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International Asset Allocation with Real Estate Securities in a Shortfall-Risk Framework: The Viewpoint of German and US Investors

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International Asset Allocation with Real Estate Securities in a Shortfall-Risk Framework: The Viewpoint of German and US Investors

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Abstract

The present paper seeks to study the possible diversification potential by the integration of indirect real estate investments in international portfolios. To this end, monthly index-return time-series in the time-period from January 1985 till December 1998 from real estate investment companies as well as common stocks and bonds in Germany, France, Switzerland, Great Britain and the USA were used. We utilize, due to the critical normal distribution assumption, a mean/lower-partial-moment framework. In order to take into account the influence of the currency risk for international investments the analyses have been undertaken both with as well as without hedging the currency risk. We take the viewpoint of a German as well as that of a US-investor to gain insight into the dependency of the diversification potential on the reference currency of the investor.

JEL-Classification: G11, G15
Keywords: Real Estate Securities, International Portfolio Choice, Shortfall Risk

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1 Introduction

Traditionally real estate has been regarded as an asset class, which displays a specific risk/return characteristic and low co-movements with investments on the domestic bond and stock markets. Therefore, adding real estate to a portfolio of stocks and bonds should improve the risk/return profile from the perspective of a domestic investor. Using the concept of hedged indices *Stevenson* (2000) recently showed, that these low co-movements could not only be found between the local but also between international capital- and real estate-markets. Because the benefits of international portfolio diversification stem mainly from the fact of low co-movements between different national asset-markets, adding real estate into an international portfolio of stocks and bonds should improve the benefits from international portfolio diversification substantially. However, the possibility to create a well-diversified international property portfolio is in contrast to the traditional asset categories burdened with some problematic features. The large size of property investments, the lack of a central market, the existence of high transaction costs, low liquidity, the need of local market knowledge and the management requirements imply substantial problems for (private as well as institutional) investors to add direct property investments into internationally diversified portfolios.

A possibility for avoiding these drawbacks of direct property investments might be to purchase units of real estate companies as an indirect (securitized) form of real estate investment. Real estate investment companies can be characterized (in the sense of a collective investment scheme) as pools of assets in which investors participate in the financial results of a specific portfolio of professionally managed income producing properties, such as housing, commercial properties or both. The shares of property investment companies are liquid in the sense, that there exists an active secondary market. A critical question, which has been the centerpiece of several empirical studies (e.g. *Eichholtz* (1996a, 1996b), *Eichholtz*/*Huisman*/*Koedijk*/*Schuin* (1997) and *Liu*/*Mei* (1998)), is whether diversifying internationally with real estate securities provides incremental diversification benefits. The main objective of this paper is to provide additional empirical evidence concerning the diversification benefits of real estate securities. Therefore we extend the existing studies in this field with respect to the database used and concerning the following aspects.

As fluctuating exchange rates represent an additional risk factor for investors who want to diversify internationally, it is important to study whether hedging the exchange rate risk influences the diversification potential. Studies regarding international bond and stock markets by, for example, *Eun*/*Resnick* (1988, 1994), *Kaplanis*/*Schaefer* (1991), *Eaker*/*Grant* (1990), *Eaker*/*Grant*/*Woodard* (1991) and *Glen*/*Jorion* (1993) have registered significant performance

differences for hedged and unhedged portfolios. For this reason, we examine the dependency of the diversification potential on a currency hedging strategy using forward contracts with unitary hedge ratios. In the case where the currency exposure is not unitary hedged, it might be assumed that the diversification potential will depend on the reference currency of the investor. In this context, *Eun*/*Resnick* (1994), *Liljeblom*/*Löflund*/*Krokfors* (1997) and *Bugár*/*Maurer* (2001) have ascertained significant differences for the potential diversification gains through the expansion of the investment universe in international bond and stock investments for investors in different countries. In order to illuminate the importance of the reference currency, we have taken the viewpoint of a German as well as a US-investor.

Most studies of international portfolio diversification have been carried out using the classical mean/variance approach, as the research framework of rational financial decision-making under risk. However, the basic limitation of such an approach is the lack of a satisfactory choice-theoretic foundation: The mean/variance framework requires either quadratic utility functions or symmetric return distributions. Neither assumption is in empirical situations necessarily correct. A quadratic utility function could be inappropriate, because it implies decreasing marginal utility of wealth as well as increasing absolute and relative risk-aversion. Both is criticized from a descriptive as well as from a normative perspective (see among others, *Hanoch*/*Levy* (1970), *Fishburn* (1977) and *Weber* (1990)). In addition empirical observations show distinctly asymmetrical return distributions with significant moments beyond mean and variance, which is inconsistent with the assumption of a symmetric bell-shaped return distribution. In order to avoid these critical assumptions we adopt a mean/shortfall-risk framework for rational financial decision making in the asset allocation context. Shortfall-risk measures formulate the downside-risk as a probability-weighted function of negative deviations from a predetermined target. These risk measures, which explicitly reflect the asymmetry of the probability distribution of asset returns, have attracted considerable interest in the more recent literature on real estate portfolio management (e.g. *Sing/Ong* 2000).

The present study is structured as follows: in the second part, the data as well as the research design, which have been used in this study, are descripted. In section three, there follows an ex-post analysis of the diversification potential of real estate companies and their dependencies on home country and currency hedging. Section four consists of an ex-ante analysis of the diversification potential. Here we have studied, within the framework of alternative investment strategies, the effects of the integration of real estate companies on international portfolios and their dependency on exchange risk hedging and reference currencies. Section five concludes the study with a summary of the most important results.

2 Data and Methodology

2.1 Data collection and description

For this study we employed historical time-series of the stock and bond markets as well as those of real estate securities for Germany (GER), France (F), Great Britain (GB), Switzerland (CH) and the USA (US) over a time-period from January 1985 till December 1998. Measured against the market capitalization and the turnovers, these countries belong to the most important financial markets with active currency forward markets, which allow hedging the exchange rate risk. The *Morgan Stanley Capital International* (*MSCI*) indices have been used as representative of the stock markets, and the *Salomon Brothers World Government Bond* (*SWGB*) indices for the bond markets. These well-diversified indices are adjusted for capital gains, dividend and interest payments and include the most important stocks/bonds of the various local markets.

