratio loss is calculated using the grand frontier portfolio on the left and a portfolio from a frontier containing four assets; which excludes a particular test asset in each column. The portfolio weights of the land composite return in the grand frontier are denoted $w_{LD\text{-}A.}$ We also report separate results for residential real estate, as it stands out as different in our statistical tests. Sharpe ratio losses for residential real estate and associated portfolio weights, $w_{LD\text{-}R}$, use LD-R instead of LD-A in its grand frontier (not reported). Establishing a threshold for economic significance requires some judgement on the part of the researcher. We make our case relative to the contribution of other assets in this Table.

Results of economic significance broadly confirm statistical tests. For the entire period, bonds are indispensable to a well-diversified portfolio while other assets are not. Losses from omitting Japanese call money are the greatest followed by the long term bond. Losses from omitting equities or real estate are minor but residential real estate (which is significant) has a greater effect than the land composite. The first sub-period losses display the same pattern as the unconditional case. The rejections for domestic equity and real estate in general in (*iii*) of Panel A of Table 2 do not seem economically meaningful with maximum Sharpe ratio losses of up to 3% for the 9/57-9/89 period. Losses when residential real estate is used are twice that of the composite (i.e., up to 6%).

Table 3 also shows that each asset in the 90s, except long term bonds, becomes more important. Domestic equities and real estate which are statistically significant [tests (*ii*) in Table 2] are also economically meaningful. Sharpe ratio losses are up to 40% for real estate and 17% for domestic equity. Showing the converse of economic and statistical significance can be true, holding US equity in the 90s does seem to have economic significance, but is not statistically significant. This is potentially due to the small number of observations during the 90s.

Our aim is to determine if real estate is an asset to be included in a well-diversified portfolio. Evidence indicates residential real estate does contribute to a well diversified portfolio. If one knew that the 90s were different from the rest of the sample then all types of real estate are statistically important. Real estate is also more economically important in the 90s.

With these results in mind there are several caveats. First, real estate is not as liquid as other assets considered. This can be remedied by forming maximum correlation portfolios made from assets that are easily traded. Next, are the large holdings of real estate as part of wealth related to the diversification demand for assets? The answer seems to be no. Consider the weights w_{LD-A}, and w_{LD-R} in Table 3. Residential real estate has the maximum possible weigh of 15%, which is far below even the most conservative figures on the part of wealth that real estate comprises.

The hedging demand for real estate seems much more compelling explanation for the large share real estate in agents' wealth. Finally, when expected returns are not constant the average and expected returns will deviate from one another. When expected returns are time-varying, average returns will contain unanticipated gains and losses not part of expected returns. For this reason, the exante and expost frontiers may not coincide. Real Estate may well have a huge weight in the composition of the exante frontier, but we may never be able to tell.

V. Conclusion

From the use of *benchmark-free* spanning test on an extensive sample of asset returns, we conclude that real estate and more importantly bonds are integral assets to Japanese investors' portfolios. Residential real estate provides more diversification opportunities than other types of property. The diversification gains from real estate although statistically significant for both sub-periods are more economically significant in the 90s. Allowing for a change in frontiers after the fall of the Japanese equity and Real estate markets provides different spanning inferences as the composition of mean variance frontiers alter. While not significant in the unconditional case, domestic equities and all types of real estate become important to sub-sample diversified portfolios. Surprisingly, holding a US equity portfolio does not contribute to investors' gains in any of our tests.

Although real estate is important to diversification, evidence cast doubt that diversification demand alone can explain the high proportion that real estate comprises of nations' wealth. The hedging demand for asset is a more intuitively appealing explanation for the heavy weight of real estate. Perhaps this is why residential real estate is more robust to our tests as it is more likely to be correlated with consumers' intertemporal marginal rates of substitution.

References

Benninga, Simon, 2002, *Financial Modeling,* MIT Press.

Campbell, John Y., Lo, Andrew W. and MacKinlay, A. Craig, 1997, *The Econometrics of Financial Markets*, Princeton University Press.

