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The Impact of Exchanges Rates on International Real Estate Portfolio Allocation

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Abstract

This paper, examines whether the asset holdings and weights of an international real estate portfolio using exchange rate adjusted returns are essentially the same or radically different from those based on unadjusted returns. The results indicate that the portfolio compositions produced by exchange rate adjusted returns are markedly different from those based on unadjusted returns. However following the introduction of the single currency the differences in portfolio composition are much less pronounced. The findings have a practical consequence for the investor because they suggest that following the introduction of the single currency international investors can concentrate on the real estate fundamentals when making their portfolio choices, rather than worry about the implications of exchange rate risk.

Keywords: *Exchange rate risk*, *Portfolio Compositions, Similarity Indices*

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1. Introduction

A number of studies have advocated international real estate investment to reduce risk and enhance return, see Sweeny (1989, 1993); Chua (1999); Baum (1999); Whitaker (2001) and Conover et al (2002) among others. Whitaker (2001) also notes that international real estate investment is where growth is likely to occur as developing countries offer higher economic growth than the developed countries. Webb and O'Keefe (2002) suggest that there are only 14 countries in the world that have real estate markets of sufficient size to provide domestic investors with a unique asset class, while the rest of the world must invest internationally to have access to sufficient investment grade real estate to incorporate into their mixed-asset portfolio. Thus, in their opinion international investment is now an essential part of the real estate portfolio construction process.

Investing in real estate markets overseas means converting your domestic currency into that of the foreign country, i.e. the international investor faces currency risk, and the few studies that have examine this issue conclude that currency fluctuations change the diversification benefits associated with international real estate investments (see Sirmans and Worzala, 2003 for a comprehensive review). This is not surprising as the adjustment of local markets returns for exchange rate fluctuations leads to changes in all the parameters of the portfolio problem and so the risks and returns of the efficient frontier produced using local market returns will inevitably be different from that using exchange rate adjusted data. This would even be the case if the asset holdings and weights of the two efficient frontiers are identical. In other words, simply showing that the risks and returns of the efficient frontiers using unadjusted or adjusted data are different is not enough to indicate whether currency risk really matters to investors. Since, if the portfolio compositions of the efficient frontiers using exchange rate adjusted and local market returns are essentially the same, portfolios based on local market real estate data will perform equally as well as those based on data adjusted for currency risk. In contrast, if the portfolio compositions are radically different using unadjusted or exchange rate adjusted data, currency risk needs to be explicitly accounted for when analysing international real estate investment. Thus, we need to establish whether the assets and weights of efficient portfolios using unadjusted returns and adjusted return are essentially the same or radically different before we can say that currency risk is a factor investors need to consider when developing an international real estate strategy, unless the investor is fully hedged.

The paper is structured as follows. The next section discusses the theoretical and empirical impact of exchange rate risk on international real estate returns. Section 3 discusses the data. Section 4 outlines the research design and presents the initial results. The following section re-examines the results before and after the introduction of the European single currency in 1999 and the constraints on international allocation resulting from the home bias of investors. Section 6 concludes the paper.

2. The Impact of Exchange Rate Risk

International investment inevitably involves exchange rate risk as it requires conversions of one domestic currency into the currency of the country in which you wish to invest, both at the beginning and the end of the investment period. In the case of investment in only one foreign market, the exchange rate adjusted return from an investment in the *ith* market can be expressed as:

$$R_{adj} = R_{LM} + R_{Ex} + R_{LM}R_{Ex} \qquad 1$$

where: R_{adj} is the exchange rate adjusted return; R_{Lm} is the local market return of the investment in the *ith* foreign market; R_{Ex} is the return on the exchange rate. For simplicity of exposition, the product term ($R_{LM}R_{Ex}$) is often assumed to be so very small that it can be removed and equation 1 can be approximated as:

$$R_{adj} = R_{LM} + R_{Ex} \qquad 2$$

thus, the exchange rate adjusted return is approximately equal too the local market return on the investment plus the exchange rate return, Eun and Resnick(1988).

The investment risk in terms of variance of the exchange rate adjusted returns can then be approximated by:

$$Var(R_{adj}) = Var(R_{LM}) + Var(R_{Ex}) + 2Cov(R_{LM}R_{Ex}) \qquad 3$$

where: Var(.) denotes the variance of the returns and $Cov(R_{LM},R_{Ex})$ is the covariance between the local market and exchange rate returns.

Equation 3 shows that the volatility of the exchange rate adjusted returns is the sum the risk of the local market investment, plus the exchange rate risk and the correlation between the local market returns and the exchange rate return. It is obvious from equation 3 that even in this approximated form that the volatility of the exchange rate contributes an additional risk to international investment, as variance is always positive. However, the impact of the covariance term in equation 3 on overall investment risk is less clear, as correlations could be either positive or negative. For instance, if the correlation is less than perfect total investment risk, as measured by standard deviation (the square root of the variance) will be considerably less than the sum of the two individual volatilities. Furthermore, if the correlation is negative and sufficiently large the exchange rate adjusted returns could in theory be below that of the local market volatility. In other words, the theoretical impact of exchange rate risk on international returns is uncertain.

The ultimate effect of exchange rate risk on international investment of cause depends on the actual relationships between exchange rate returns and local market risk. However, in the context of international real estate portfolio allocation, most studies either completely neglect currency risk, or assume returns are fully hedged at no cost, see Sweeny (1989, 1993); Chua (1999); and Baum (1999) among others.

