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Abstract
A market portfolio is constructed in this paper that is in the spirit of Roll (1977). It consists of equity assets, fixed-income securities, and real estate, and tests whether the real estate investment trust (REIT) risk premium that is estimated using an equity index alone is robust to the misspecification of the market portfolio. The results show that REIT betas increase significantly relative to a more complete market proxy. Moreover, adding real estate to the market portfolio accounts for a significant portion of the bias in the estimated REIT market risk premium.

Keywords
market portfolio, equity, asset management, real estate investment trusts, REITs, risk management

Disciplines
Finance and Financial Management | Portfolio and Security Analysis | Real Estate

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The Composition of Market Proxy in REITs Risk Premium Estimation

Executive Summary. *A market portfolio is constructed in this paper that is in the spirit of Roll (1977). It consists of equity assets, fixed-income securities, and real estate, and tests whether the real estate investment trust (REIT) risk premium that is estimated using an equity index alone is robust to the misspecification of the market portfolio. The results show that REIT betas increase significantly relative to a more complete market proxy. Moreover, adding real estate to the market portfolio accounts for a significant portion of the bias in the estimated REIT market risk premium.*

by Xiaolong Liu*
Peng Liu**

Since the 1990s, real estate investment trusts (REITs) have become a popular investment vehicle with both individual and institutional investors. During this period, both the market capitalization and liquidity of REITs has risen significantly, sparking interest on the part of practitioners as well as academics in achieving a better understanding of the risk and return profiles of this investment class through applying the standard capital asset pricing model (CAPM) and its multifactor extensions. As a well-defined asset pricing model, the CAPM stipulates that, excepting ad hoc risk factors, investors should be concerned only with the undiversifiable market risk of their investments. In other words, investors should be compensated for systematic risk exposure. Therefore, the market risk premium, which is the product of beta and the expected excess market return, provides an informative measure of the risk exposure that is inherent in REIT investments. Ex ante, investors would be able to use an accurate measure of the market risk premium to inform their capital budgeting decisions if they were to allocate an appropriate portion of funds into REITs. Ex post, the market risk premium is relevant to assessing the performance of REIT investments.

Under CAPM theory, the market risk premium is determined by the true market portfolio's expected excess return and the systematic risk of an asset with respect to such a market portfolio. The market portfolio is thus the key to an accurate estimation of the market risk premium of a given asset. It also provides a sensible interpretation of

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beta as an indication of systematic risk exposure to "the" market portfolio. By definition, the true market portfolio is unique and should include all investable assets in the asset universe, which is of course not observable in practice. In consequence, ambiguities exist in the empirical application of the CAPM to estimate the market risk premium in determining the appropriate market proxy to use. Both practitioners and academics seem perfectly content to use equity indices, such as the S&P 500 and CRSP indices, to proxy for the true market portfolio in their empirical work. Recent studies have consistently shown that using such equity indices results in REITs with low betas (Chan, Hendershott, and Sanders, 1990; Han and Liang, 1995; Peterson and Hsieh, 1997; Lee, Lee, and Chiang, 2008). Although these findings seem to confirm the low or moderate market risk compensation of REITs, investors should be wary of the robustness of these results to an alternative specification of a more diversified market portfolio that is more in line with the true market portfolio as prescribed by CAPM theory. There is also reliable empirical evidence demonstrating that the risk exposures of REITs go beyond the risk involved in equities (Chan, Hendershott, and Sanders, 1990, 1990; Ling and Naranjo, 1997; Peterson and Hsieh, 1997; Clayton and Mackinnon, 2001, 2003; Lee, Lee, and Chiang, 2008). In fact, using equity indices alone as market proxies is rather restrictive in the sense that such a practice captures only an asset's risk exposure to the equity market and leaves part of the market risk to be diversified away as the market portfolio becomes more complete by incorporating various non-equity assets.

Due to the unobservability of the true market portfolio as dictated in theoretical CAPM, the implication of using equity market proxies in empirical research has less to do with the exclusion of certain asset classes from the market portfolio per se and more to do with the sensitivity of inferences based on CAPM to the misspecification of the market portfolio. In the context of estimating the REIT market risk premium, the question is whether the composition of the market portfolio matters for assessing the riskiness of REITs. This is a critical issue for investors who are prone to misallocation of funds and erroneous performance evaluation due to misstatement of the riskiness underlying their investments.

The purpose of this paper is to address this issue by constructing a more comprehensive market portfolio that incorporates not only equity but also fixed-income securities and real estate, and to test whether the market risk premium estimation for REITs is sensitive to market portfolio composition. It is worth noting that the concept is not to attempt to build an exhaustive market portfolio, one that ultimately includes all asset classes, but rather to identify, for testing purposes, a market proxy that is broader than the restrictive equity market proxy. The REIT betas are found to increase significantly when a more diversified market portfolio is used, indicating that REITs are not as conservative as investors perceive them to be in terms of their systematic risk exposure with respect to a more diversified market proxy. Moreover, estimation of the market risk premium of REITs seems sensitive to both the structural break in the REITs market in terms of REIT returns, as well as to market proxy composition. Adding real estate to the market proxy accounts for a significant portion of the bias that occurs in the estimation of the REIT market risk premium.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 illustrates the U.S. data used in this study. Section 4 discusses the methodology and some estimation issues. An analysis of the results is presented in Section 5. Section 6 concludes.

Literature Review

As a popular and novel investment vehicle, REITs provide investors with exposure to the real estate market while maintaining a high level of liquidity. Relevant research, mostly in the field of REIT performance evaluation and REIT risk exposure analysis, has consistently shown that REITs provide low market risk exposure as evidenced by low betas with respect to various equity market proxies. These studies also shed light on the inadequacy of using the equity market proxy by showing that returns on REITs are compensated for exposure to not only the equity market, but also to the bond and real estate markets.

Peterson and Hsieh (1997) studied the risk exposures of REITs using the monthly returns of a value-weighted REIT portfolio from 1976 to 1992. Applying the NYSE/ASE/NASDAQ monthly value-weighted index as the market proxy, they found the betas of equity and mortgage REITs to be equal to 0.62 and 0.70, respectively. Moreover, they showed that, in addition to the market portfolio, risk premiums on equity REITs can be explained by size and book-to-market equity factors in common stock returns, and that risk premiums on mortgage REITs are related to bond market factors.

Clayton and MacKinnon (2001) analyzed the time-varying nature of the link between REITs, real estate, and other financial assets. They employed a multi-factor model that included stocks, bonds, and real estate. Using quarterly data from 1978 through 1998, they illustrated the risk exposure of REITs to large and small cap stocks, bonds, and real estate. Moreover, their results also showed the asymmetric nature of REITs under varying market conditions. As an extension of this study, Clayton and MacKinnon (2003) demonstrated that the REIT market transformed from being driven largely by the same economic factors that drive large cap stocks through the 1970s and 1980s to being more strongly related to both small cap stocks and real estate–related factors in the 1990s.

Lee, Lee, and Chiang (2008) studied the real estate risk exposure of equity REITs by applying a multi-factor model that included Fama-French stock and bond factors (Fama and French, 1993) plus a real estate factor proxied by the Russell-NCREIF Property Index. They showed that the beta of the NAREIT (National Association of Real Estate Investment Trusts) equity REITs index on the value-weighted CRSP Index covering the period from 1978 to 2003 was below 0.6. Their results confirmed that REITs suffered from risk exposure to the unsecuritized real estate market during the period examined.