To provide comparable index portfolios with a designated investment objective in the major local real estate securities, use has been made of the NAREIT-Index for the USA, the ISB Bopp-Index for Switzerland and FTSE-Property Index for Great Britain. For France and Germany we employed the database described in the study of *Maurer*/*Sebastian* (2000). In the case of Germany, we used an index-portfolio consisting of the major German open-ended real estate funds and combined this with an index of the major German listed real estate stocks into an equally weighted index. In the case of France we employed a value-weighted index, which consists of the major listed corporate property companies.

Table 1 gives an overview of some descriptive statistics of the applied monthly index time-series for the period of study from January 1985 till December 1998 on the basis of monthly returns, which have been calculated from the month-end balances of the respective indices. As expected, the mean returns and the return standard deviations of the stock markets are significantly higher than those of the bond markets. The real estate companies display, on average, higher mean returns than bonds, with return standard deviations which are very similar to those of the stock markets.

The empirical skewness gives an impression of the asymmetry of the probability distribution of the return series around their means. The estimated values shown in Table 1 for the skewness suggest that the monthly returns for the stock markets all display long left tails. The empirical skewness of the bond markets is uneven and, additionally, with the exception of the German bond market, relatively small. The empirical skewness for the real estate companies

suggests a long right tail for Germany, Switzerland and the USA, while for France and Great Britain a leftward skewed probability distribution appears.

Another measure to characterize the probability distribution is the excess-kurtosis. In the case of all stock markets and the real estate companies, the empirical excess-kurtosis shows significantly positive values. For the bond markets, although they are also positive in most cases, they are only slightly greater than zero. This would suggest that the probability distribution for the stock markets and real estate companies is peaked relative to the normal distribution.

Table 1: Descriptive Statistics for the Index Time-Series of the Utilized Stock and Bond Markets and the Real Estate Companies

	Stock Markets					**Bond Markets**					**Real Estate Companies**				
	GER	**F**	**GB**	**CH**	**US**	**GER**	**F**	**GB**	**CH**	**US**	**GER**	**F**	**GB**	**CH**	**US**
$\bar{r}$	1.30	1.48	1.37	1.53	1.56	0.64	0.87	0.97	0.47	0.79	0.96	0.63	1.00	0.71	1.17
$\hat{\sigma}$	6.17	6.15	4.94	5.55	4.34	0.99	1.29	1.95	0.95	1.43	2.53	5.65	6.08	2.42	4.62
$\hat{\gamma}$	-0.72	-0.30	-1.01	-0.94	-1.12	-0.55	-0.05	-0.08	-0.08	0.13	0.47	-1.46	-0.66	0.40	3.55
$\hat{\kappa}$	1.77	0.95	4.63	2.55	4.46	0.15	-0.02	1.29	0.92	-0.05	2.22	7.57	2.37	1.92	31.79
J/B	36.65	8.90	178.2	70.59	174.3	8.53	0.09	11.76	6.10	0.46	40.79	461.2	51.74	30.20	7428
p	0.00	0.01	0.00	0.00	0.00	0.01	0.96	0.00	0.05	0.79	0.00	0.00	0.00	0.00	0.00
TT	-2.08	-1.37	-1.45	-1.42	-1.72	-0.88	-0.21	-1.27	-0.16	-3.75	-0.33	-0.95	1.05	0.92	1.34
p	0.04	0.17	0.15	0.16	0.09	0.38	0.83	0.20	0.87	0.00	0.74	0.34	0.30	0.36	0.18

Notes: $\bar{r}, \hat{\sigma}, \hat{\gamma}$ and $\hat{\kappa}$ are the mean (in % p.m.), the empirical standard deviation (in % p.m.), the empirical skewness and the empirical excess-kurtosis for the respective index time-series. *J*/*B* is the test statistic for the *Jarque*/*Bera*-normal distribution test, *TT* the test statistic for the *Randles*/*Fligner*/*Policello II*/*Wolfe*-symmetry test and *p* denotes the marginal significance level of the tests. For the calculation of the statistics the 168 monthly observations of the individual return time-series of the countries Germany (GER), France (F), Great Britain (GB), Switzerland (CH) and USA (US) in the time-period 01/1985 till 12/1998 have been used.

These indications of the presence of non-symmetrical probability distributions makes the assumption of elliptical return distributions (see *Chamberlain* 1983) - necessary for the application of the *Markowitz* mean/variance framework - critical in the present case.

Two statistical test procedures have been applied for further verification. Firstly, a symmetry test based on *Randles*/*Fligner*/*Policello II*/*Wolfe* (1980), which tests the null-hypothesis for the symmetry of the observed distribution around the median and which is asymptotically standard-normal distributed under this null. Secondly, a normal distribution test based on *Jarque*/*Bera* (1987), which is, under the null-hypothesis of a normal distribution, χ^2-distributed as with 2 degrees of freedom.

From Table 1 it may be seen that the symmetry test was able in three cases (German stock market and US stock and bond market) to reject the symmetry hypothesis with usual levels of

significance.[1] If one looks at the results of the *Jarque*/*Bera*-test one must conclude that the hypothesis of normal returns for all observed stock markets and the real estate companies with a level of significance lower than or equal to 1% is to be rejected. For the bond markets, the normal distribution assumption can be rejected for all countries at the 5% level; only for France and the US a rejection fails at usual levels of significance.

It remains to conclude that the existence of a-bell shaped symmetrical return distribution is doubtful and in particular, the existence of normally distributed monthly returns for almost all parts of the observed markets is to be rejected.

2.2 International Asset Allocation in a Shortfall-Risk Framework

2.2.1 Lower Partial Moments and Utility Theory

To be able to evaluate the different investment strategies (i.e. the probability distributions of portfolio returns) determined by the vector of portfolio weights and hedge ratios in a quantitative framework, it is necessary to introduce a formal criterion for investment decision making under uncertainty. In this paper we take the assumption of a risk averse investor who uses a Lower Partial Moment (LPM) as the measure of risk and applies the mean/LPM rule introduced by *Bawa* (1975) to evaluate the different portfolio strategies. This means that a higher expected return and a lower LPM is more desirable for the investor. The LPM refers to the realisations below some critical target specified by the investor over a specific holding period. Returns below the target (losses) are considered to be undesirable or risky, while returns above the target (gains) are desirable or non-risky. In this sense, LPM are called “relative” or “pure” measures of risk. Thus these risk-measures are closer to an intuitive understanding of risk as something “bad happening” than the traditional measures.