One of the first to explicitly analyse the impact of currency risk on real estate returns is Wurtzebach (1991). In particular, Wurtzebach (1991) distinguishes between the currency risk an investor faces from periodic cash flow and long-term capital appreciation. With respect to the former one he argues that investors may be able to use hedging. On the latter one he raises the question, that it might be difficult and expensive for investors to hedge such long-term positions, which implies that investors should not hedge.

In a similar vein, using data from 1970-1990 Gordon (1991) finds that while the currency adjustments significantly alter the return patterns for the various asset classes and he suggests that an investor should simply take the long view of real adjusted estate and ignore short-term currency fluctuations.

Worzala (1992) examined exchange rate adjusted estate US and UK data and finds that the correlation coefficients between the two countries are relatively low for all of the different property types: Retail Office and Industrial. Worzala (1992) also finds gains from international diversification are greater for local market than exchange rate adjusted returns.

Newell and Webb (1996) examined the risk and return characteristics for five countries: US, UK, Canada, Australia and New Zealand, using biannual data from 1985-1993. The authors find that after adjusting the returns for currency fluctuations the risk (standard deviation) increases, while the correlation coefficients are reduced providing evidence that international diversification benefits could be improved.

Addae-Dapaah and Choo (1996) analyse the impact of adding international property stock to a Singaporean portfolio. On basis of currency unadjusted returns the authors find that international diversification should be a Singaporean investor's preferred strategy. However, once the authors account for the effects of currency volatility international returns decline, risk increases and correlation coefficients also decrease. Nonetheless, a test of statistical significance at the 95% level reveals that the differences between currency unadjusted and adjusted returns are insignificant. The authors concluding that Singaporean investors should be more concerned about the diversification benefits of international investment and less concerned about currency volatility, as the latter are insignificant.

A subsequent study by Addae-Dapaah and Yong (1998) examined the impact of currency risk on performance, risk and correlation characteristics of the currency unadjusted and adjusted efficient frontiers in the Asian-Pacific region, again from a Singaporean perspective. The results revealed that the unadjusted efficient frontier in general dominates the adjusted efficient frontier, even though the difference of both frontiers is also statistically insignificant. Thus the authors conclude that a Singaporean investor will gain benefits of diversification for the sample region, as once again the impact of currency volatility was insignificant.

The latest study by Addae-Dapaah and Loh (2005) examines performance differences of emerging real estate markets of the Asian-Pacific region compared to developed markets with full acknowledgment of currency volatility. The authors build the hypothesis that before and after currency adjustments a portfolio fully invested in the emerging markets will have superior risk and return characteristics. For currency

unadjusted returns this hypothesis holds true, as generally the emerging economies dominate the developed economies. However, after adjusting the returns for changes in the currency the authors find that the risk characteristics of both markets are insignificantly different at the 5% level of significance. The authors conclude that dollar denominated investors may be well advised to favour emerging markets compared to developed countries.

Hudson-Wilson and Stimpson (1996) perform a three level portfolio allocation analysis of adding U.S. real estate to a Canadian portfolio from the perspective of a Canadian investor consequently all returns are denominated in Canadian dollars. Their first analysis is on a national level for which they conclude that at the low end of the risk spectrum a portfolio would be fully invested in U.S. real estate, whereas on the high end of the risk spectrum the portfolio would be 100% invested in Canadian real estate. These findings suggest that adding U.S. real estate will benefit a Canadian investor as an efficiency improvement is achieved because of diversification effects. The second level analysis focuses on the benefits of adding different U.S. property types to the Canadian portfolio i.e. examining which property type offers the best return-enhancing or risk reducing advantages for a Canadian investor. Their results suggest that U.S. apartments add the most diversification benefit. For their third analysis Hudson-Wilson and Stimpson (1996) disaggregate all property types into metropolitan areas and select three areas for each kind for the examination of diversification benefits. Their findings suggest that the benefits for a Canadian investor depend on the different property types and metropolitan areas. Finally the authors address possible implications to their results resulting from currency risk. They suggest that hedging would reduce the benefits of investing in U.S. real estate, under the assumption that exchange rate effects will net out over time. However, they conclude that with respect to their analyses these effects would be rather small, as only a small portion of assets would be invested in the U.S. and the diversification benefits of adding theses assets to a Canadian portfolio are great.

In the indirect market Eichholtz and Koedijk (1996) find that if currency risk is not hedged the volatility of returns decreases whereas correlation coefficients increase. Thus, for the real estate security market the authors conclude that hedging against currency volatility will diminish the benefits of international diversification for an investor.

The perceived importance of currency risk to institutional real estate investors is also not uniform. For instance, Worzala (1994) reports that only 44% of the UK, Dutch and German institutions sampled perceived currency fluctuations as an important variable in the international investment decision. Although this may be due to the preference of European investors to concentrate their overseas investments in the other countries of Europe or the developed markets such as the US and Australia, where currency risk may be felt to be of only a minor impact. Similarly, McAllister (1999) finds that British institutions rank currency risk fourth in a possible list of eight potential problems associated with overseas investment. In contrast, surveys based on Asian investors find that the respondents are much more concerned with exchange rate risk than investors in Europe, Worzala and Newell (1997) and Lim (2000). In other words, although currency fluctuations are not perceived as the primary concern of investors when considering international diversification (except by Asian investors), it appears to play a minor role.