Case, B., W. Goetzman and K.G. Rouwenhorst, 2000, Global Real Estate Markets: Cycles and Fundamentals, *NBER, Working Paper Series.*

Chandrashekaren, V., 1999, Time-Series Properties and Diversification Benefits of REIT Returns, *Journal of Real Estate Research*, 17, 91-112.

Cochrane, John, 2001, *Asset Pricing,* Princeton University Press.

Dahlquist, M. and P. Soderlind, 1999, Evaluating Portfolio Performance with Stochastic Discount Factors, *Journal of Business* 72, 347-383.

DeRon, F.A., E. Nijiman and B.J.M. Werker, 2001, Testing for Mean-Variance Spanning with Short Sales Constraints and Transaction Costs: The Case of Emerging Markets, *Journal of Finance* 56, 723-744.

DeRon, F.A.and E. Nijiman, 2001, Testing for Mean-Variance Spanning: a Survey, *Journal of Empirical Finance*, 8, 111-155.

De Santis, Giorgio, 1994, Asset Pricing and Portfolio Diversification: Evidence from Emerging Financial Markets, *Investing in Emerging Markets* edited by M. Howell, Euromoney Books, London.

Eichholtz, P.M.A., 1996a, Does International Diversification Work Better for Real Estate than for Stock and Bonds?, *Financial Analysis Journal*, 52, 56-62.

Eichholtz, P.M.A., 1996b, The Stability of the Covariance's of International Property Share Return, *Journal of Real Estate Research*, 11, 149-158.

Firstenberg, P., S. Ross, and R. Zisler, 1988, Real estate: The whole story, *Journal of Portfolio Management*, Spring, 22-34.

Fischer, J., M. Miles, and J. Webb, 1999, How Reliable Are Commercial Appraisals? Another Look, *Real Estate Finance*, 16, 9-15.

French, Kenneth and James Poterba, 1991, Were Japanese Stock Prices Too High?, *Journal of Financial Economics*, 29, 23-55.

Geltner, David, 1998, How accurate is the NCREFI Index as a Benchmark, and Who Cares?, *Real Estate Finance*, 14, 25-38.

Gordon, J.N., T.A. Canter and J. Webb, 1998, The Effect of International Real Estate Securities on Portfolio Diversification, *Journal of Real Estate Portfolio Management*, 4, 83-91.

Grauer, Robert R. and Nils H. Hakansson, 1995, Gains From Diversifying Into Real Estate: Three Decades of Portfolio Returns Based on the Dynamic Investment Model, *Real Estate Economics,* 23, 2, 117-159.

Hansen, Lars P., 1982, Large Sample Properties of Generalized Method of Moments Estimators, *Econometrica*, 50, 1029-54.

Hansen, Lars P. and Ravi Jagannathan, 1991, Implications of Security Market Data for Models of Dynamic Economies, *Journal of Political Economy, 99*, 225-262.

Hansen, Lars P. and Scott F.Richard, 1987, The Role of Conditioning Information in Deducing Testable Restrictions Implied by Dynamic Asset Pricing Models, *Econometrica* 55, 587-613.

Heaton, John, and Deborah Lucas, 2000, Portfolio Choice and Price: The Importance of Entrepreneurial Risk, *Journal of Finance*, 55, 3, 1163-1198.

Huberman, Gur, and Shmuel Kandel, 1987, Mean-Variance Spanning, *Journal of Finance, 42*, 873-888.

Hudson-Wilson, S., and B. L. Elbaum, 1995, Diversification Benefits for Investors in Real Estate, *Journal of Portfolio Management*, Spring, 92-99.

Ibbotson, Roger G., Laurence B. Siegel, and Kathryn S. Love, 1985, World Wealth: Market Values and Returns, *Journal of Portfolio Management*, Fall, 4-23.