Studies conducted by Han and Liang (1995) and Corgel and Djoganopoulos (2000) provided evidence that using a restrictive market proxy could lead to biased estimates of the cost of capital and performance evaluations of REITs. Han and Liang (1995) examined the issues of benchmark selection and survivor bias in REIT performance evaluation. They assembled portfolios of REITs that were free of survivor bias for the period of 1970 through 1993, and used the equally-weighted CRSP Index to proxy for the market portfolio. They found that both the use of the S&P 500 Index and of a survivor sample of REITs led to an over-estimation of REIT performance. The beta estimates in their study ranged from 0.68 to 0.87 when the equally-weighted CRSP Index was used to proxy for the market. Their findings shed light on the fact that, if the riskiness of REITs is understated due to using the less-diversified S&P 500 Index as the market proxy rather than the small stock-inclusive CRSP Index, a better performance measure is likely to emerge ex post. The caveat pertaining to their study, however, is that the equally-weighted CRSP Index tends to over-represent small caps in the equity market portfolio, leading to enhanced market returns.

Similar results were also found by Corgel and Djoganopoulos (2000). Their REIT sample consisted of more than 60 REIT companies with return series spanning the period from January 1993 through November 1997. They found that estimation of the mean cost of capital using the S&P 500 Index was generally understated by 0.8% on an annual basis as compared with using an alternative Russell 2000 Index.

All of the aforementioned empirical studies of the risk of and return on REITs take equity portfolios as "default" market proxies irrespective of their limited inclusion relative to the full asset universe. Roll (1977) highlighted the issue of choosing the right market portfolio empirically in the context of CAPM testing. He argued that the market portfolio should include all individual assets while also conceding that such an endeavor might not succeed in reality. Stambaugh (1982) was the first to address Roll's critique by constructing a broad market portfolio that incorporated not only equity but also fixed income securities, consumer durables, and real estate. He concluded that CAPM testing seemed insensitive to market portfolio composition. Despite rough measures of asset returns, his market portfolio was the most comprehensive at

the time when relevant data were not readily available.

Liu, Hartzell, Grissom, and Greig (1990) tackled the issue of the composition of the market portfolio and REIT performance evaluation. Their sample included 18 equity REITs for the period 1978 through 1986. They expanded the market portfolio by including fixed-income securities, equities, and real estate. Using quarterly data, they demonstrated that the composition of the market proxy did not necessarily lead to varying inferences regarding REIT performance. However, their results should be approached with caution. First, survivor bias might arise due to their sampling scheme, in which the REITs in their sample were assumed to possess a continuous return series covering the full study period. Second, as the authors acknowledged, there is a possible double-counting issue involved in simply taking the outstanding market values of assets while neglecting multiple financial claims on the same underlying assets.

In the same vein, Benefield, Anderson, and Zumpano (2007) examined an issue similar to the one explored in Liu, Hartzell, Grissom, and Greig (1990) while focusing on post-1986 REIT performance. They included REITs with price information for the period 1995 through 2002. The chosen market proxies were the equally- and value-weighted CRSP Index, the S&P 500 Index, and the small cap decile of the CRSP Index. Adopting various performance measures and quarterly return data, their results showed the insensitivity of the REIT performance measure to market proxy composition. Apart from suffering from the survivor bias problem as was the case with Liu, Hartzell, Grissom, and Greig, the authors failed to address the breadth of the market proxy issue by applying very restrictive equity indices rather than synthesizing across a range of asset classes when approximating various market proxy compositions.

This paper distinguishes itself from earlier research in three ways. First, it addresses the impact of market portfolio composition on assessing the riskiness of REITs. This is a more fundamental issue as compared with ex ante capital allocation and ex post REIT performance evaluation. Second, the analysis is performed on the basis of individual REITs rather than REIT portfolios, a strategy that is motivated by the fact that aggregating stocks into portfolios conceals important information contained in individual stock betas and reduces cross-sectional variation in betas (Ang, Liu, and Schwarz, 2008). Ferson and Harvey (1999) noted that stock grouping works only when the characteristics used for portfolio formation are good proxies for the risk shared by stocks within the portfolio. Bauer, Cosemans, Frehen, and Schotman (2009) demonstrated strong heterogeneity within portfolios that were formed based on Fama and French (1993). Third, the paper examines the survivor bias problem explicitly by including REITs that are short-lived in the analysis, in contrast to Liu, Hartzell, Grissom, and Greig (1990) and Benefield, Anderson, and Zumpano (2007).

Data

The objective of this study is to check the robustness of estimating the market risk premiums of REITs using the restrictive equity index to an alternative market proxy that is more diversified across various asset classes in addition to equity.[1] The popular CRSP Equity Index is used, which synthesizes stocks traded on the NYSE, the AMEX, and NASDAQ as the "default" market proxy. The CRSP Equity Index is more representative of the U.S. equity market in the sense that it incorporates large as well as small cap stocks, and has been used in several studies, allowing comparisons with the results of earlier research.[2] The alternative market portfolio is constructed by taking into account not only equities but also asset classes such as fixed income securities and real estate, which is similar to the procedures employed in Stambaugh (1982) and Liu, Hartzell, Grissom, and Greig (1990). The construction of this comprehensive market portfolio requires (1) a rate of return series for each candidate asset class in the portfolio and (2) market values that are used to compute the weights in order to construct the composite market index. The sample consists of a monthly asset return series from January 1990 through June 2008. Assuming an annual rebalancing of the market portfolio at the beginning of the year, market capitalization data are assembled for individual asset classes from the end of 1989 to the end of 2007.

Asset Market Value and Weights

The market portfolio is composed of four asset classes: equity, fixed-income securities, real estate, and time and savings deposits. The equity asset class comprises mainly corporate equity. Fixed-income securities can be divided into treasury securities, municipal securities, and corporate bonds. The real estate asset class is divided into residential and commercial real estate. In estimating the market value of each of the individual assets, special attention is paid to the double-counting issue that is involved, as noted by Stambaugh (1982) and Liu, Hartzell, Grissom, and Greig (1990). The double counting of asset market values could arise if the calculation is naïvely based on the outstanding market value of the asset. For example, there can be cross-holding of firm shares or bonds, or multiple claims on the same underlying assets, such as mortgage- and asset/mortgage-backed securities.

With the exception of commercial real estate, end-of-year market values of assets were obtained from flow-of-funds accounts composed by the U.S. Federal Reserve.[3] The details are as follows.