More formally, the *n*-th order LPM to the target *t* (LPM_t^n) with a random variable *R*, in our case the uncertain monthly return on an asset, is defined as

$$\mathrm{LPM}_t^n(R) := E[\max(t - R; 0)^n]. \qquad \textbf{(1)}$$

The asset’s risk can therefore be quantified by the expected value (*E*) of the downside-deviations of the target *t* through the possible realizations of the returns. The parameter $n \exists 0$ determines the weights attached to negative deviations from the target, i.e. it can be viewed as a measure of risk aversion where risk aversion increases with *n*. *Fishburn* (1977) shows that by varying the degree *n* of the lower partial moments, the utility function defined can accu-

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[1] Due to the fact that the *Randles*/*Fligner*/*Policello II*/*Wolfe*-symmetry test is (virtually) distribution-free, it, in comparison to other symmetry-tests, which make explicit distribution assumptions, tends to show a lower power.

rately reflect the preferences of an individual towards risk for below-target returns. Additionally *Bawa* (1975, 1978), *Fishburn* (1977) and *Levy* (1992) show that there is a strong relationship between the LPM risk measurements and the concepts of stochastic dominance. This is important, because stochastic dominance analysis does not make any distributional assumptions of returns and belongs to a very general class of utility functions.

In the context of portfolio optimization, the implementation of the LPM occurs analogously to the *Markowitz* portfolio theory through the integration of the LPM measures into the decision principle $\Phi(R) = H(E(R); LPM(R))$ and the maximization of this over all possible alternatives. The evaluation of the uncertain returns *R* occurs therefore through the function *H*, which is by convention increasing in expected value and decreasing in the risk-measure.

Without the necessity of the exact specification of a utility function, the set of efficient portfolios - in the sense of the portfolios not dominated by the above decision principle, and analogous to the mean/variance optimization - can be determined.

2.2.2 International Portfolio-Optimization with Lower Partial Moments

Within the framework of our study, we have taken the perspective of an institutional investor who considers risk as a downside-deviation from the risk-free interest rate. The return on a sure investment is a natural reference point in risky investment decision situations because it represents the return that could be achieved with certainty if all risky investments were to be rejected. For the German investor we have applied the one-month FIBOR and for the US investor the one-month US treasury bill rates as a proxy for a risk-free investment.

The optimization problem takes concrete form for the investor observed here, according to *Harlow* (1991), as follows:

$$\frac{1}{T}\sum_{t=1}^{T}\max\{0\,,\, r_{f,t} - \sum_{i=1}^{N} x_i R_{i,t}\} \quad \rightarrow \quad \min_{x_i \;\; i=1,2,\ldots,N}$$

subject to the constraints

$$\sum_{i=1}^{N} x_i \overline{R}_i = \overline{R}_p \qquad \textbf{(2)}$$

$$\sum_{i=1}^{N} x_i = 1$$

$$x_i \geq 0, \quad i = 1,2,\ldots,N$$

Where *T* represents the number of observed periods. $\overline{R}_i$ is the mean return on the asset *i* over all periods, $\overline{R}_P$ the prescribed portfolio return and x_i the portfolio weight of asset *i*. $r_{f,t}$ represents the risk free rate at the beginning of period *t*. In addition we have excluded short

sales, because many institutional investors like insurance companies, mutual and pension funds are restricted in this regard.

For the portfolio optimization by way of approach **(2)** the national returns of the respective countries have been converted into local returns of the home country of the German or US investor through the relation

$$R_i = (1 + R_i^a) \cdot (1 + e^a) - 1 = R_i^a + e^a + R_i^a \cdot e^a . \qquad \textbf{(3)}$$

The uncertain local one period return R_i on an asset *i* from country *a* from the perspective of the respective home country corresponds to the national one-period return on investment R_i^a in addition to the exchange rate return e^a between country *a* and the home-country of the investor as well as a cross-product from national returns and exchange rate returns. The exchange rate return between the home-country and the observed foreign country *a* in a period *t* is defined as $e^a = (S_{t+1}^a - S_t^a)/S_t^a$ and therefore as the relative change of the exchange-rate between the foreign country and the home-country from the perspective of the home-country in period *t*. For the determination of the exchange rate returns for the German perspective, we use the average rates at the end of the month on the *Deutsche Börse Frankfurt* kassa priced exchange rates of the respective currencies to DM. For the US perspective we calculated the exchange rates of the individual currencies vis-à-vis the US dollar excluding a "triangular arbitrage" from the DM exchange rates.

As a currency hedging strategy a fully hedged strategy in the sense of *Glen*/*Jorion* (1993) has been applied. Hereby the entire original investment amount is hedged in each case by means of currency forwards. The fully hedged return R_i^h on asset *i* from country *a* with reference to the originally invested amount results, from the perspective of the home-country of the investor in:

$$R_i^h = R_i^a + f^a + R_i^a \cdot e^a \qquad \textbf{(4)}$$

Hereby $f^a := (F_{t+1}^a - S_t^a)/S_t^a$ represents the forward premium between country *a* and the respective home country. F_{t+1}^a is the forward price at the point in time *t* for the delivery of the currency of the country *a* at the point in time *t*+1 from the perspective of the home country. S_t^a represents the price for one unit of the currency of the country *a* at the point in time *t* from the perspective of the home country.