Ito, Takatoshi, and Tokuo Iwaisako, 1996, Explaining Asset Bubbles in Japan, *Bank of Japan Monetary and Economic Studies, 14*(1): 143-93.

Japan Real Estate Institute, 2003, *Urban Land Price Index and National Wooden House Market Value Index.*

Japan Securities Research Institute, 1996, *Securities Market in Japan*.

Ling, D. and A. Naranjo, 2002, Commercial Real Estate Performance: A Cross Country Analysis, *Journal of Real Estate Finance and Economics,* 24, 119-142.

Liu, C. and J. Mei, 1998, The Predictability of International Real Estate Markets, Exchange Risks and Diversification Consequences, *Real Estate Economics,* 26, 1, 3-39.

Matsumura, T., 2002, Growth Prospects for the Newly Formed J-REIT Market, *NLI Research Institute*.

Maroney, N. and A. Protopapadakis, 2002, The Book-to-Market and Size Effects in a General Asset Pricing Model: Evidence from Seven national Markets, *European Finance Review*, 6, 189-221.

Newey, W. and K. West, 1987, A Simple Positive Semi-Definite, Heteroskedasticity Consistent Covariance Matrix, *Econometrica, 55*, 703-708.

Noguchi, Yukio, 1994, Land Prices and House Prices in Japan, *Housing Markets in the United States and Japan* edited by Y. Noguchi and J. Poterba, University of Chicago Press.

Quan, Daniel C. and Sheridan Titman, 1999, Do Real Estate Prices and Stock Prices Move Together? An International Analysis, *Real Estate Economics,* 27, 2, 183-207.

Rubens, Jack, David Louton and Elizabeth Yobaccio, 1998, Measuring the Significance of Diversification Gains, Journal of Real Estate Research, 16, 73-86.

Suzuki, M., 1998, Fudosan (Real Estate) Big Bang, Nikkan Kogyo Shinbunsha (in Japanese).

Ueda, Kazuo, 1990, Are Japanese Stock Prices Too High?, *Journal of the Japanese and International Economies 4*(4): 351-70.

Webb, J., 1990, On the exclusion of real estate from the market portfolio, *Journal of Portfolio Management*, Fall, 78-84.

Willson, Patric J. and Ralf Zurbruegg, 2003, "Does it Pay to Diversify Real Estate Assets? A Literary Perspective, *CIES Discussion Paper*.

Ziobrowski, A., B. Ziobrowski and S. Rosenberg, 1997, Currency Swaps and International Real Estate Investment, *Real Estate Economics*, 25, 223-251.

Table 1. Descriptive Statistics

Panels contain descriptive statistics on semi-annual holding period return, in decimal form, on Japanese Call Money (RF), Japanese Long-term Bonds (BD), the S&P composite expressed in Yen terms (US), the Nikkei 225 (NK), and Japanese Land Price Appreciation (LD-) of Composite (A), Commercial (C), Residential (R), and Industrial (I) properties. The constructions of these series are in data section. Sample spans September 1957 to September 2001. The same statistics reported for pre- and post crash of the Japanese equity market.

Panel A. Average Return and Standard Deviation

	Average			Standard Deviation		
Asset	9/57 -9/01	9/57 - 9/89	3/90 - 9/01	9/57 -9/01	9/57 - 9/89	3/90 - 9/01
RF	0.031	0.038	0.012	0.017	0.013	0.014
BD	0.037	0.040	0.029	0.023	0.022	0.027
US	0.048	0.043	0.061	0.122	0.117	0.139
NK	0.043	0.073	-0.040	0.149	0.134	0.158
LD-A	0.040	0.059	-0.012	0.055	0.049	0.031
LD-C	0.035	0.057	-0.025	0.057	0.045	0.039
LD-R	0.044	0.063	-0.005	0.052	0.047	0.026
LD-I	0.040	0.057	-0.004	0.057	0.057	0.026