1. **Equity:** The gross corporate equity portion of the flow-of-funds accounts excludes ADRs and mutual fund shares.[4] In addition, it takes inter-corporate holdings into account to avoid double counting. Due to the fact that REIT shares form part of the gross corporate equity, the REIT portion is subtracted from the corporate equity to avoid double counting of equity and commercial real estate.
2. **Fixed Income Securities:** Treasury securities comprise U.S. government securities of varying maturities, such as Treasury bills, Treasury notes, and Treasury bonds. Municipal securities include both short- and long-term municipal bonds while excluding the trade debt of state and local governments and U.S. government loans to them. The direct and indirect holdings of corporate bonds are considered in the calculation of corporate bond market capitalization. Direct holdings of corporate bonds are taken from the household sector, while indirect holdings are obtained from mutual funds and pension funds holdings, etc. Moreover, cross-holdings among issuers are taken into account. For example, the holdings of corporate bonds by local governments that are also issuers of municipal bonds are not considered. ABS issuers are also excluded to avoid double counting due to multiple claims on the same underlying asset. For instance, ABS issuers securitize mortgage loans, but including ABS would constitute double counting since real estate is also included in the market portfolio.
3. **Time and Savings Deposits:** The market value figure is retrieved from direct holdings in the household sector and indirect holdings through funds.
4. **Residential Real Estate:** Holdings of residential real estate are concentrated within the household sector and can be taken from the balance sheet of U.S. households from flow-of-funds accounts. It consists of all types of owner-occupied housing including farm houses and mobile homes, as well as second homes that are not rented, vacant homes for sale, and vacant land. The calculation of the market value of residential real estate excludes real estate held by non-profit organizations, such as hospitals and museums.
5. **Commercial Real Estate:** In measuring the market value of commercial real estate, securitized and unsecuritized commercial real estate holdings are examined. Holdings of securitized commercial real estate relate to investment in commercial real estate through purchasing REIT shares, while unsecuritized commercial real estate holdings refer to holdings that are exposed to the commercial real estate market through funds under a fiduciary setting, such as pension funds holdings of commercial real estate. Market capitalization data on REITs is obtained from the NAREIT. The aggregate market value of unsecuritized commercial real estate is provided directly by the National Council of Real Estate Investment Fiduciaries (NCREIF). Data deficiency precludes a more accurate measure of commercial real estate since NCREIF members represent only a small subset of firms holding unsecuritized income-generating commercial real estate.

Exhibit 1 presents the estimates of year-end market value and weights of assets in the market portfolio. Over the sampling period of 1990 through 2008, the corporate equity portion of the asset market ranges from 19% in 1991 to 44% in 2000 in

Exhibit 1
Asset Weights and Aggregate Market Value

Asset Class	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Corporate Equity (excl. REITs)	0.2061	0.1880	0.2334	0.2461	0.2596	0.2511	0.3010	0.3302	0.3792	0.4008	0.4424	0.4042	0.3513	0.2743	0.3068	0.3015	0.2849	0.2863	0.2772
Corporate Bonds	0.0707	0.0775	0.0754	0.0777	0.0846	0.0887	0.0897	0.0889	0.0851	0.0872	0.0810	0.0846	0.0950	0.1048	0.0984	0.0976	0.0952	0.0979	0.1012
Gov. Bonds	0.1251	0.1367	0.1383	0.1443	0.1464	0.1506	0.1389	0.1317	0.1169	0.1042	0.0900	0.0841	0.0844	0.0936	0.0910	0.0905	0.0904	0.0875	0.0898
Muni. Bonds	0.0553	0.0571	0.0564	0.0539	0.0534	0.0503	0.0421	0.0377	0.0347	0.0334	0.0304	0.0315	0.0345	0.0394	0.0373	0.0364	0.0373	0.0374	0.0399
Time saving and deposits	0.1561	0.1534	0.1356	0.1214	0.1086	0.1055	0.1004	0.0980	0.0923	0.0875	0.0799	0.0879	0.0971	0.1079	0.1008	0.1016	0.1045	0.1060	0.1134
Residential Real Estate	0.3841	0.3845	0.3582	0.3538	0.3440	0.3499	0.3236	0.3082	0.2850	0.2808	0.2708	0.3014	0.3305	0.3722	0.3571	0.3625	0.3772	0.3721	0.3671
Commercial Real Estate																			
Securitized REITs	0.0007	0.0005	0.0007	0.0008	0.0015	0.0020	0.0023	0.0033	0.0046	0.0041	0.0032	0.0037	0.0041	0.0044	0.0054	0.0067	0.0067	0.0082	0.0057
Unsecuritized Pension Funds	0.0019	0.0022	0.0020	0.0020	0.0019	0.0019	0.0020	0.0020	0.0022	0.0020	0.0021	0.0026	0.0030	0.0034	0.0032	0.0032	0.0038	0.0046	0.0056
Total Market Value ($ Trillion)	16.86	17.11	18.95	20.12	21.43	21.82	24.64	27.09	30.72	33.96	38.51	37.73	37.47	36.48	41.79	46.01	49.46	53.26	54.61

terms of market value. More than half of the asset market in terms of value is represented by fixed income securities and residential real estate. In comparison, commercial real estate accounts for a small value weight in the asset market, ranging from 0.3% in 1990 to 1.3% in 2007.[5] Overall, using equity market assets to proxy for the market portfolio is rather restrictive and inadequate due to its negligence of important asset classes that have significant value weights in the asset market.

Asset Returns

Monthly asset returns were obtained as follows:

1. **REITs:** The individual REIT return series obtained from the CRSP/Ziman Real Estate Database includes all REITs traded on the NYSE, AMEX, and NASDAQ exchanges. The REIT sample survivor REITs with return information spanning the full sampling period were obtained, as well as REITs that were terminated prior to the end of the sample period. Moreover, in order to reduce noise in the estimation process, REITs that have available return series of more than 30 months were used. Based on the indicators of REIT types provided by CRSP/Ziman, equity REITs are used for the estimation, along with using all REITs.
2. **Corporate Equity:** The CRSP Value-weighted Equity Index was obtained from the CRSP U.S. Indices Database. Since REITs are included in the construction of the CRSP Index, REITs were filtered out from the CRSP Equity Index in order to have a "clean" proxy for corporate equity performance. To do this, data were collected from the CRSP database on market capitalization of both the CRSP Value-weighted Index and the CRSP/Ziman REIT Index, as well as total returns on the CRSP/Ziman REIT Index. Following formula (1) to calculate value-weighted CRSP equity index returns, the "cleaned" value-weighted equity index that excludes REITs is:

$$R_{REITs} \times weight_{REITs} + R_{Clean} \times weight_{Clean} = R_{CRSP}. \quad (1)$$

3. **Corporate Bonds:** Based on credit ratings, corporate bonds were classified into investment grade and junk bonds. Therefore, a representative corporate bond index should take both into account. Lehman investment-grade and high-yield corporate bonds indices were obtained from Datastream. The market values of these two indices were provided directly by Barclays Capital. These measures were useful in the construction of a value-weighted corporate bond index that incorporates both investment-grade and junk corporate bonds.
4. **Treasury Securities:** Applying a similar approach to the one used in constructing a representative corporate bond index, both short- and long-term Treasury securities were included in the representative Treasury index. Both the Lehman U.S. Short Treasury Index and the Lehman U.S. Treasury Index were obtained, excluding Treasury bills, from Datastream, along with corresponding market capitalization. Thus, the value-weighted U.S. composite Treasury index that was constructed contains Treasury securities with varying maturities.
5. **Municipal Bonds:** The Lehman Municipal Index, accessible through Datastream, was used to proxy for returns on municipal bonds. This index involves both investment-grade and high-yield municipal issues, and covers the U.S. dollar-denominated long-term (longer than one year) tax exempt bond market. The index covers four main sectors: state and local general obligation bonds, revenue bonds, insured bonds, and pre-refunded bonds.
6. **Residential Real Estate:** The S&P/Case-Shiller Home Price Index was used find a good return proxy for residential real estate. This index is calculated on a monthly basis and made available on the S&P website. The S&P/Case-Shiller Index employs a repeat sales methodology to measure changes in home prices given that quality attributes remain unchanged over time. The index covers 20 major metropolitan areas, and the Value-weighted Composite Home Price Index is used to impute the return series that represents the performance of the U.S. residential real estate market. Essentially, due largely to data limitations, only the capital gains on residential real estate are considered and do not take into account imputed rents (net of maintenance) in calculating total returns.