There also appears to be a fundamental difference between practice and academia as to whether the decision to invest in certain countries an integrated or a separated process incorporating both the asset and currency implications of international investment. To the academic international investment is usually viewed as an integrated process. Where the decision as to what assets to hold is entwined with the currency implications of such decisions. In contrast, practitioners look upon country allocation and the embedded exposure to currency movements from a separated perspective, i.e. foreign currency exposure is treated as a separate asset from the actual investment and is managed by a separate specialist team (Giddy, 1994). In other words, in practice real estate managers focus on returns in local currencies to make country allocation decisions and then let a currency manager decide whether the investment should be hedged, what proportion to hedge and how to hedge the currency risk (D'Arcy and Lee, 1998).

Lastly, although investors have at their disposal a number of money market instruments with which they can hedge currency fluctuations the work of Ziobrowski and Ziobrowski (1993), Addae-Dapaah and Choo (1996) and Worzala (1995) finds that while such instruments provided a limit to the magnitude of downside losses over relatively short periods (one year), their effectiveness is lost over the typically longer holding periods of real estate investment. In addition, the cost of hedging using traditional methods and the difficulties of applying hedging techniques within the real estate market are problematical; see Worzala (1995), Worzala, et al (1997), Worzala and Newell (1997); Lizieri, et al (1998); and Johnson et al (2005).

In summary, previous studies indicate that the risk and return characteristics of currency adjusted real estate returns are worse than those of the unadjusted data. Nonetheless, the actual impact of currency risk is apparently small and insignificant. Additionally, the complexity and cost of hedging international real estate investments implies that most portfolios will not be hedged. However, the presence of currency fluctuations adds an additional dimension of uncertainty to the investment decision, which many investors may prefer to avoid. If this is the case it seems important to investigate whether an allocation strategy based on local market data produces portfolio allocations that are similar or radically different from exchange rate adjusted data.

3. Data

In order to examine these empirical relationships using the quarterly capital returns on office real estate covering the period Q1 1989 to Q1 2005 in 12 European countries from CB Richard Ellis.

The appreciation figures, however, are not based on appraisals, but upon changes in capitalised asking rents on hypothetical or notional properties. Such returns are not constructed from aggregating the income/expenditure and capital value movements (as measured by property valuations) of individual properties, but by tracking general rental and yield movements in the property market.

In the construction of such notional returns, it is assumed that properties meet certain specifications concerning condition, repair, position and size etc. Notional returns also

assume that the properties are continually new and continuously let at open market rental value. Whereas, actual indices reflect the cash-flows from and valuations of the sample buildings, which captures the reality that properties differ in terms of their location, size, age, lease terms and non-recoverable outgoings, notional returns fail to portray this state of affairs completely. The rental figures used are net of service charges and local taxes. The exchange rate data comes from Thompson Datastream. The summary statistics are shown in Table 1 for the unadjusted returns (local market returns) and exchange rate adjusted returns of the 12 countries in the sample.

Column 1 of Table 1 lists the 12 countries used in the analysis. Columns 2-4 show the means of the local market real estate data; the exchange rate data and the adjusted returns. Columns 5-7 show the standard deviations of the unadjusted data; the exchange rate data and the adjusted returns. Finally, Column 6 shows the correlation between the exchange rate and the local market returns over the period.

Table 1: Summary Statistics Quarterly Data Q1 1989 to Q1 2005

	Mean			SD			Corr
Country	Local	Exch.	Adjust	Local	Exch.	Adjust	LM,Ex
Austria	5.58	-0.16	5.42	5.24	4.48	7.08	0.01
Belgium	7.61	-0.20	7.42	3.65	4.45	6.49	0.00
Denmark	6.50	0.18	6.67	2.38	4.36	4.80	0.00
France	5.47	-0.19	5.26	6.52	4.31	7.69	-0.16
Germany	5.17	-0.16	5.00	6.36	4.45	7.92	-0.21
Ireland	8.20	-0.05	8.16	4.95	4.14	6.89	0.18
Italy	6.59	0.28	6.89	6.44	3.98	8.02	-0.19
Netherlands	7.16	-0.16	7.03	3.77	4.47	6.74	-0.17
Portugal	9.39	0.17	9.54	6.73	4.17	7.66	-0.05
Spain	6.04	0.23	6.22	7.65	4.25	8.15	0.27
Sweden	5.25	-0.28	5.01	5.84	4.44	8.15	-0.17
UK	4.82	0.00	4.82	5.45	0.00	5.45	0.17

Table 1 shows a number of features of interest. First, UK investors would have seen higher returns in all other countries real estate markets. However, investors would have lost money on the exchange rate. Nonetheless, overseas returns were still greater that those in the UK even after adjusting for exchange rates. Second, the local markets risks of the real estate market data displays low variability relative to the mean, indicative of appraisal smoothing in the data. In contrast, the variability of the exchange rate data is many times larger than their corresponding means, which emphasises the high volatility investors face from currency fluctuations. Finally, Table 1 shows that there is little or no positive correlation between the exchange rates and local market returns. This indicates that exchange rate adjusted risk will not be the sum of the local market risk and the exchange rate risk, but rather a value considerably less than the sum of the parts. For instance, the exchange rate adjusted risk of Spain is only 7 per cent greater than its local market risk.

Turning to the next question of covariability of returns, Table 2 gives the correlation matrix between the 12 countries in this study. Unadjusted returns are in the lower triangle of the table and show that the tendency of country returns not to move in unison can clearly be discerned for essentially all countries considered. The average correlation coefficient is only 0.23 and 95 per cent of the correlation coefficients are below +0.5.