Panel B. Asset Correlation

Asset		BD	US	NK	LD-A	LD-C	LD-R	LD-I
RF	9/57 -9/01	0.07	-0.05	0.06	0.59 ***	0.62	0.57	0.53
	9/57 - 9/89	-0.19	0.05	-0.28 **	0.25 **	0.20	0.25	0.28
	3/90 - 9/01	0.11	-0.15	-0.11	0.70 ***	0.77	0.58	0.71
BD	9/57 -9/01	1	-0.01	0.25 **	-0.07	-0.04	-0.10	-0.05
	9/57 - 9/89	1	-0.01	0.21 *	-0.17	-0.16	-0.21	-0.13
	3/90 - 9/01	1	0.04	0.16	-0.49 **	-0.43	-0.58	-0.47
US	9/57 -9/01		1	0.28 ***	-0.05	-0.06	-0.06	-0.02
	9/57 - 9/89		1	0.26 **	-0.02	-0.01	-0.05	0.02
	3/90 - 9/01		1	0.44 **	-0.03	-0.07	0.03	0.01
NK	9/57 -9/01			1	0.22 **	0.26	0.20	0.22
	9/57 - 9/89			1	0.10	0.15	0.05	0.12
	3/90 - 9/01			1	-0.22	-0.24	-0.20	-0.18

*,**,*** are two-tailed significance levels at 1,5, and 10% respectively.

Table 2. Spanning Tests Results

Panels A-D (*i*) reports *J-stat* p-values of the restriction on equations (7) that a set of four assets can span one remaining test asset excluded from its construction; over the entire sample. There is one test asset (q) in each test and two discount factors, which totals four restrictions [*df*=4]. (*ii*) through (iv) reports p-values from restrictions on equations (8) to test (ii) if each test asset belongs in sub-sample frontiers [*df*=8], (iii) if each asset belongs to the frontier of the early period [*df*=4] (*iv*) if the weight of test asset significantly changes in the 90s [*df*=4]. (*v*) reports the p-value from testing if the frontier defined by the 90s is different. It is the restriction that ϕ=0 on all assets in two discount factors [*df*=20]. Tests in Panels B-D use each of the three component land price indices into the asset set in place of LD-A. The assets are Japanese Call Money (RF), Japanese Long-term Bonds (BD), the S&P composite expressed in yen terms (US), the Nikkei 225 (NK), and four Japanese Land Price Appreciation indices (LD-All, Commercial, Residential, Industrial). The constructions of these series are in data section.

Panel A. *J*-stat P-values of Spanning Tests with Land Return Composite (LD-A)

Tests	Restrictions	Test Asset (q)				
		RF	BD	US	NK	LD-A
(*i*) Unconditional	$\beta_{qj} = 0$	0.000	0.000	0.232	0.621	0.194
(*ii*) 9/57-9/89 and 3/90-9/01	$\delta_{qj} = \phi_{qj} = 0$	0.000	0.000	0.148	0.007	0.002
(*iii*) 9/57-9/89	$\delta_{qj} = 0$	0.000	0.000	0.997	0.023	0.018
(*iv*) 3/90-9/01	$\phi_{qj} = 0$	0.967	0.006	0.225	0.046	0.007
(*v*) Difference in frontiers	$\phi_{pj} = 0$	0.002				

Panel B. *J*-stat P-values of Spanning Tests with Commercial Property (LD-C)

Tests	Restrictions	Test Asset (q)				
		RF	BD	US	NK	LD-C
(*i*) Unconditional	$\beta_{qj} = 0$	0.000	0.000	0.281	0.808	0.246
(*ii*) 9/57-9/89 and 3/90-9/01	$\delta_{qj} = \phi_{qj} = 0$	0.000	0.000	0.081	0.009	0.001
(*iii*) 9/57-9/89	$\delta_{qj} = 0$	0.000	0.000	0.999	0.050	0.021
(*iv*) 3/90-9/01	$\phi_{qj} = 0$	0.120	0.001	0.166	0.026	0.004
(*v*) Difference in frontiers	$\phi_{pj} = 0$	0.001				