Exhibit 2
Correlations and Descriptive Statistics of Monthly Asset Returns (1990.01–2008.06)

	1	2	3	4	5	6	7	8
1. Corporate Equity	1.000							
2. Corporate Bonds	0.353	1.000						
3. Muni Bonds	0.126	0.719	1.000					
4. Time Saving Deposits	0.036	0.253	0.248	1.000				
5. Gov. Bonds	−0.020	0.756	0.736	0.431	1.000			
6. Secu. Commer. R. E.	0.435	0.345	0.225	−0.048	0.049	1.000		
7. Unsecu. Commer. R. E.	0.037	0.014	−0.026	−0.146	−0.049	0.046	1.000	
8. Residential R. E.	−0.055	−0.047	−0.008	−0.327	−0.085	0.061	0.378	1.000
Mean[a]	0.009	0.006	0.005	0.004	0.005	0.010	0.025	0.004
Std. Dev.	0.041	0.013	0.012	0.002	0.009	0.039	0.033	0.008

Note:
[a]The large average return on unsecuritized real estate is found to be due to large outliers in the monthly return series. The exclusion of imputed rents from total returns on residential real estate explains the lower return on residential real estate as compared with returns on other asset classes.

7. **Commercial Real Estate:** As mentioned above, commercial real estate was divided into securitized and unsecuritized commercial real estate holdings. Returns on securitized commercial real estate investments through REIT shares were obtained from the CRSP/Ziman Real Estate Database. The CRSP/Ziman REIT Index is representative of the performance of the REIT market in that it incorporates REITs traded in all major exchanges in the U.S. Unsecuritized commercial real estate investment returns were taken from the Transaction-based Index (TBI) provided by the MIT Center for Real Estate. The MIT/TBI is based on the transaction prices of property sold as reported in the NCREIF Property Index (NPI) database, and is available on a quarterly basis. In comparison with the popular alternative, NPI, the MIT/TBI is more transparent and objective and does not suffer from issues associated with appraisal-based indices (Geltner, MacGregor, and Schwann, 2003). The obvious drawback of the MIT/TBI for this study is that it is available only quarterly. Therefore, in order to match the data frequency with that of other assets in the construction of the market portfolio, an intra-quarter linear interpolation was applied to the MIT/TBI to obtain the monthly return series. One natural consequence of the linear interpolation is that the overall return volatility of the weighted market portfolio is reduced. However, this is not a serious concern here, since the market value of unsecuritized commercial real estate holdings is small compared with those of other asset classes, so the impact of such a treatment on the value-weighted market portfolio considered here is negligible.
8. **The Risk-free Rate.** The one-month Treasury bill rate was used to proxy for the risk-free rate and was retrieved from the CRSP database.

Exhibit 2 displays the descriptive statistics, as well as correlations among these assets on a monthly basis over the entire sampling period from January 1990 through June 2008. It is noteworthy that securitized commercial real estate in the form of REITs exhibits strong correlations with fixed-income securities and corporate equity. This is consistent with early findings that there are relationships between REIT returns and returns on stocks and bonds.[6] The fixed-income characteristic of REITs is derived from the stable payout ratio of their taxable income, which is a minimum of 90% annually. REITs also resemble equity in nature because they are publicly traded shares. Moreover, since REITs normally exhibit relatively small market capitalization, they behave similarly to small cap stocks, evidence of which has appeared in other studies such as Chan, Hendershott, and Sanders (1990), Han and Liang (1995), and Peterson

and Hsieh (1997). As a result, the volatility of the equity market has substantial bearing on REIT performance. In contrast, REITs appear to be weakly correlated with unsecuritized commercial real estate, as well as with residential real estate, which indicates that REITs cannot be treated as perfect substitutes for unsecuritized real estate. The weak correlations of unsecuritized real estate with respect to other asset classes, however, suggest that adding unsecuritized real estate to the market portfolio brings diversification potential.

Methodology and Estimation Issues

On the basis of the CAPM, the market risk premium of an individual asset can be calculated as follows:

$$\beta_i \times E(R_m - R_f), \quad (2)$$

where β_i measures the systematic risk exposure of asset i with reference to the market portfolio, and $E(R_m - R_f)$ is the unconditional expectation of the excess market return. Therefore, the estimation of the market risk premium involves two steps. First, beta is estimated using the historical return series of both the REITs and the market portfolio.

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_i \times (R_{m,t} - R_{f,t}) + \varepsilon_{i,t}, \quad (3)$$

where $(R_{i,t} - R_{f,t})$ is the excess return on REITs i at month t, $(R_{m,t} - R_{f,t})$ is the excess return on the market portfolio at month t, and $\varepsilon_{i,t}$ is the standard error term. The second step requires estimating the expected excess market return. Controversy exists with respect to the appropriate estimation procedures of the expected excess market return. On the one hand, using a long history of market returns improves estimation precision.[7] On the other hand, it is more likely that important structural breaks within a long time series are neglected than otherwise, relying on more recent data (Pástor and Stambaugh, 2001). The current study estimates the expected excess market return by averaging over the historical market return series that matches the time span of the return information for each individual REIT. For example, suppose a REIT has a return series from 1992 to 2004. Market information during the 1992–2004 period is employed in formulating the expected excess market return in the estimation of the market risk premium of this particular REIT. Some estimation accuracy due is lost to averaging over a short period of time with this procedure, but it is less likely that the calculated expected excess market return is subject to possible structural breaks in the REIT market.[8]

The REIT sample includes both survivor REITs and REITs with short lives. In order to reduce noise in the estimation, REITs that have available return information of less than or equal to 30 months are excluded so that the degrees of freedom in the regression specification (3) are at least 30. The analysis is performed on all REITs, including equity REITs, mortgage REITs, and hybrid REITs, as well as equity REITs alone, which dominate the REIT sample. Three progressively broader market proxies are used in the calculation of the market risk premiums of REITs on the basis of equation (2). The first market proxy (No. 1) is the "default" CRSP equity index. The second market proxy (No. 2) encompasses the first market proxy plus fixed-income securities. The third market proxy (No. 3) includes the second market proxy, as well as both commercial and residential real estate. Therefore, for each individual REIT, there are three estimated market risk premiums corresponding to the respective market proxies used. A paired-sample t-test is employed to assess the extent to which market composition matters in the estimation of the market risk premium for REITs.

The sampling period is from January 1990 until June 2008, which covers the "new REITs era" during which REITs experienced significant rises in both market capitalization and liquidity.[9] In order to evaluate the stability of the results, the possible structural break in the REITs industry in 2001 was taken into account, when the REIT Modernization Act was put into effect. Specifically, the Act permits a REIT to own up to a 100% controlling stake in taxable REIT subsidiaries (TRS) that can provide services to REIT tenants without disqualifying the tax exempt status of the rents that a REIT receives from its tenants. However, the Act puts an upper limit on the TRS securities holdings of REITs, which may not exceed 20% of their total assets. Moreover, the dividends from TRS are not

classified as tax-exempt REIT income. One consequence of the Act is that REITs will operate more like firms than like funds, evidence of which is seen in the inclusion of a number of REITs by the S&P in its market indices in October 2001 (Chan, Erickson, and Wang, 2003). The results of the Chow test on the structural break in the REITs market regarding REIT returns as shown in Exhibit 3 support the notion that the REIT market experienced a structural break around 2001.[10] Therefore, besides analyzing the full sampling period, the analysis is repeated for two subperiods: from January 1990 through December 2000 and from January 2001 through June 2008.