The correlation matrix of exchange rate adjusted rates of return is given in the upper triangle of Table 2 and is quite different from the unadjusted results. Adjusting the quarterly returns by the UK exchange rate introduces an element of positive covariance between many countries. As a result the correlation among the exchange rate adjusted returns of the countries is higher in many cases, with now only 56 per cent of the correlation coefficient below +0.5. However, in a number of cases the correlation coefficients are lower, indicating a negative influence of the exchange rates on the correlation between several countries.

To test the equality of unadjusted and exchange rate adjusted correlation matrix we employ the Box M test (Tang, 1995). The calculate F statistics show that the equality of the correlation matrices can be rejected at the 6% significance level, suggesting that the correlation matrices based on the unadjusted and exchange rate adjusted data are significantly different. The equality of the two covariance matrices (not shown) can also be rejected at the 5% significance level. These results are in contrasts, to the findings of Addae-Dapaah and Choo (1996); Addae-Dapaah and Goh (1998) Addae-Dapaah and Loh (2005) but supportive of the conclusions of Ziobrowski and Curcio (1991): Worzala (1995) and Newell and Webb (1996) and suggest that the countries and weights in the efficient portfolios using the unadjusted and exchange rate adjusted data sets are likely to be radically different.

Table 3 shows a UK investor would have achieved substantial diversification benefits from investing overseas. Allocating only 10% abroad, irrespective of the country, would have provided improvements in portfolio performance, with gains in exchange rate adjusted returns between 0.38 to 9.77 basis points and reductions in risk of between 4 to 10 basis points. Adding 50% to a UK real estate portfolio would have seen even greater increases in return and reductions in risk. However, beyond the 50% point the gains in return are off set by increases in risk.

A portfolio spread across more than two countries would achieve even better performance. For instance, a naïve equal allocations across all countries would a shown an exchange rate adjusted return of 6.45% per quarter and a risk of 4.21% per quarter, i.e. an increase in return of 34 basis points and a reduction in risk of 23 basis points for a UK investor. The question therefore is can a UK investor gain the greatest benefit of international diversification by concentrating on the local real estate market performance or does the investor have to consider exchange rate risk when making real estate portfolio decisions?

Table 2: Local Market and Exchange Rate Adjusted Correlation Matrices
Quarterly Data Q1 1989 to Q1 2005

	Austria	Belgium	Denmark	France	Germany	Ireland	Italy	Netherlands	Portugal	Spain	Sweden	UK
Austria		0.647	-0.539	0.601	0.675	0.662	0.463	0.672	0.680	0.597	-0.071	0.042
Belgium	0.239		-0.757	0.531	0.568	0.588	0.547	0.701	0.572	0.544	-0.291	0.175
Denmark	0.072	-0.060		-0.417	-0.455	-0.451	-0.340	-0.686	-0.428	-0.345	0.526	0.008
France	0.372	0.140	0.163		0.524	0.570	0.453	0.520	0.484	0.532	-0.007	0.217
Germany	0.449	0.197	0.135	0.295		0.616	0.530	0.592	0.568	0.595	-0.231	0.007
Ireland	0.385	0.112	0.362	0.349	0.391		0.504	0.731	0.724	0.621	-0.054	0.179
Italy	0.362	0.378	0.188	0.320	0.431	0.265		0.447	0.494	0.399	-0.196	0.130
Netherlands	0.252	0.082	0.192	0.091	0.202	0.432	0.178		0.595	0.490	-0.325	0.133
Portugal	0.488	0.317	0.080	0.262	0.404	0.606	0.376	0.318		0.456	-0.171	-0.057
Spain	0.336	0.212	0.281	0.327	0.416	0.437	0.374	0.041	0.326		0.124	0.266
Sweden	0.133	0.103	0.495	0.331	0.021	0.370	0.130	-0.013	0.020	0.380		0.299
UK	-0.161	-0.022	0.508	0.091	-0.165	0.020	0.059	-0.068	-0.240	0.173	0.539	

Table 3: A UK Investors Gain in Portfolio Performance from Investing Overseas
Quarterly Data Q1 1989 to Q1 2005