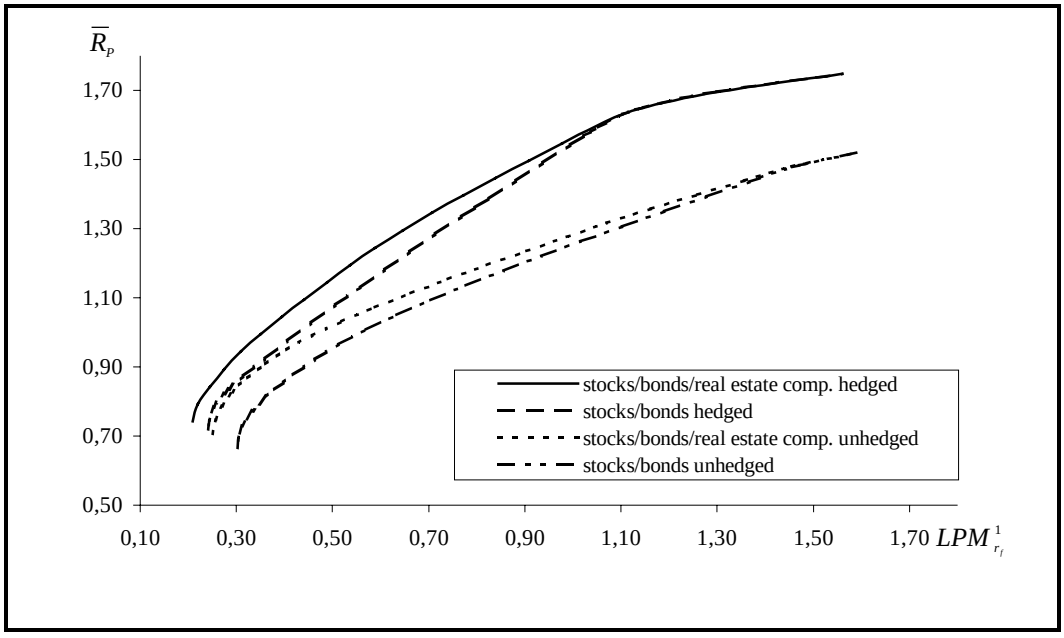
The forward prices used in the following examination against the US dollar are derived from Datastream (for the US perspective) and have been calculated excluding a "triangular arbitrage" from the forward prices against the US dollar (for the German perspective).

3 Ex-post Diversification Potential

3.1 Efficient Mean/LPM Sets

In order to gain a first impression of the scope of the diversification potential of the real estate companies, the efficient boundaries have been calculated with and without this class of investment. The figures 1 and 2 include the efficient sets from the German and the US perspectives with and without real estate companies and with as well as without currency hedging in the Mean/LPM$^1_{r_f}$ space.

Figure 1: International Efficient Boundaries from the German Perspective



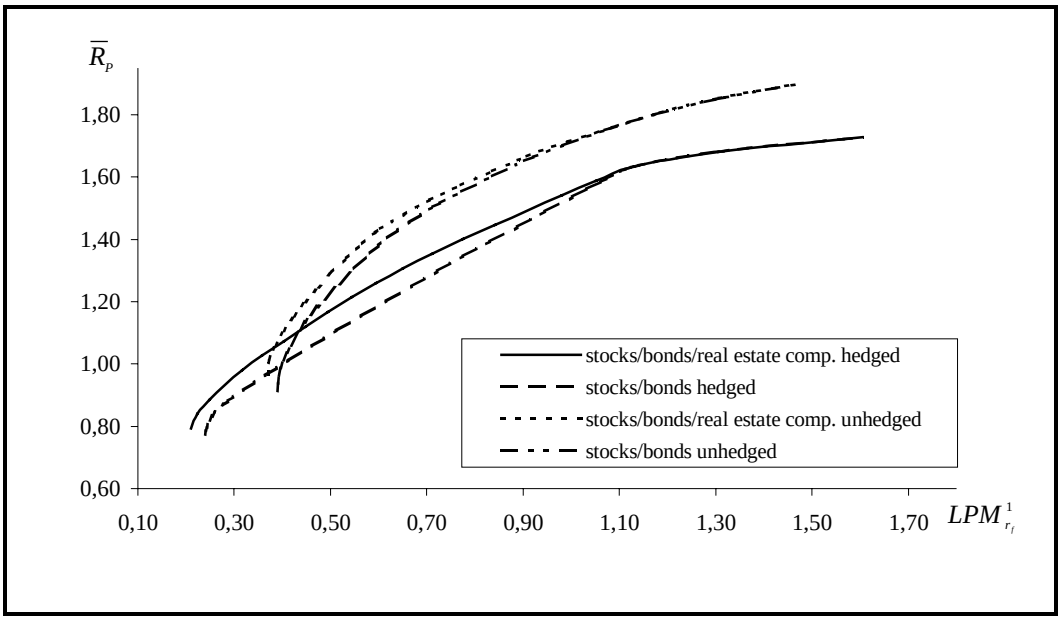
Notes: $\overline{R}_P$ and LPM$^1_{r_f}$ are the mean returns (in % p.m.) and the empirical first order lower partial moment to the target of risk-free interest rate (in % p.m.) calculated on the basis of 168 observations of the individual international return time-series in the time-period 01/1985 till 12/1998. As unhedged are represented the efficient boundaries without currency hedging, as hedged the efficient boundaries with full currency hedging.

From the perspective of the German investor the extension of the investment universe to real estate companies leads both in the hedged as well as in the unhedged case to a shift in the efficient boundaries to the left. While this shift in the area of high average returns results in small gains, it is correspondingly stronger in the area of lower returns.

The integration of real estate companies brings therefore in the case of the German investor an improvement in the risk/return characteristics in particular for conservative (low risk-tolerance) to balanced (medium risk-tolerance) portfolios. The applied unitary hedging brings,

additionally, a significant improvement in the risk/return characteristics relative to the unhedged case.

Figure 2: International Efficient Boundaries from the US Perspective



Notes: $\overline{R}_p$ and $\mathrm{LPM}^1_{r_f}$ are the mean returns (in % p.m.) and the empirical first order lower partial moment to the target of risk-free interest rate (in % p.m.) calculated on the basis of 168 observations of the individual international return time-series in the time-period 01/1985 till 12/1998. As unhedged are represented the efficient boundaries without currency hedging, as hedged the efficient boundaries with full currency hedging.