Exhibit 4 displays the descriptive statistics and correlations of various market proxies for the full sampling period, as well as for the two subperiods. Exhibit 4 makes the diversification effect obvious, as the market proxy becomes progressively broader. Monthly stock returns are rather volatile for all periods. However, the market portfolio standard deviation drops dramatically, by almost 50%, if fixed-income securities is included in addition to equity, and decreases still further if both commercial and residential real estate are included in the market portfolio. The correlations within the pairs of three market proxies are rather strong, on an order of 0.95 or higher. The strong correlations suggest that the equity market proxy closely tracks the movement of monthly returns on the broader market proxies. Overall, Exhibit 4 sheds light on the inadequacy of using equity alone as the market proxy with respect to capturing the magnitude and dispersion of returns on alternative market proxies that are more complete.

Exhibit 3
Chow Tests on the Stability of the REIT Beta

	F-Statistic		
Market Proxy	No. 1	No. 2	No. 3
All REITs	2.754*	3.084**	3.376**
Equity REITs	2.285	2.527*	2.747*

Notes: This table shows the results of the structural break test at approximately the time of the introduction of the REIT Modernization Act. The No. 1 market proxy is the CRSP Equity Index. The No. 2 market proxy is the No. 1 market proxy plus fixed-income securities. The No. 3 market proxy includes the No. 2 market proxy and real estate. The sample is 1990.01–2000.12 vs. 2001.01–2008.06.
* Significant at the 10% level.
** Significant at the 5% level.

Exhibit 4
Descriptive Statistics Indicating Monthly Returns on Market Proxies and their Correlations

			Correlations between Market Proxies	
Market Proxy	Mean	Std. Dev.	No. 2	No. 3
1990.01–2008.06				
No. 1	0.009	0.041	0.977	0.952
No. 2	0.006	0.022		0.977
No. 3	0.005	0.015		
1990.01–2000.12				
No. 1	0.013	0.042	0.974	0.953
No. 2	0.009	0.022		0.988
No. 3	0.007	0.015		
2001.01–2008.06				
No. 1	0.003	0.040	0.981	0.950
No. 2	0.003	0.021		0.961
No. 3	0.004	0.014		

Notes: This table displays the descriptive statistics on the three market proxies and the correlations among them. The No. 1 market proxy is the CRSP equity index. The No. 2 market proxy is the No. 1 market proxy plus fixed-income securities. The No. 3 market proxy includes the No. 2 market proxy and real estate.

The details regarding the REIT sample that satisfy the inclusion criteria are shown in Exhibit 5. For the full sampling period and the two subperiods, equity REITs dominate the REIT sample. Therefore, few mortgage REITs or hybrid REITs are available for independent analysis along with equity REITs. Moreover, the survivor REITs represent only a small portion of the full REIT sample, which includes REITs with short lives in addition to survivor REITs. For the entire sampling period, the number of REITs in the survivor sample is roughly 10% of that in the full sample, which rises to around 50% during the period of 2001–2008. In particular, more than 80% of REITs perished during the 1990–2000 period as compared with less than 50% for the 2001–2008 period. The underrepresentation of REITs in the survivor sample casts doubt on the possibility of obtaining unbiased estimation results based on using surviving REITs exclusively in the analysis. Exhibit 5 demonstrates that, on average, survivor REITs outperform those in the full REIT sample on a risk-adjusted basis

Exhibit 5
REIT Sample Statistics

	1990.01–2008.06	1990.01–2000.12	2001.01–2008.06
Survivor Sample			
Number of all REITs	39	50	115
Mean nominal return	0.013	0.012	0.013
Std. dev. of return	0.006	0.008	0.007
Number of equity REITs	31	40	95
Mean nominal return	0.012	0.011	0.013
Standard dev. of return	0.006	0.009	0.006
Full Sample			
Number of all REITs	370	300	223
Mean nominal return	0.009	0.008	0.011
Std. dev. of return	0.014	0.012	0.015
Number of equity REITs	299	249	183
Mean nominal return	0.010	0.009	0.013
Std. dev. of return	0.012	0.012	0.010

Note: This table shows the sample statistics pertaining to the REITs in both the survivor sample and the full sample that includes REITs with short lives.

for both the full sampling period and the two subperiods.

Estimation Results

REIT Betas

Following the two-step estimation procedure outlined above, the beta for each individual REIT is estimated on the basis of the regression specification (3). Exhibit 6 displays the summary statistics on the estimated betas based on the survivor REIT sample. It is interesting to note that the mean REIT beta exhibits a systematic tendency to increase as the market proxy becomes broader. Specifically, the mean REIT beta rises more than twofold when the market proxy transitions from using the CRSP Index alone to including fixed-income securities, as well as commercial and residential real estate. Caution should be exercised when interpreting this result insofar as one should not compare betas on absolute terms as the market proxy changes from one to another, which is similar to rescaling the beta as the reference market portfolio is adjusted. In other words, beta can be interpreted sensibly only with respect to the market portfolio. Therefore, the upward trend of the mean REIT beta implies that REITs involve more systematic risk exposure when included in a more diversified market portfolio.

When comparing the means of the REIT betas with reference to the same market proxy when using all REITs and equity REITs alone, the mean REIT beta is higher for all REITs than for equity REITs for the January 1990–June 2008 and January 1990–December 2000 periods. This finding indicates a relatively high systematic risk exposure for mortgage REITs and hybrid REITs when they are included in the all REIT sample in addition to equity REITs, which is in line with the findings of Goldstein and Nelling (1999). The picture is reversed, however, for the January 2001–June 2008 period, during which equity REITs are marginally riskier than mortgage REITs. During the full sampling period, the systematic risk exposure of REITs is below unity with respect to all market proxies, indicating that REITs are rather conservative investment relative to the market. Exhibit 6 also provides evidence of the asymmetric pattern of REIT betas over the two subperiods. In particular, the mean REIT beta is lower during the January 1990–December 2000 period than it is during the January 2001–June 2008 period for both the all REIT sample and the equity REIT sample. Over the January 2001–June 2008 period, for both the all REIT sample and the equity REIT sample, the mean REIT beta is approximately 1.3 when the most diversified market portfolio is employed in beta estimation, which demonstrates that REITs are not as conservative as investors once perceived

Exhibit 6
Summary Statistic of Survivor REIT Beta Estimates

	No. 1		No. 2		No. 3	
Market Proxy	Beta	SE	Beta	SE	Beta	SE
Panel A: All REITs						
1990.01–2008.06						
Mean beta	0.319	0.146	0.578	0.280	0.829	0.405
Std. dev.	0.192	0.093	0.355	0.179	0.506	0.259
Min.	−0.090	0.051	−0.237	0.097	−0.301	0.141
Max.	0.845	0.596	1.659	1.143	2.581	1.653
N	39		39		39	
Mean Adj. R^2	0.031		0.027		0.026	
1990.01–2000.12						
Mean beta	0.354	0.203	0.623	0.388	0.837	0.564
Std. dev.	0.258	0.137	0.451	0.262	0.636	0.379
Min.	−0.414	0.069	−0.279	0.131	−0.526	0.190
Max.	1.055	0.902	2.032	1.723	2.667	2.499
N	50		50		50	
Mean Adj. R^2	0.030		0.023		0.019	
2001.01–2008.06						
Mean beta	0.435	0.196	0.835	0.379	1.284	0.538
Std. dev.	0.279	0.102	0.546	0.197	0.795	0.281
Min.	−0.933	0.072	−1.953	0.137	−2.560	0.196
Max.	1.456	0.630	2.675	1.218	3.870	1.736
N	115		115		115	
Mean Adj. R^2	0.074		0.072		0.082	
Panel B: Equity REITs						
1990.01–2008.06						
Mean beta	0.284	0.134	0.510	0.257	0.732	0.372
Std. dev.	0.160	0.099	0.272	0.190	0.374	0.274
Min.	−0.090	0.051	−0.237	0.097	−0.301	0.141
Max.	0.623	0.596	1.041	1.143	1.462	1.653
N	31		31		31	
Mean Adj. R^2	0.033		0.028		0.027	
1990.01–2000.12						
Mean beta	0.301	0.186	0.511	0.356	0.673	0.518
Std. dev.	0.228	0.142	0.349	0.272	0.478	0.394
Min.	−0.414	0.069	−0.279	0.131	−0.526	0.190
Max.	0.821	0.902	1.317	1.723	1.677	2.499
N	40		40		40	
Mean Adj. R^2	0.029		0.022		0.017	
2001.01–2008.06						
Mean beta	0.453	0.173	0.861	0.336	1.313	0.476
Std. dev.	0.277	0.078	0.544	0.151	0.771	0.216
Min.	−0.933	0.072	−1.953	0.137	−2.560	0.196
Max.	1.456	0.630	2.675	1.218	3.870	1.736
N	95		95		95	
Mean Adj. R^2	0.085		0.082		0.094	