Weight Overseas	10%		25%s		50%		75%		90%	
Statistics	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Austria	4.88	4.99	4.97	4.52	5.12	4.56	5.27	5.54	5.36	6.42
Belgium	5.08	5.06	5.47	4.66	6.12	4.59	6.77	5.28	7.16	5.96
Denmark	5.01	4.94	5.29	4.27	5.75	3.65	6.21	3.86	6.49	4.36
France	4.87	5.13	4.93	4.88	5.04	5.17	5.15	6.20	5.22	7.06
Germany	4.84	4.98	4.87	4.56	4.91	4.82	4.96	6.10	4.98	7.15
Ireland	5.16	5.08	5.66	4.71	6.49	4.76	7.33	5.58	7.83	6.32
Italy	5.03	5.07	5.34	4.78	5.86	5.13	6.38	6.34	6.69	7.31
Netherlands	5.04	5.04	5.37	4.63	5.92	4.61	6.48	5.41	6.81	6.16
Portugal	5.30	4.92	6.00	4.42	7.18	4.57	8.36	5.83	9.07	6.88
Spain	4.96	5.18	5.17	5.03	5.52	5.48	5.87	6.61	6.08	7.50
Sweden	4.84	5.21	4.87	5.09	4.92	5.54	4.96	6.65	4.99	7.51
UK	4.82	5.45	4.82	5.45	4.82	5.45	4.82	5.45	4.82	5.45
Gain/Loss Bp	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Austria	1.23	-8.53	3.09	-17.04	6.17	-16.43	9.26	1.53	11.11	17.68
Belgium	5.39	-7.17	13.47	-14.60	26.94	-15.81	40.42	-3.13	48.50	9.38
Denmark	3.83	-9.50	9.58	-21.67	19.15	-33.13	28.73	-29.25	34.47	-20.12
France	0.91	-5.93	2.27	-10.49	4.54	-5.16	6.81	13.78	8.18	29.39
Germany	0.36	-8.74	0.91	-16.46	1.82	-11.57	2.72	11.89	3.27	31.12
Ireland	6.92	-6.91	17.29	-13.58	34.58	-12.71	51.88	2.24	62.25	15.93
Italy	4.29	-6.94	10.73	-12.29	21.46	-5.84	32.19	16.27	38.62	34.09
Netherlands	4.57	-7.54	11.41	-15.16	22.83	-15.49	34.24	-0.83	41.09	13.00
Portugal	9.77	-9.70	24.43	-19.02	48.87	-16.15	73.30	6.87	87.96	26.23
Spain	2.89	-4.92	7.22	-7.72	14.44	0.41	21.65	21.24	25.98	37.60
Sweden	0.38	-4.46	0.95	-6.74	1.90	1.58	2.86	21.91	3.43	37.80
UK	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

4. Research Design and Results

In order to test whether similar efficient portfolio are produced when exchange rate adjusted and local market data is used we derived a simple test. First, using the local market data we calculated 10 efficient portfolios and recorded the number of countries and their weights in each portfolio. Then, we used these portfolio asset and weight combinations to calculate the risk and returns such an allocation would produce if the exchange rate data was used. Next, these risk and returns levels were then compared with the efficient portfolios with the same risk (return) derived using the exchange rate adjusted data.

The first part of the analysis is designed to show the extent of any increase in risk or reduction in return the investor would have faced if he had based his investment strategy on local real estate market data alone, the results shown in Column 2 of Table 4. As can be clearly seen in Table 4 using local market data the least losses in return and increases in risk occur at the two extremes of the efficient frontier, the maximum return portfolio and the minimum risk portfolio. However, at all other points on the efficient frontier using local market data results in substantial losses in return of up to 92 basis points per quarter and increases in risk of up to almost 250 basis points, once exchange rate risk is considered. This supports the previous studies which all indicate the substantial differences in risk and return between efficient frontiers based on unadjusted and exchange rate adjusted data.

Table 4: Similarity Indices of Unadjusted and Exchange Rate Adjusted Portfolios With the same Risk and Return

Panel A	Increase in	Same Risk using Unadjusted Composition					
Portfolio	Return Bp	Un-adj	Adjust	Common	Overlap	Weight	Similarity
10 Max Return	0.00	1	1	1	100.0%	100.0%	100.0%
9	9.61	3	2	1	25.0%	88.9%	22.2%
8	20.43	3	2	1	25.0%	77.3%	19.3%
7	32.94	3	2	1	25.0%	65.3%	16.3%
6	47.90	3	2	1	25.0%	52.5%	13.1%
5	66.82	3	2	1	25.0%	38.3%	9.6%
4	91.79	4	2	1	20.0%	25.1%	5.0%
3	79.28	5	2	2	40.0%	32.1%	12.8%
2	53.47	5	3	3	60.0%	51.9%	31.1%
1 Min Risk	11.76	6	4	3	42.9%	95.0%	40.7%
Panel B	**Reduction in**	**Same Return using Unadjusted Composition**					
Portfolio	**Risk Bp**	**Un-adj**	**Adjust**	**Common**	**Overlap**	**Weight**	**Similarity**
10 Max Return	0.00	1	1	1	100.0%	100.0%	100.0%
9	-32.03	3	2	1	25.0%	88.9%	22.2%
8	-66.75	3	2	1	25.0%	77.3%	19.3%
7	-104.75	3	2	1	25.0%	65.3%	16.3%
6	-146.68	3	2	1	25.0%	52.5%	13.1%
5	-193.27	3	2	1	25.0%	38.3%	9.6%
4	-248.19	4	3	2	40.0%	33.5%	13.4%
3	-187.55	5	3	3	60.0%	48.7%	29.2%
2	-103.50	5	4	4	80.0%	67.7%	54.2%
1 Min Risk	-0.89	6	6	6	100.0%	96.1%	96.1%

Then to test whether the efficient portfolio compositions based on the different data sets are essentially the same, two issues need to be addressed (Philips, 1993). First, to what extent do the same assets appear in each optimum model? Second, for those assets that are contained in each solution, to what extent do they appear in similar proportions? The results presented in columns 3-8 of Table 4.

Columns 3 and 4 of Table 4 compares the number of countries held for the 10 portfolios using unadjusted and adjusted data for portfolios of the same risk (return), using the exchange rate adjusted data. For instance, in Panel A of Table 4 portfolio 9, derived using unadjusted data contains 3 countries, whereas the optimum portfolio derived using the exchange rate adjusted data with the same risk is composed of 2 countries. In a similar vein, the number of countries chosen for portfolio 4 in Panel B using the local market data is 4 whereas using exchange rate adjusted data the efficient portfolio with the same return contains 3 countries. These raw numbers can then be used to calculate *portfolio overlap, weight* and *similarity* indices (see Philips, 1993 for details).