From the perspective of the US investor, the same effects are to be observed as regard to the integration of the real estate companies. Here too, these lead, both in the presence as well as in the absence of a currency hedging, to an improvement in particular for conservative and balanced portfolios. A significant difference from the German perspective however, exists in the effects of the unitary hedging. Whereas in the German case, it always led to a significant improvement relative to the unhedged variant, in the case of the US investor, it leads only to an improvement for very conservative portfolios.

Unitary hedging however makes it possible for the US investor as well as for the German investor, to attain positions of very low risk, which unhedged portfolios do not allow.

3.2 Special Portfolios and Performance-Measurement

In order to gain a more precise view of the extent of the diversification potential of real estate companies, three selected portfolios will be analyzed in greater detail: the equally-weighted portfolio (EWP), the minimum-risk portfolio (MRP) and the tangency portfolio (TP).

The EQW consists in equal parts of the possible international investment alternatives and therefore represents a naive diversification strategy. The determination of the EQW is simple and in contrast to the other international portfolios does not need any optimization procedures for ascertaining the weights of the investments. Although the EQW is, from the viewpoint of an ex-post analysis, generally an inefficient portfolio, it nonetheless represents the possibility of realizing some diversification gains at a low technical expense.

A very conservatively guided portfolio may also be seen in the MRP, which represents the international portfolio with the lowest obtainable risk.

The tangency portfolio finally, maximizes the risk-adjusted returns over the international investment universe and thereby represents the portfolio, which displays the highest returns per unit of risk.

For the performance-evaluation and the comparison of the international portfolios in relation to the benchmark, the reward-to-lower-partial-moment-ratio, suggested by *Sortino*/*Price* (1994) and also known as the *Sortino*-ratio has been applied. Similar to the reward-to-variability-ratio, also known as the *Sharpe*-ratio, the *Sortino*-ratio (SR) results as the ratio from the average excess-return over the risk-free rate ($\overline{R}_P - r_f$) and the risk measure, in the present case, the first order lower partial moment (LPM^1), hence

$$SR = \frac{\overline{R}_P - r_f}{\mathrm{LPM}^1}. \qquad \textbf{(5)}$$

3.3 Risk/Return Characteristics of the Selected Portfolios

In Table 2 the mean returns, $\mathrm{LPM}^1_{r_f}$ and the *Sortino*-ratios of the international portfolios from the perspective of the German and the US investor are given.

From the perspective of the German investor the extension of the investment universe to the real estate companies results in significant performance improvements for all observed hedged and unhedged portfolios, with the exception of the EWP, measured according to the *Sortino*-ratio. These performance improvements take their origin less in an increase of the average return than in a risk-reduction, measured according to the $\mathrm{LPM}^1_{r_f}$ for the respective portfolios. Additionally, the performance improvements in the hedged as well as the unhedged cases are of approximately the same scope, so that here no interdependence between the effects of the integration of the real estate companies and the unitary hedging is to be assumed.

The currency hedging of itself brings about in both cases - with and without real estate companies - a partly significant increase in the risk-adjusted performance of all portfolios including the EWP, which has already been observed in the analysis of the efficient sets. The cause of this improvement lies in an increase of the mean returns and/or a reduction in the $\mathrm{LPM}^1_{r_f}$.

Table 2: Risk/Return Characteristics of the Selected Ex-post Portfolios

	Unhedged			Hedged		
	$\overline{R}_p$	$\mathrm{LPM}^1_{r_f}$	SR	$\overline{R}_p$	$\mathrm{LPM}^1_{r_f}$	SR
GERMAN PERSPECTIVE						
Stocks and Bonds						
EWP	1,00	0,90	0,61	1,04	0,72	0,81
MRP	0,66	0,30	0,70	0,72	0,24	1,10
TP	0,85	0,39	1,01	0,84	0,28	1,35
Stocks, Bonds and Real Estate Securities						
EWP	0,93	0,86	0,56	0,97	0,67	0,76
MRP	0,71	0,25	1,00	0,74	0,21	1,38
TP	0,84	0,30	1,29	0,88	0,27	1,60
US PERSPECTIVE						
Stocks and Bonds						
EWP	1,39	0,80	1,11	1,06	0,73	0,78
MRP	0,91	0,39	1,07	0,77	0,24	1,15
TP	1,28	0,53	1,48	0,85	0,27	1,33
Stocks, Bonds and Real Estate Securities						
EWP	1,32	0,81	1,02	0,99	0,69	0,73
MRP	0,97	0,37	1,27	0,79	0,21	1,41
TP	1,27	0,49	1,59	0,89	0,26	1,56

Notes: $\overline{R}_p$, $\mathrm{LPM}^1_{r_f}$ and SR represent the mean return (in % p.m.), the empirical first order lower partial moment to the target of risk-free interest rate (in % p.m.) and the empirical *Sortino*-ratio of the respective ex-post strategies. EWP represents the equally weighted international portfolio, MRP the international portfolio with the lowest risk and TP the international tangency portfolio. For the calculation the 168 monthly observations of the individual return time-series for the time-period 01/1985 till 12/1998 were used.

For the US investor there are tendencies toward weaker effects to be noted. The integration of the real estate companies into the portfolios leads to moderate performances improvement of the TP both with and without currency hedging. The EWP on the other hand, performed somewhat more weakly in the presence of the real estate companies. Also noteworthy is the significant performance improvement of the MRP, which unlike the German case, is more due to an increase in the average return than to a reduction in the portfolio risk.

The application of a currency hedging strategy results in a performance reduction for the efficient portfolio TP. The same is the case for the EWP, where the deterioration is very clearly observable. Also noticeable is the significant improvement of the *Sortino*-ratio for the MRP. The cause of the performance improvement of the MRP with currency hedging can be clearly

seen in risk-reduction. While the average returns for the US MRP sink sharply, the reduction in risk is even more extreme, so that a significant rise in the *Sortino*-ratio occurs as a result.

3.4 Portfolio Structures

In order to gain insight into the composition of the ex-post optimal portfolios, the investment weights have been calculated for these. From Table 3 it may be gathered that in the case of the German investor, the integration of real estate companies into the portfolios is accompanied by the flow of substantial shares of the investment budget into this class of investment.