Notes: This table shows the beta estimates using the survivor REIT sample for the full sampling period, as well as the two subperiods with respect to various market proxies. The No. 1 market proxy is the CRSP Equity Index. The No. 2 market proxy is the No. 1 market proxy plus fixed-income securities. The No. 3 market proxy includes the No. 2 market proxy and real estate. The number of observations is 95.

them to be with reference to a broad market portfolio.

In order to assess the robustness of the findings relating to REIT betas using only survivor REITs, the beta estimation procedure is repeated using the full REIT sample that takes into account REITs with short lives along with survivor REITs. The beta estimation results are summarized in Exhibit 7. The findings regarding the mean REIT beta are similar to those found using the survivor REIT sample. The mean REIT beta increases monotonically as the market portfolio becomes more diversified. The relatively high systematic risk exposures of mortgage REITs and hybrid REITs as compared with those of equity REITs are also evident when contrasting the mean REIT beta using the all REIT sample with that using the equity REIT sample. The asymmetric nature of the mean REIT beta is present over the two subperiods. To evaluate the degree of survivor bias in terms of beta estimation, the estimated mean REIT beta is compared across Exhibit 6 and Exhibit 7 while controlling for the market proxy used in the estimation. Over the full sampling period, using the survivor REIT sample understates the systematic exposure of REITs to the market for both the all REIT sample and the equity REIT sample. Interesting results emerge regarding survivor bias over the two subperiods. During the January 1990–December 2000 period, the mean REIT beta using survivor REITs marginally overstates that using the full REIT sample. However, over the following subperiod, the survivor bias turns negative as is the case over the full sampling period.

In general, the findings regarding REIT betas when using the equity index as the market proxy confirm the results of other studies that REITs have low betas relative to the equity market proxy (Chan, Hendershott, and Sanders, 1990; Peterson and Hsieh, 1997; Lee, Lee, and Chiang, 2008). Contrary to the findings of these other studies, for the January 2001–June 2008 period, the mean REIT beta is well above unity (1.3 or higher) when taking the most diversified market proxy in the estimation, which persists for both the survivor and full REIT samples. The result showing the asymmetric nature of REIT betas is in line with prior findings of varying REIT betas during varying market circumstances (Sagalyn, 1990; Goldstein and Nelling, 1999; Chatrath, Liang, and W. McIntosh, 2000; Chiang, Lee, and Wisen, 2004, 2005). In the context of this paper, the asymmetric REIT betas seem to suggest that the systematic risk exposure of REITs is sensitive to the structural break in the REIT market.

The rise in REIT betas relative to the broader market proxy is, to a large extent, due to the addition of other asset classes in the market proxy along with equities that substantially reduce the overall volatility of the market proxy. Exhibit 8 illustrates the return correlations of the CRSP/Ziman REIT Index with other asset classes, as well as with market proxies. The correlations of REITs with various market proxies are quite close to one another for all periods. Therefore, the source that drives REIT betas to increase as the market proxy becomes broader is the diversification effect through the inclusion of other assets in the market proxy, which is evidenced by the standard deviations of the market proxies in Exhibit 8. Examining the correlations of REITs with various asset classes over the two sub-periods, it is interesting to note that REIT returns are more strongly correlated with returns on fixed-income securities while being more weakly correlated with returns on unsecuritized real estate for the January 1990–December 2000 period than are those for the subsequent period. Overall, correlations of REITs with the three market proxies are close to 0.5 over the January 2001–June 2008 period, while they are below 0.41 for the period prior to 2001. Given similar return volatilities of REITs and the three market proxies over the two sub-periods, the finding of the time dependence of REIT betas seems attributable to the time dependence of the return correlation structure between REITs and various market proxies.[11]

The REIT Market Risk Premium

Given the estimated beta for each individual REIT, the corresponding market risk premium with respect to various market proxies can be calculated by following equation (2). The summary statistics for the estimated market risk premium using the survivor REIT sample are shown in Exhibit 9. For the full sampling period, the estimated mean REIT

Exhibit 7
Summary Statistics for Full REIT Beta Estimates

	No. 1		No. 2		No. 3	
Market Proxy	Beta	SE	Beta	SE	Beta	SE
Panel A: All REITs						
1990.01–2008.06						
Mean beta	0.431	0.253	0.847	0.512	1.214	0.748
Std. dev.	0.470	0.207	0.975	0.465	1.488	0.696
Min.	−0.944	0.051	−1.617	0.097	−2.757	0.141
Max.	3.113	1.330	6.473	2.948	12.060	4.730
N	370		370		370	
Mean Adj. R^2	0.049		0.047		0.047	
1990.01–2000.12						
Mean beta	0.287	0.249	0.531	0.022	0.754	0.735
Std. dev.	0.292	0.178	0.585	0.044	0.865	0.659
Min.	−1.006	0.069	−1.968	−0.032	−2.950	0.190
Max.	1.426	1.207	2.956	0.253	4.450	4.730
N	300		300		300	
Mean Adj. R^2	0.024		0.022		0.020	
2001.01–2008.06						
Mean beta	0.571	0.262	1.150	0.086	1.672	0.731
Std. dev.	0.545	0.190	1.127	0.102	1.748	0.529
Min.	−0.944	0.072	−1.953	−0.028	−2.562	0.196
Max.	3.113	1.330	6.473	0.579	12.060	3.698
N	223		223		223	
Mean Adj. R^2	0.087		0.086		0.091	
Panel B: Equity REITs						
1990.01–2008.06						
Mean beta	0.382	0.222	0.733	0.442	1.014	0.649
Std. dev.	0.423	0.174	0.858	0.390	1.156	0.598
Min.	−0.944	0.051	−1.617	0.097	−2.757	0.141
Max.	3.113	1.156	6.473	2.619	8.117	4.150
N	299		299		299	
Mean Adj. R^2	0.050		0.048		0.047	
1990.01–2000.12						
Mean beta	0.261	0.229	0.469	0.445	0.661	0.661
Std. dev.	0.265	0.168	0.516	0.381	0.767	0.602
Min.	−1.006	0.069	−1.968	0.131	−2.950	0.190
Max.	1.124	1.156	2.804	2.619	4.409	4.150
N	249		249		249	
Mean Adj. R^2	0.024		0.022		0.021	
2001.01–2008.06						
Mean beta	0.518	0.221	1.026	0.436	1.439	0.619
Std. dev.	0.490	0.127	0.999	0.262	1.335	0.211
Min.	−0.944	0.072	−1.953	0.137	−2.562	0.196
Max.	3.113	0.889	6.473	1.771	8.117	2.511
N	183		183		183	
Mean Adj. R^2	0.091		0.090		0.093	

Notes: This table shows the beta estimates using the full REIT sample including REITs with short lives along with survivor REITs for the full sampling period as well as for the two subperiods with respect to various market proxies. The No. 1 market proxy is the CRSP Equity Index. The No. 2 market proxy is the No. 1 market proxy plus fixed-income securities. The No. 3 market proxy includes the No. 2 market proxy and real estate.