The *portfolio overlap* index for between the unadjusted and adjusted portfolio allocations is defined as the ratio of the number of assets that overlap, i.e. are in common, between the two portfolios solutions, compared with the number of assets at the union between the two data series. The union between the two datasets is equal to the number of assets in the unadjusted portfolio solution plus the number of assets in the adjusted solution, minus the number of assets in common. For instance, while the unadjusted and adjusted solutions of portfolio 4 in Panel B contained (4) and (3) assets respectively, only 2 were common to both. The ratio of the overlap between the two solutions to the union between the two solutions is therefore 2/(4+3-2) = 40%. In other words, only 40% of countries contained in the unadjusted solution are also contained in the exchange rate adjusted solution with the same level of return. The results presented in Column 6 of Panel A of Table 4 for portfolio with the same level of risk and Panel B for the unadjusted and adjusted solutions of the with the same return.

The calculation of *portfolio overlap indice*s only addresses one facet of the similarity or dissimilarity of portfolio compositions. When two portfolios contain exactly the same assets the portfolio overlap index will be 100%. However, the weights within such portfolios could vary markedly. This has important investment implications.

To test the similarity between the weights attached to assets held in common by two portfolios a *portfolio weight* index can be constructed. The index is measured by summing the minimum weight attached to each asset that overlaps two portfolio solutions. For example, Panel B of Table 4 shows a *portfolio overlap* index of portfolio 1, the minimum risk portfolio, is 100% using the unadjusted and adjusted solutions. This indicates that the two solutions contain the same countries. However, the two countries are not in the same weight in each solution. That is, the sum of the minimum weights found in the portfolios between the two solutions for the holdings that are common in both solutions is 96%. In other words, 96% of the weight in the unadjusted portfolio solution is common to the adjusted solution. The results for the other portfolios are presented in Column 7 of Panel A of Table 4, for portfolios of the same risk. The *portfolio weight* indices for the unadjusted and adjusted solutions of portfolios with the same return are calculated in the same way and presented in Panel B of Table 4

Multiplying the *portfolio overlap* indices by the *portfolio weight* indices gives the proportion of assets in common to both risk measures with similar weights, i.e. a *portfolio similarity* index. These are shown in Column 8 of Table 4. For example,

portfolio 4 in Panel B has a *portfolio overlap* index of 40% and a *portfolio weight* index of 33.5% giving a similarity index of only 13% (0.4*0.335). The *portfolio similarity* indices of the unadjusted and adjusted solutions of portfolios with the same risk are shown in Panel A of Table 4, while the corresponding results for the portfolios with the same return are shown in Panel B.

Table 4 shows a number of features of interest. First, in all cases the number of countries in the efficient portfolios with the same risk (return) as that produced using the exchange rate adjusted date is always less than or equal to that chosen using the local real estate market data. The portfolio overlap indices are therefore all less than or equal to 100%. Secondly, the weight indices show that apart from the two extreme portfolios even if the two solutions contain the same countries they would have contained markedly different weights. Consequently, the similarity indices are all small, apart from the extreme solutions. In other words, the efficient portfolio combinations using unadjusted or adjusted data leads to solutions that are radically different, consequently this initial analysis suggests that any international allocation decision needs to consider the effect exchange rates are likely to have on future performance and not just the expected returns from real estate.

5. Robustness Tests

The results above however may have exaggerated the impact of exchange rate risk on international portfolio performance for at least two reasons. First, no constraints were placed on the allocation to the domestic market, even though investors have a home basis, i.e. allocate more to their home market than can be justified by modern portfolio theory (see French and Poterba, 1991). Second, nine of the countries in the analysis entered the single currency at the start of 1999. This means that for those countries in the single currency exchange rate risk is eliminated, although not for outside investors. Nonetheless, a UK investor now has only one exchange rate to consider when allocating funds to those countries in the single currency as such the investment decisions facing a UK investor may have been simplified with the introduction of the single currency. The following section considers the impact of both these issues on the similarity of international real estate portfolios.

Constraints

Table 5 shows the similarity indices over the whole period for international portfolios with an allocation of 50 per cent to the UK, i.e. a home bias to the domestic market. Table 5 shows a number of features of interest. First, using local market data still results in losses in return or increases in risk compared with the exchange rate solution, albeit less than for the unconstrained solution (see Table 4). Additionally, like the results in Table 4 the least losses in return and increases in risk occur in the maximum return portfolios. However, unlike the unconstrained solution the greatest losses in return and increases in risk occur in the least risky portfolio.

Second, Table 5 shows that in all cases the number of countries in the efficient portfolios with the same risk (return) as that produced using the exchange rate adjusted data is again always less than or equal to that chosen using the unadjusted data. Additionally, the weight indices show that even if the two solutions contain the same countries they are held in markedly different weights. Consequently, the

similarity indices are small, although generally greater than for the unconstrained solution. In other words, the efficient portfolio combinations using unadjusted or adjusted data leads to solutions that are still markedly different, even if a UK investor where to allocate 50% of his international real estate portfolio to his home market.