Table 2 continued

Panel C. *J*-stat P-values of Spanning Tests with Residential property (LD-R)

Tests	Restrictions	Test Asset (q)				
		RF	BD	US	NK	LD-R
(i) Unconditional	$\beta_{qj} = 0$	0.000	0.000	0.201	0.471	0.034
(ii) 9/57-9/89 and 3/90-9/01	$\delta_{qj} = \phi_{qj} = 0$	0.000	0.000	0.385	0.006	0.003
(iii) 9/57-9/89	$\delta_{qj} = 0$	0.000	0.000	0.983	0.026	0.005
(iv) 3/90-9/01	$\phi_{qj} = 0$	0.168	0.089	0.346	0.056	0.077
(v) Difference in frontiers	$\phi_{pj} = 0$	0.006				

Panel D. *J*-stat P-values of Spanning Tests with Industrial property (LD-I)

Tests	Restrictions	Test Asset (q)				
		RF	BD	US	NK	LD-I
(i) Unconditional	$\beta_{qj} = 0$	0.000	0.000	0.226	0.621	0.259
(ii) 9/57-9/89 and 3/90-9/01	$\delta_{qj} = \phi_{qj} = 0$	0.000	0.001	0.246	0.003	0.023
(iii) 9/57-9/89	$\delta_{qj} = 0$	0.000	0.001	0.996	0.008	0.112
(iv) 3/90-9/01	$\phi_{qj} = 0$	0.411	0.025	0.277	0.064	0.036
(v) Difference in frontiers	$\phi_{pj} = 0$	0.001				

Table 3. Economic Significance

This table reports the economic significance of excluding assets by comparing the Sharpe ratios from grand frontier portfolios composed of all five assets (using LD-A) to Sharpe ratios from frontiers composed of a combination of the remaining four; deleting each asset given in the columns to the right one at a time. The Sharpe ratio, average, and standard deviation of the three grand frontiers given by sample period under consideration are reported to the left--in semi-annual decimal. Results for LD-R use this index in place of LD-A in the grand frontier. The portfolio weight of the composite real estate measure is $w_{LD\text{-}A}$ and for residential real estate is $w_{LD\text{-}R}$. Results are reported for various semi-annual values of the reference asset. *n.c.* means no comparison because tangency portfolio is on underside of frontier.

Sharpe Ratio Loss

Date	Frontier Portfolio						Sharpe % Loss from Deletion of Asset					
	Ref	Sharpe	$E(r_p)$	σ_p	$w_{LD\text{-}A}$	$w_{LD\text{-}R}$	RF	BD	US	NK	LD-A	LD-R
	-1%	3.117	0.033	0.014	-2%	1%	-23	-19	-2	-1	0	0
9/57-9/01	0%	2.397	0.033	0.014	-1%	2%	-20	-20	-3	-1	0	0
	1%	1.682	0.034	0.014	0%	5%	-17	-23	-3	-1	0	-1
	2%	0.985	0.035	0.015	5%	12%	-9	-30	-5	-1	-1	-5
	-1%	5.115	0.040	0.010	3%	4%	-41	-18	0	-2	-1	-2
9/57-9/89	0%	4.084	0.040	0.010	3%	5%	-40	-18	0	-2	-1	-2
	1%	3.057	0.040	0.010	4%	6%	-38	-18	0	-3	-2	-3
	2%	2.040	0.040	0.010	5%	8%	-33	-18	0	-3	-3	-6
	-1%	2.745	0.032	0.015	-72%	-7%	-33	-1	-13	-6	-17	0
3/90-9/01	0%	2.151	0.041	0.019	-109%	-40%	-36	-3	-17	-11	-26	-3
	1%	1.743	0.076	0.038	-253%	-381%	n.c.	-8	-20	-17	-40	-18
	2%	-1.665	-0.120	0.084	n.c.	149%	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.

Figure 1. M-V Frontiers with and without Real Estate: 9/57-9/01