Exhibit 8
Correlations of REITs with Other Asset Classes and Market Proxies

	1990.01–2000.12	2001.01–2008.06	1990.01–2008.06
Corporate Bonds	0.396	0.293	0.345
Muni Bonds	0.284	0.163	0.225
Time Saving Deposits	0.067	−0.149	−0.048
Gov. Bonds	0.222	−0.132	0.049
Corporate Equity	0.403	0.497	0.435
Unsecu. Commer. R. E.	−0.151	0.057	0.046
Residential R. E.	−0.097	0.161	0.061
Market Proxy			
No. 1	0.409	0.513	0.446
No. 2	0.368	0.499	0.415
No. 3	0.341	0.524	0.415
Std. Dev.			
REITs	0.036	0.044	0.039
Market Proxy			
No. 1	0.042	0.040	0.041
No. 2	0.022	0.021	0.022
No. 3	0.015	0.014	0.015

Notes: This table shows the correlation between REITs and various asset classes that are used to construct three distinct market proxies. The No. 1 market proxy is the CRSP Equity Index. The No. 2 market proxy is the No. 1 market proxy plus fixed-income securities. The No. 3 market proxy includes the No. 2 market proxy and real estate.

Exhibit 9
Summary Statistics for the Market Risk Premium of Survivor REITs

	All REITs			Equity REITs		
Market	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3
1990.01–2008.06						
Mean	0.002	0.002	0.002	0.002	0.002	0.002
Std. dev.	0.001	0.001	0.001	0.001	0.001	0.001
N	39	39	39	31	31	31
1990.01–2000.12						
Mean	0.003	0.003	0.002	0.003	0.002	0.002
Std. dev.	0.002	0.002	0.002	0.002	0.002	0.001
N	50	50	50	40	40	40
2001.01–2008.06						
Mean	0.000	0.001	0.002	0.000	0.001	0.002
Std. dev.	0.000	0.000	0.001	0.000	0.000	0.001
N	115	115	115	95	95	95

Notes: This table shows the statistics for the market risk premium of survivor REITs. The No. 1 market proxy is the CRSP Equity Index. The No. 2 market proxy is the No. 1 market proxy plus fixed-income securities. The No. 3 market proxy includes the No. 2 market proxy and real estate.

market risk premium using the all REIT sample does not differ across choices of market proxy. On average, REITs are compensated by 17 basis points monthly for their exposure to general market risk.

Similar results obtain for the equity REIT sample. However, the marginally lower mean market risk premium of equity REITs suggests that, on average, mortgage REITs and hybrid REITs are riskier than equity REITs are. Overall, using the CRSP

Exhibit 10
Summary Statistics for the Market Risk Premium of Full REITs

	All REITs			Equity REITs		
Market	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3
1990.01–2008.06						
Mean	0.002	0.003	0.002	0.002	0.002	0.002
Std. dev.	0.003	0.003	0.004	0.003	0.003	0.003
N	370	370	370	299	299	299
1990.01–2000.12						
Mean	0.003	0.003	0.002	0.003	0.002	0.002
Std. dev.	0.003	0.003	0.002	0.003	0.003	0.003
N	300	300	300	249	249	249
2001.01–2008.06						
Mean	0.001	0.002	0.003	0.001	0.001	0.002
Std. dev.	0.003	0.003	0.005	0.002	0.002	0.004
N	223	223	223	183	183	183

Notes: This table shows the statistics for the market risk premium of REITs using the full REIT sample that includes REITs with short lives along with survivor REITs. The No. 1 market proxy is the CRSP Equity Index. The No. 2 market proxy is the No. 1 market proxy plus fixed-income securities. The No. 3 market proxy includes the No. 2 market proxy and real estate.

Equity Index as the market portfolio seems robust to the issue of market portfolio composition. Nonetheless, when the structural break in the REIT market around 2001 is taken into account, the estimated mean REIT market risk premium exhibits a systematic tendency to decrease as the market portfolio becomes more diversified over the January 1990–December 2000 period. A significant portion of such a decrease is driven by the inclusion of real estate assets in the market portfolio. For instance, for the all REIT sample, a reduction of 9 out of 10 basis points of the estimated monthly market risk premium is the result of altering the market portfolio to incorporate real estate assets. On the other hand, over the January 2001–June 2008 period, there is an upward trend in the mean estimated REIT market risk premium as the market portfolio becomes progressively broader, which is mostly accounted for as real estate assets enter the market portfolio composition. Using the CRSP Index as the default market portfolio, the degree of bias is small, on the order of 1 to 3 basis points monthly in absolute terms, as compared with the alternative market portfolio that consists of fixed-income securities in addition to equity. When real estate assets are considered in the market portfolio composition as well as equity and fixed-income securities, the degree of bias is more pronounced, which, in absolute terms, ranges from 10 to 16 basis points monthly.

Since the results shown in Exhibit 9 are obtained through applying only survivor REITs, they may be subject to survivor bias. To examine the robustness of these results, the identical estimation procedure is followed while using the full REIT sample. The results are in Exhibit 10. Similar patterns of estimated REIT market risk premiums are found as compared with those in Exhibit 8 for various market proxies. Over the full sampling period, the mean estimated REIT market risk premium does not vary significantly as the market portfolio becomes more complete. On average, there is a mere 1 basis point difference between using market proxies No. 1 and No. 3 for both the all REIT sample and the equity REIT sample. For the January 1990–December 2000 subperiod, using the CRSP Equity Index as the market portfolio causes an upward bias in the estimation of the REIT market risk premium of between 5 and 10 basis points monthly relative to the most diversified market portfolio. However, the bias turns negative for the January 2001–June 2008 period, and the degree of downward bias using the CRSP Equity Index is from 14 to 15 basis points monthly with respect to the market portfolio consisting of equity, fixed-

Exhibit 11

Results of Paired Sample *t*-tests of the Mean Risk Premium Difference

	Survivor REITs Sample		Full REITs Sample	
Market Proxy	All REITs	Equity REITs	All REITs	Equity REITs
1990.01–2008.06				
No. 1–No. 2	−0.00006	−0.00004	−0.00017**	−0.00009**
	(0.00004)	(0.00004)	(0.00003)	(0.00004)
No. 2–No. 3	0.00010**	0.00008**	0.00027	0.00019
	(0.00003)	(0.00003)	(0.00016)	(0.00013)
No. 1–No. 3	0.00004	0.00004	0.00010	0.00009
	(0.00004)	(0.00005)	(0.00015)	(0.00013)
1990.01–2000.12				
No. 1–No. 2	0.00013	0.00019**	0.00004	0.00011**
	(0.00008)	(0.00009)	(0.00004)	(0.00004)
No. 2–No. 3	0.00088**	0.00076**	0.00059**	0.00042**
	(0.00009)	(0.00009)	(0.00009)	(0.00008)
No. 1–No. 3	0.00101**	0.00095**	0.00064**	0.00053**
	(0.00013)	(0.00015)	(0.00007)	(0.00007)
2001.01–2008.06				
No. 1–No. 2	−0.00029**	−0.00030**	−0.00035**	−0.00033**
	(0.00002)	(0.00002)	(0.00003)	(0.00003)
No. 2–No. 3	−0.00125**	−0.00127**	−0.00106**	−0.00106**
	(0.00007)	(0.00007)	(0.00027)	(0.00025)
No. 1–No .3	−0.00154**	−0.00157**	−0.00141**	−0.00138**
	(0.00009)	(0.00009)	(0.00028)	(0.00026)