Table 5: Similarity Indices of Unadjusted and Exchange Rate Adjusted Portfolios With the same Risk and Return: 50% Allocation to the UK

Panel A	Increase in	Same Risk using Unadjusted Composition					
Portfolio	Return Bp	Un-adj	Adjust	Common	Overlap	Weight	Similarity
10 Max Return	0.00	2	2	2	100.0%	100.0%	100.0%
9	3.56	3	3	2	50.0%	97.2%	48.6%
8	7.59	3	3	2	50.0%	94.3%	47.2%
7	12.27	3	3	2	50.0%	91.1%	45.6%
6	17.87	3	3	2	50.0%	87.6%	43.8%
5	24.57	4	3	2	40.0%	83.9%	33.6%
4	32.42	4	3	2	40.0%	80.1%	32.0%
3	42.49	4	3	2	40.0%	75.5%	30.2%
2	57.86	4	3	2	40.0%	69.1%	27.6%
1 Min Risk	114.13	6	3	2	28.6%	56.0%	16.0%
Panel B	**Reduction in**	**Same Return using Unadjusted Composition**					
Portfolio	**Risk Bp**	**Un-adj**	**Adjust**	**Common**	**Overlap**	**Weight**	**Similarity**
10 Max Return	0.00	2	3	2	66.7%	100.0%	66.7%
9	-9.53	3	3	2	50.0%	97.2%	48.6%
8	-19.86	3	3	2	50.0%	94.3%	47.2%
7	-31.18	3	3	2	50.0%	91.1%	45.6%
6	-43.87	3	3	2	50.0%	87.6%	43.8%
5	-57.77	4	3	2	40.0%	83.9%	33.6%
4	-72.18	4	3	2	40.0%	80.1%	32.0%
3	-87.78	4	3	2	40.0%	75.5%	30.2%
2	-105.44	4	3	2	40.0%	69.1%	27.6%
1 Min Risk	-121.83	6	7	6	85.7%	69.6%	59.7%

The Single Currency

Tables 6 and 7 repeat all of the analyses above using the unadjusted and exchange rate adjusted data before and after the introduction of the single currency. Table 6 shows the results before the introduction of the SEC and Table 7 the results after the introduction of the SEC. Table 6 shows that during the period before the introduction of the SEC exchange rate risk mattered to international investors, even if the investor had 50% of their monies in the UK. The results show that using local market data to construct a European property portfolio over this period would have chosen different countries and shown worse performance compared would portfolios based in exchange rate adjusted data.

In contrast, Table 7 shows that since the introduction of the single currency European investment decisions have been simplified. The similarity indices showing that in many cases the use of local market data, unadjusted for currency fluctuations, would have produce efficient portfolio combinations identical to those based on the exchange rate adjusted data, irrespective of whether the UK investor had a hone bias or not. Additionally, even where there are differences in the loss in return or increases in risk, from relying on local market data, the difference is small except for the minimum risk portfolio.

Table 6: Similarity Indices of Unadjusted and Exchange Rate Adjusted Portfolios With the same Risk and Return: 50% Allocation to the UK: Pre-Single Currency Period

Panel A	Increase in	Same Risk using Unadjusted Composition					
Portfolio	Return Bp	Un-adj	Adjust	Common	Overlap	Weight	Similarity
Unconstrained							
10 Max Return	0.00	1	1	1	100.0%	100.0%	100.0%
9	5.92	2	2	1	33.3%	85.7%	28.6%
8	13.88	2	2	1	33.3%	70.7%	23.6%
7	25.11	2	2	1	33.3%	54.4%	18.1%
6	42.45	3	2	1	25.0%	36.6%	9.2%
5	67.98	3	2	1	25.0%	25.9%	6.5%
4	104.10	3	2	1	25.0%	13.2%	3.3%
3	96.43	5	3	3	60.0%	27.0%	16.2%
2	73.89	5	4	4	80.0%	53.8%	43.1%
1 Min Risk	0.00	5	4	3	50.0%	97.1%	48.5%
Constrained							
10 Max Return	0.00	2	2	2	100.0%	100.0%	100.0%
9	4.15	3	3	2	50.0%	95.5%	47.8%
8	9.50	4	3	2	40.0%	92.7%	37.1%
7	15.62	4	3	2	40.0%	90.1%	36.0%
6	22.72	4	3	2	40.0%	87.3%	34.9%
5	31.21	4	3	2	40.0%	84.1%	33.6%
4	41.94	4	3	2	40.0%	80.4%	32.2%
3	57.03	4	3	2	40.0%	75.8%	30.3%
2	84.93	5	3	2	33.3%	69.8%	23.3%
1 Min Risk	160.58	6	3	2	28.6%	56.4%	16.1%
Panel B	**Reduction in**	**Same Return using Unadjusted Composition**					
Portfolio	**Risk Bp**	**Un-adj**	**Adjust**	**Common**	**Overlap**	**Weight**	**Similarity**
Unconstrained							
10 Max Return	0.00	1	2	1	50.0%	100.0%	50.0%
9	-15.68	2	2	1	33.3%	85.7%	28.6%
8	-35.90	2	2	1	33.3%	70.7%	23.6%
7	-62.80	2	2	1	33.3%	54.4%	18.1%
6	-100.98	3	2	1	25.0%	36.6%	9.2%
5	-152.32	3	3	2	50.0%	34.0%	17.0%
4	-215.75	3	4	3	75.0%	31.8%	23.9%
3	-168.85	5	4	4	80.0%	46.0%	36.8%
2	-96.68	5	5	5	100.0%	64.2%	64.2%
1 Min Risk	-0.75	5	5	4	66.7%	97.2%	64.8%
Constrained							
10 Max Return	0.00	2	3	2	66.7%	100.0%	66.7%
9	-8.49	3	3	2	50.0%	95.5%	47.8%
8	-18.82	4	3	2	40.0%	92.7%	37.1%
7	-29.91	4	3	2	40.0%	90.1%	36.0%
6	-41.76	4	3	2	40.0%	87.3%	34.9%
5	-54.58	4	3	2	40.0%	84.1%	33.6%
4	-68.81	4	3	2	40.0%	80.4%	32.2%
3	-85.40	4	3	2	40.0%	75.8%	30.3%
2	-105.37	5	4	3	50.0%	71.7%	35.8%
1 Min Risk	-115.13	6	7	5	62.5%	71.4%	44.6%