Table 3: Optimal Ex-post Portfolio Weights for the MRP and TP from the Perspective of the German Investor

	Unhedged		Hedged	
	MRP	**TP**	**MRP**	**TP**
Stocks				
F	0	0	0	0
GB	0	0	0	0
CH	0	3,36	0	0
US	0	0	0,99	8,95
GER	0	0	0	0
Bonds				
F	18,82	40,95	8,74	0,43
GB	0	0	0	0
CH	16,42	0	42,57	36,89
US	0	0	14,87	12,28
GER	45,59	22,14	15,94	1,86
Real Estate Securities				
F	0	0	0,84	0
GB	0	0	0	0
CH	0	2,35	1,51	17,90
US	0,14	0	0,19	1,57
GER	19,04	31,20	14,34	20,12

Notes: The weights are given in percentages. MRP represents the international portfolio with the lowest risk and TP the international tangency portfolio. For the calculation the 168 monthly observations of the individual return time-series of the countries Germany (GER), France (F), Great Britain (GB), Switzerland (CH) and USA (US) in the time-period 01/1985 till 12/1998 have been used.

In the case of the unhedged portfolios, the investment weights for the German real estate companies were 19,04% for the MRP and 31,20% for the TP. Real estate companies in the other countries however, only showed weights between 0% and 2,35%. With the additional application of the currency hedging strategy, the investment weight of the German real estate companies is reduced, however, this occurs mainly to the advantage of the real estate companies of the other countries, in particular Switzerland, so that the aggregated investment weight for this class of investment is hardly altered.

The optimal ex-post portfolios of the US investor likewise display high investment weights toward the real estate companies, as becomes clear in Table 4. Here the investment weights for the unhedged portfolios for German and US companies respectively stand at 8,74% for MRP and 17,29% for TP and at 8,69% for MRP and 14,77% for TP. For the other countries the weights are at zero and 0,31% in the case of unhedged portfolios. The application of the currency hedging strategy leads once again to an internal shift of the portfolio weights to the Swiss real estate companies; however here, there is also hardly any change in the aggregated weight for the investment class of real estate companies.

Table 4: Optimal Ex-post Portfolio Weights of the MRP and TP from the Perspective of the US Investor

	Unhedged		Hedged	
	MRP	**TP**	**MRP**	**TP**
Stocks				
F	0,21	0	0	0
GB	0	0	0	0
CH	0,03	4,08	0	0
US	6,79	21,72	1,40	8,06
GER	0,33	0	0	0
Bonds				
F	2,11	19,35	3,16	0,71
GB	5,18	4,54	0	0
CH	0,94	0	43,17	34,53
US	66,40	18,25	17,17	17,54
GER	0	0	18,32	7,47
Real Estate Companies				
F	0,31	0	0,27	0
GB	0	0	0	0
CH	0,26	0	1,75	13,03
US	8,69	14,77	0	2,13
GER	8,74	17,29	14,77	16,53

Notes: The weights are given in percentage. MRP represents the international portfolio with the lowest risk and TP the international tangency portfolio. For the calculation the 168 monthly observations of the individual return time-series of the countries Germany (GER), France (F), Great Britain (GB), Switzerland (CH) and USA (US) in the time-period 01/1985 till 12/1998 have been used.

One further interesting observation is that the composition of the MRP with an application of a unitary currency hedging and consideration of real estate companies for the German and US investor only differ slightly from another. If one considers Table 2 once again, it is striking that the MRPs in this case display an almost identical risk/return profile for the German and the US-investor.[2]

[2] Similar results occur for the ERP and the TP in the case of exchange rate hedging. A direct comparison of the hedged efficient boundaries of the German and the US investor shows that these are also almost exactly the same in the Mean/LPM-space.

4 Ex-ante Diversification Potential

4.1 Study-Design

The present study showed that the integration of real estate companies in the portfolio construction could lead to a significant improvement in the ex-post portfolio performance. In order to investigate whether such an improvement also occurs in the case of an ex-ante observation, three ex-ante portfolio strategies will be examined, each with and without currency hedging, with and without real estate companies, and each from the perspective of a German and a US investor. The portfolio strategies involve investments in the same portfolios which were analyzed in the ex-post study: EWP, MRP and TP.

For the evaluation of the strategies we use a back-testing procedure as with *Eun*/*Resnick* (1994) or *Levy*/*Lim* (1994), among others, and define an estimation period of 48 months as well as a holding period of one month, which immediately follows the estimation period. In the estimation period the optimal portfolio weights of the strategies MRP and TP are determined. These weights are then applied to the holding period and the returns on the resulting portfolios are determined. Subsequently, the estimation and holding periods are shifted one month forward and the procedure described above is then repeated.

There result in the time-period from January 1985 till December 1998 for each strategy 120 independent out-of-sample return observations.

4.2 Performance of the Strategies

In Table 5 the mean returns, the $LPM^1_{r_f}$ and the *Sortino*-ratios derived from the 120 return observations of the ex-ante strategies are reproduced.

From the perspective of the German investor there is a risk-reduction, which can be observed for all hedged and unhedged portfolio strategies through the consideration of real estate companies. For the MRPs and the unhedged TP, this risk-reduction involves an increase in the average returns and therefore also an increase in the *Sortino*-ratios. With the (naive) EWP strategies and the hedged TP a reduction of the mean return occurs, which overcompensates for the risk-reduction of this portfolio and thereby leads to a performance reduction.

The application of the fully hedging strategy results in significant performance improvements for all portfolios with and without real estate, measured according to the *Sortino*-ratio. These improvements are once again due more to a risk-reduction than to an increase in the mean returns.

From the perspective of the US investor, the consideration of real estate companies for all unhedged strategies leads to an increase in the LPM relative to the stock/bond portfolios. For the hedged portfolios however, a risk-reduction always occurred. Additionally, for all hedged and unhedged strategies with the exception of the hedged MRP, a reduction of the mean return was observed through the integration of the real estate companies. The consequence is a reduction of the performance of almost all strategies in the presence of real estate companies. The exception is the hedged MRP by which, apart from a risk-reduction, a significant increase in the average return through the real estate companies occurs and subsequently leads to a significant improvement in performance.