Notes: This table shows the *t*-test results to determine whether the mean risk premiums of the three market proxies are significantly different from each other. The test is conducted for both survivor REITs as well as the full REIT sample, including REITs with short lives along with the survivor REITs. The No. 1 market proxy is the CRSP Equity Index. The No. 2 market proxy is the No. 1 market proxy plus fixed-income securities. The No. 3 market proxy includes the No. 2 market proxy and real estate.
** Significant at the 5% level.

income securities, and real estate. In absolute terms, a large portion of the bias can be attributed to the inclusion of real estate assets in the market portfolio, which is consistent with the findings obtained when using only the survivor REIT sample.

Comparing the mean estimated market risk premium while controlling for the market proxy across Exhibits 9 and 10, survivor REITs exhibit, on average, a lower market risk premium than does the full REIT sample, which holds true for the full sampling period, as well as for the January 2001–June 2008 period. This indicates that survivor REITs suffer less market risk exposure as compared with REITs that have short lives.

Overall, Exhibits 9 and 10 demonstrate that bias arises in the estimation of the REIT market risk premium as the market portfolio composition varies. However, the direction of bias seems sensitive to the structural break in the REITs market, which is positive over the subperiod of January 1990–December 2000 and turns negative for the period of January 2001–June 2008 period. In addition, examining the degree of bias as various market portfolios are used in the estimation of the REIT market risk premium reveals that adding real estate assets to the market portfolio accounts for a significant portion of the bias. Over the January 1990–December 2000 period, including real estate in the market proxy accounts for more than 80% of the total bias, which is more than 75% that of the January 2001–June 2008 period.

Exhibit 11 shows the results of paired sample *t*-tests used to evaluated the statistical significance

of the difference in the estimated market risk premium of REITs using various market portfolios.[12] For the full sampling period, the difference in the estimation of REIT market risk premiums with respect to any pair of market proxies does not appear to be significantly different from zero. Moreover, the mean differences are small in absolute terms, ranging from 0.4 to 2.7 basis points monthly. Therefore, for the full sampling period, market portfolio composition does not significantly affect the estimation of the REIT market risk premium. In other words, using the equity index alone is robust to the estimation of the REIT market risk premium. However, when the structural break in the REIT market is taken into account, the mean REIT market risk premium differs significantly across the pairs of market proxies used in the estimation. During the January 1990–December 2000 period, using a less diversified market proxy significantly overstates the REIT market risk premium, and the bias turns negative for the January 2001–June 2008 period. Most of the paired differences are significant at the 5% level. In addition, using the REIT survivor sample, on average, overstates the degree of the significant positive bias as compared with that for full REIT sample.

Conclusion

Estimation of the asset risk premium is potentially subject to bias that may arise due to the omission of certain asset classes from the market portfolio proxy according to the CAPM. In practice, popular market proxies such as the S&P 500 Index and the CRSP Equity Index are prone to such bias due to their excluding some asset classes from the full asset universe. This paper empirically examines the degree and significance of bias in the estimation of the REIT market risk premium that results from excluding various asset classes, such as fixed-income securities and real estate, from the market proxy.

There are three primary findings. First, the mean REIT beta estimation is positively related to the breadth of the market proxy used. As the market proxy becomes progressively broader, the mean REIT beta rises accordingly. This indicates that REIT investments are not as conservative as investors once perceived them to be when equity indices are used to proxy for the market portfolio. Second, the estimation of the market risk premium of REITs is sensitive to both the structural break in the REITs market and the composition of the market proxy. The composition of the market proxy does not seem to matter for the estimation of the REIT market risk premium over the full sampling period, but when the structural break in the REITs market that occurred around 2001 is taken into consideration, the REIT market risk premium is overstated significantly, by 5 to 10 basis points monthly, when using the most restrictive market proxy as compared with the most diversified market proxy over the pre-2001 period. The bias turns significantly negative, ranging from 14 to 15 basis points monthly, over the post-2001 period. Third, a substantial portion of the bias in REIT market risk premium estimation arising from using the most restrictive market proxy can be attributed to the exclusion of real estate from the market proxy, which is more than 80% during the January 1990–December 2000 period and 75% over the following period, respectively.

The findings are relevant to both institutional and individual investors who are seeking real estate exposure through investing in REITs due to the increasing market capitalization and liquidity of this asset class. The composition of the market proxy matters for estimating the REIT market risk premium; ignoring market proxy composition can potentially lead to erroneous capital budgeting decisions, as well as faulty performance evaluations.

Appendix

Flow of Funds Sources for Retrieving Asset Market Values

Asset Class	Flow of Funds Account Source
Corporate Equity	L.213 Account No. 20 − REITs
Treasury Securities	L.209 Account No. 3
Muni. Securities	L.211 Account No. 2
Corporate Bonds	L.212 Account No. 13 + 20 + ... + 27
Time and Saving Deposits	L.205 Account No. 17 + 27 + 28 + 29
Residential Real Estate	B.100 Account No. 4

Endnotes

1. No attempt is made to find a market portfolio that is exhaustive in its coverage of assets. Therefore, the market portfolio omits consumer durables and human capital due to the complexity and questionable validity involved in estimating their market values, as well as returns.
2. It should be noted that the CRSP Equity Index contains REITs and is therefore not a "pure" equity index representing the U.S. equity market.
3. Source details on the flow-of-funds accounts used to retrieve the asset market value are in the Appendix.
4. Mutual funds shares are excluded to avoid double counting of corporate equity.
5. Due to data limitations regarding the market value of commercial real estate, these figures should not be generalized to represent the market value of the entire actual unsecuritized commercial real estate asset class.
6. See, for example, Chan, Hendershott, and Sanders (1990), Liang, McIntosh, and Webb (1995), and Sanders (1998).
7. The equity return series used dates back to the nineteenth century and was constructed in Schwert (1990).
8. Another practical issue that motivates us in using short time series of market returns is that of data limitations. Some assets within our market portfolio possess return information only after the 1980s or even later, which prohibits us from estimating the expected excess market return through averaging over a long time horizon.
9. One of the factors contributing to the growth of REITs after 1990 is the passage of the Omnibus Budget Reconciliation Act of 1993, which stimulated pension fund investments in REITs, leading to growth in REIT market capitalization and increased liquidity in the REIT market.
10. The Chow test is performed using total returns on the all REIT portfolio and the equity REIT portfolio that represent the overall REIT market and the equity REIT market, respectively. The return data were obtained from NAREIT.
11. The time dependence of return correlations between REITs and market portfolio merits further exploration, which is beyond the scope of this paper.
12. The paired sample t-test statistic = $\bar{d}/se_{\bar{d}}$, where $\bar{d}$ is the mean difference between the pairs, and $se_{\bar{d}}$ is the standard error of the mean difference between the pairs.

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