Table 7: Similarity Indices of Unadjusted and Exchange Rate Adjusted Portfolios With the same Risk and Return: 50% Allocation to the UK: Single Currency Period

Panel A	Increase in	Same Risk using Unadjusted Composition					
Portfolio	Return Bp	Un-adj	Adjust	Common	Overlap	Weight	Similarity
Unconstrained							
10 Max Return	0.00	1	1	1	100.0%	100.0%	100.0%
9	0.00	2	2	2	100.0%	100.0%	100.0%
8	0.00	2	2	2	100.0%	100.0%	100.0%
7	0.00	2	2	2	100.0%	100.0%	100.0%
6	0.00	2	2	2	100.0%	100.0%	100.0%
5	0.00	2	2	2	100.0%	100.0%	100.0%
4	8.17	3	3	2	50.0%	80.9%	40.5%
3	14.38	6	3	3	50.0%	73.5%	36.7%
2	11.14	6	3	3	50.0%	81.7%	40.9%
1 Min Risk	117.35	5	3	2	33.3%	46.1%	15.4%
Constrained							
10 Max Return	-69.57	2	4	2	50.0%	54.4%	27.2%
9	-58.46	3	3	2	50.0%	61.4%	30.7%
8	0.00	3	3	3	100.0%	100.0%	100.0%
7	0.00	3	3	3	100.0%	100.0%	100.0%
6	0.00	3	3	3	100.0%	100.0%	100.0%
5	0.00	3	3	3	100.0%	100.0%	100.0%
4	0.00	3	3	3	100.0%	100.0%	100.0%
3	0.00	3	3	3	100.0%	100.0%	100.0%
2	4.28	4	4	3	60.0%	91.1%	54.7%
1 Min Risk	74.65	4	4	3	60.0%	70.4%	42.2%
Panel B	**Reduction in**	**Same Return using Unadjusted Composition**					
Portfolio	**Risk Bp**	**Un-adj**	**Adjust**	**Common**	**Overlap**	**Weight**	**Similarity**
Unconstrained							
10 Max Return	0.00	1	1	1	100.0%	100.0%	100.0%
9	0.00	2	2	2	100.0%	100.0%	100.0%
8	0.00	2	2	2	100.0%	100.0%	100.0%
7	0.00	2	2	2	100.0%	100.0%	100.0%
6	0.00	2	2	2	100.0%	100.0%	100.0%
5	0.00	2	2	2	100.0%	100.0%	100.0%
4	-37.84	3	3	2	50.0%	80.9%	40.5%
3	-65.12	6	3	3	50.0%	73.5%	36.7%
2	-39.83	6	3	3	50.0%	81.7%	40.9%
1 Min Risk	-146.90	5	5	3	42.9%	70.0%	30.0%
Constrained							
10 Max Return	0.00	2	2	2	100.0%	100.0%	100.0%
9	0.00	3	3	3	100.0%	100.0%	100.0%
8	0.00	3	3	3	100.0%	100.0%	100.0%
7	0.00	3	3	3	100.0%	100.0%	100.0%
6	0.00	3	3	3	100.0%	100.0%	100.0%
5	0.00	3	3	3	100.0%	100.0%	100.0%
4	0.00	3	3	3	100.0%	100.0%	100.0%
3	0.00	3	3	3	100.0%	100.0%	100.0%
2	-16.75	4	4	3	60.0%	91.1%	54.7%
1 Min Risk	-115.14	4	4	4	100.0%	72.3%	72.3%

6. Conclusions

International real estate investments are made in a foreign country's property market in order to reduce the investor's portfolio risk level. However, going overseas means facing exchange rate risk, i.e. that changes in the currency can diminish or eliminate the gains from international diversification. We examine this issue from a UK investor's point of view by considering investing into Europe, using quarterly data over the period from 1989 to 2005, and find that relying on local market data to construct optimum portfolio combinations is inefficient compared to those produced using exchange rate adjusted data. This is true even if the investor were to allocate 50% to his domestic portfolio, i.e. the UK investor displays a home bias. In other words, the initial results suggesting that investors need to incorporate exchange rate

expectations into their international investment strategy, unless they are fully hedged or are using an exchange rate overlay program.

However, the results are somewhat different between the period before and after the introduction of the single currency. In the pre-single currency period exchange rate risk would certainly have mattered to UK investors, has the efficient portfolio composition based on local market data would have been radically different to those suggested by the exchange rate based data. Following the introduction of the single currency the differences in portfolio composition are miniscule. In other words, the introduction of the single currency has meant that even foreign investors outside the single currency now face less daunting investment decisions as they can on concentrate on the real estate fundamentals when making their portfolio choices, rather than worry about the implications of exchange rate risk on their investment options.

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