Table 5: Risk/Return Characteristics of the Ex-ante Strategies

	Unhedged			Hedged		
	$\overline{R}_P$	$\mathrm{LPM}^1_{r_f}$	SR	$\overline{R}_P$	$\mathrm{LPM}^1_{r_f}$	SR
GERMAN PERSPECTIVE						
Stocks and Bonds						
EWP	1,07	0,89	0,65	1,06	0,72	0,80
MRP	0,66	0,39	0,43	0,69	0,33	0,60
TP	0,78	0,77	0,38	0,99	0,61	0,81
Stocks, Bonds and Real Estate Companies						
EWP	0,96	0,87	0,54	0,95	0,69	0,67
MRP	0,75	0,34	0,74	0,77	0,32	0,87
TP	0,81	0,73	0,44	0,83	0,56	0,61
US PERSPECTIVE						
Stocks and Bonds						
EWP	1,12	0,75	0,89	1,00	0,73	0,75
MRP	0,84	0,40	0,96	0,64	0,33	0,57
TP	1,14	0,69	0,99	0,94	0,60	0,81
Stocks, Bonds and Real Estate Companies						
EWP	1,01	0,78	0,72	0,89	0,70	0,62
MRP	0,83	0,44	0,85	0,72	0,32	0,83
TP	1,03	0,73	0,79	0,76	0,58	0,52

Notes: $\overline{R}_P$, $\mathrm{LPM}^1_{r_f}$ and SR represent the mean returns (in % p.m.), the empirical first order lower partial moment to the target of risk-free interest rate (in % p.m.) and the empirical *Sortino*-ratio of the respective ex-ante strategies. EWP represents the equally weighted international portfolio, MRP the international portfolio with the lowest risk and TP the international tangency portfolio. For the calculation, the 120 monthly out-of-sample observations of the individual return time-series in the time-period from 01/1989 till 12/1998 were used.

The application of currency hedging strategies has, as in the German case, for all portfolio strategies with and without real estate companies a partly significant risk-reduction as a consequence but it is also always accompanied by an equally significant reduction in the mean returns. The result is a performance reduction of all portfolios in the presence of a currency hedging.

4.3 Stochastic Dominance Analysis

In order to build a bridge towards decision-theory, the ex-ante strategies were subjected to a stochastic dominance analysis. This analysis allows a comparison of various investment strategies or portfolios from the perspective of a broad class of investors. The mean/ LPM[1] - optimization model studied here corresponds, as *Bawa* (1975, 1978) has shown, with the concept of second order stochastic dominance. This means that if alternative A dominates alternative B in the sense of second order stochastic dominance, then alternative A is better than alternative B for every investor maximizing his monotonously growing, concave utility function. Table 6 shows the stochastically undominated alternatives (labeled X) from the German and US perspectives (Appendix B includes a more detailed overview of the SSDR-dominance relationships, whereby there the dominated strategies are labeled X). The analysis was conducted both with (SSDR) and without (SSD) a risk-free asset. For the implementation of the analysis the algorithms by *Levy*/*Kroll* (1979) with the extension by *Levy* (1998) were used.

Table 6: Stochastically Undominated Ex-ante Strategies

	Stocks/Bonds						**Stocks/Bonds/Real Estate Comp.**					
	Unhedged			**Hedged**			**Unhedged**			**Hedged**		
	EWP	**MRP**	**TP**	**EWP**	**MRP**	**TP**	**EWP**	**MRP**	**TP**	**EWP**	**MRP**	**TP**
GERMAN PERSPECTIVE												
SSDR		**X**									**X**	
SSD	**X**	**X**		**X**	**X**	**X**	**X**			**X**	**X**	**X**
US PERSPECTIVE												
SSDR		**X**						**X**			**X**	
SSD	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	

Notes: Undominated strategies are labeled X. SSDR and SSD represent second order stochastic dominance with the existence of and the non-existence of a risk-free investment opportunity, respectively. EWP represents the equally weighted international portfolio MRP the international portfolio with the lowest risk and TP the international tangency portfolio. For the calculation the 120 monthly out-of-sample observation of the individual return time-series in the time-period 01/1989 till 12/1998 were used.

Regarding the SSD-criterion, relatively many strategies proved to be undominated from the perspective of the German and the US investor. Using the SSDR-criterion, with the additional assumption of the existence of a risk-free investment opportunity, only the hedged MRP strategy with real estate companies as well as the unhedged MRP without real estate companies proved to be undominated from the perspective of the German investor.

For the US investor, only the MRP strategies are, using the selective SSDR-criterion, undominated: the unhedged MRP strategy without real estate companies and the hedged as well as the unhedged MRP strategy with real estate companies.

5 Conclusion

The objective of the present study has been the evaluation of the diversification potential of real estate companies in the context of international diversified stock and bond portfolios. To this end, the stock and bond markets as well as the real estate companies of the countries Germany, France, Great Britain, Switzerland and the USA in the time-period January 1985 till December 1998 were subjected to an ex-post and an ex-ante analysis. The analysis was conducted from the perspective of a German as well as of a US investor in the context of a mean/LPM framework.

In the ex-post perspective, significant diversification benefits appeared for both investors through the consideration of real estate companies. The source of these diversification gains was largely to be seen in a risk-reduction. The additional application of a unitary currency hedging was always advantageous to the German investor. The unitary hedging was only beneficial for the US investor in the area of very risk-averse portfolios. Additionally, no noteworthy interdependencies between the application of a unitary hedging and a consideration of real estate companies could be observed.

In the ex-ante study, the integration of the real estate companies in some portfolio strategies both for the German as well as for the US investor led to a risk-reduction relative to the corresponding stock/bond strategies. The unhedged strategies of the US investor represented the only exception to this.

From the perspective of the German investor, efficiency-increases were able to be determined for two of the three unhedged and one of the hedged strategies in the sense of risk-adjusted performance. For the US investor, only the hedged MRP showed efficiency improvements.

It remains to be noted that the diversification potential of real estate companies mainly takes the form of risk-reduction potential. Through consideration of this class of investment in international portfolios, certain efficiency improvement potential exists, which however, is less accessible to naive strategies. On the contrary, the application of modern portfolio theory is required to exhaust this potential.

Appendix A

Table 7: Average Ex-ante Portfolio Weights of the MRP- and TP-Strategy from the Perspective of the German Investor

	Unhedged		Hedged	
	MRP	**TP**	**MRP**	**TP**
Stocks and Bonds				
Stocks				
F	0.04	6.95	0.07	2.00
GB	0.32	4.03	0.18	0.02
CH	0.72	12.54	0.34	8.43
US	0.60	3.09	4.13	24.11
GER	1.82	2.64	0.64	0.44
Bonds				
F	19.34	36.47	9.27	2.81
GB	1.28	4.29	0.35	1.09
CH	17.41	7.52	44.80	20.48
US	1.10	0.06	22.22	32.55
GER	57.37	22.42	17.99	8.08
Stocks, Bonds and Real Estate Companies				
Stocks				
F	0.01	0.03	0	0.01
GB	0.02	0.21	0	0
CH	0.24	11.53	0.13	5.75
US	0.25	2.36	2.28	8.26
GER	0.33	0.78	0.15	0.13
Bonds				
F	13.34	20.47	6.48	2.65
GB	0.61	3.11	0.89	1.32
CH	12.19	7.14	25.12	11.78
US	0.18	0.04	21.27	22.89
GER	48.81	18.92	18.85	8.94
Real Estate Companies				
F	0.61	1.07	0.44	0.57
GB	0.05	0.72	0.10	0.35
CH	5.60	4.77	10.78	11.30
US	0.88	2.48	1.71	5.84
GER	16.88	26.39	11.80	20.22

Notes: The weights are given in percentages. MRP represents the international portfolio with the lowest risks, TP the international tangency portfolio. For the calculation, the 120 monthly out-of-sample observations of individual return time-series of the countries Germany (GER), France (F), Great Britain (GB), Switzerland (CH) and USA (US) in the time-period 01/1989 till 12/1998 were used.

Table 8: Average Ex-ante Portfolio Weights of the MRP- and TP-Strategy from the Perspective of the US Investor

	Unhedged		Hedged	
	MRP	**TP**	**MRP**	**TP**
Stocks and Bonds				
Stocks				
F	1.79	2.32	0.17	2.13
GB	1.38	3.10	0.23	0.04
CH	1.22	12.29	0.38	6.83
US	8.70	27.54	3.83	23.56
GER	1.30	0.57	0.47	0.58
Bonds				
F	5.12	15.33	8.79	2.61
GB	2.83	7.31	0.07	1.15
CH	1.92	0.03	43.50	21.03
US	74.23	30.23	23.44	34.44
GER	1.51	1.28	19.12	7.63
Stocks, Bonds and Real Estate Companies				
Stocks				
F	0.27	0.30	0.01	0.01
GB	0.12	0.05	0	0
CH	1.50	10.79	0.14	4.96
US	6.19	16.25	2.21	8.09
GER	0.47	0.27	0.10	0.15
Bonds				
F	2.49	6.06	7.06	2.65
GB	1.23	4.29	0.60	0.98
CH	1.67	0.10	25.39	12.14
US	69.18	18.98	21.53	23.76
GER	1.41	1.86	20.02	8.72
Real Estate Companies				
F	0.98	0.41	0.31	0.60
GB	1.59	1.47	0.18	0.38
CH	0.77	1.17	9.24	10.82
US	6.03	16.59	1.75	6.05
GER	6.09	21.41	11.47	20.68

Notes: The weights are given in percentages. MRP represents the international portfolio with the lowest risks, TP the international tangency portfolio. For the calculation, the 120 monthly out-of-sample observations of individual return time-series of the countries Germany (GER), France (F), Great Britain (GB), Switzerland (CH) and USA (US) in the time-period 01/1989 till 12/1998 were used.

Appendix B

Table 9: Ex-ante SSDR-Dominance Relations from the Perspective of the German Investor

			Without Real Estate Companies						With Real Estate Companies					
			Unhedged			Hedged			Unhedged			Hedged		
			EWP	MRP	TP	EWP	MRP	TP	EWP	MRP	TP	EWP	MRP	TP
Without Real Estate Companies	Unhedged	EWP			X				X					
		MRP	X		X	X		X	X		X	X		X
		TP												
	Hedged	EWP			X				X		X	X		
		MRP	X		X	X		X	X		X	X		X
		TP												
With Real Estate Companies	Unhedged	EWP												
		MRP	X		X	X		X	X		X	X		X
		TP			X									
	Hedged	EWP			X						X			
		MRP	X		X	X	X	X	X	X	X	X		X
		TP	X		X				X		X	X		

Notes: If the strategy of the line *i* dominates the strategy of column *j*, then this is labeled with an X in Table element (*i, j*). SSDR represents the second order stochastic dominance with the existence of a risk-free investment opportunity. EWP represents the equally weighted international portfolio, MRP the international portfolio with the lowest risk and TP the international tangency portfolio. For the calculation, the 120 monthly out-of-sample observations of the individual return time-series in the time-period 01/1989 till 12/1998 were used.

Table 10: Ex-ante SSDR-Dominance Relations from the Perspective of the US- Investor

			Without Real Estate Companies						With Real Estate Companies					
			Unhedged			Hedged			Unhedged			Hedged		
			EWP	MRP	TP	EWP	MRP	TP	EWP	MRP	TP	EWP	MRP	TP
Without Real Estate Companies	Unhedged	EWP							X		X			
		MRP	X		X	X		X	X		X	X		X
		TP							X		X	X		
	Hedged	EWP										X		
		MRP	X		X	X		X	X		X	X		X
		TP												
With Real Estate Companies	Unhedged	EWP												
		MRP	X		X	X		X	X		X	X		X
		TP												
	Hedged	EWP												
		MRP	X		X	X	X	X	X		X	X		X
		TP												

Notes: If the strategy of the line *i* dominates the strategy of column *j*, then this is labeled with an X in Table element (*i*, *j*). SSDR represents the second order stochastic dominance with the existence of a risk-free investment opportunity. EWP represents the equally weighted international portfolio, MRP the international portfolio with the lowest risk and TP the international tangency portfolio. For the calculation, the 120 monthly out-of-sample observations of the individual return time-series in the time-period 01/1989 till 12/1998 were used.

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