Simulating Currency Risk on Private Investments in Real Estate

Executive Summary. *International real estate investment performance is highly sensitive to currency fluctuations. While large professional investors hedge currency at the portfolio level, not by asset class or asset, smaller, specialist investors hedge at the individual asset level, facing considerable specific risk. Hedging products are ill suited to international real estate. This paper uses a Monte Carlo framework to examine hedging using combinations of currency swaps for the rental income and expected terminal value of an office investment. The study suggests that the currency swap strategy results in considerable reduction of the downside risk associated with currency fluctuations and produces superior risk-adjusted returns.*

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International investment in property has become a persistent feature of real estate markets in the developed economies in the last fifteen years. In 1991, there were only eleven identifiable investment funds in the United States that had an international investment strategy (Worzala, 1992). In contrast, in June 2004 there were seventy-three active U.S. investment funds that had been established to invest in international real estate (Institutional Real Estate, Inc.) with a total planned investment of $69.8 billion. Over this time period, investors have seen a tenfold increase in funds focused on international real estate investment. For the funds that provided allocations, close to 60% were invested 100% in international real estate whereas 20% indicated they had a portion of the portfolio allocated to U.S. real estate investments. Similar developments can be seen in Europe and Australia.

It is clear that real estate investors and advisors increasingly act in a global capacity. Cross-border activity means that real estate investment must focus not only on cash flow patterns—changes in rents and capital values—but also on the impact of currency movements. Incorporating exchange rate fluctuations into the analysis of an international investment can substantially alter the expected return–risk characteristics.

For major portfolio investors, returns for all international investments are adjusted on a periodic basis. While this might be consistent with market

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practice on performance reporting, it does not accord with actual international investment cash flows faced by individual investors. As one might expect, adjusting international real estate investments for currency fluctuations has an adverse impact on the financial performance of the investment.

Real estate is a capital intensive and relatively illiquid investment that requires a long-term holding period. Due to the long investment horizon, it is very difficult to fully hedge an international real estate investment. Using a common rolling-forward contract, the risk associated with the fully hedged investment is much greater than if the investor had adjusted returns for currency fluctuations on a period-by-period basis (Worzala, 1995). Conventional hedging techniques may not be the most appropriate for hedging a multi-period asset like real estate (Soenen, 1991; and Grant and Soenen, 2004). This study explores the use of a currency swap to eliminate most of the exchange rate exposure associated with an international real estate investment.

For major institutional and professional investors, international real estate assets will simply form part of a global asset. Hedging is then generally based on a currency overlay basis—the net exposure to particular currencies being hedged by a specialist treasury function. For the majority of international real estate investors, however, acquisitions will be piecemeal, with no guarantee that property returns will track local performance benchmarks and with far greater specific risk. It is those individual investments that are the focus of this paper.

In an individual real estate investment, there are three sets of cash flows that an investor must consider: the initial investment, the periodic cash flows, and the sale at the end of the holding period. If periodic cash flows are known with certainty or are relatively stable, then the initial investment and the periodic flows can be swapped into the home currency of the investor.

The currency swap market, along with other financial derivatives products, has grown substantially over the last decade and this hedging technique is becoming readily available to the international investor. According to the Bank for International Settlement, in June 2004 the notional amount of outstanding OTC single currency interest rate derivatives was almost $165 trillion. The vast majority of these contracts, 77%, were currency swaps.

The most difficult cash flow to protect in an international real estate investment is the uncertain sales price or terminal value at the end of the holding period. With the plain vanilla currency swap, the initial investment is protected but any appreciation or depreciation that has occurred over the holding period will still be subject to the risks associated with currency fluctuations. An alternative strategy would be to swap the *anticipated* terminal value of the asset at the end of the investor's holding period rather than the initial acquisition price. This would be useful in protecting the expected appreciation from variation in exchange rates. The value of this strategy, however, is dependent on the ability to estimate the terminal value and leaves the investor exposed to the difference between anticipated and actual sales proceeds.

The present value distribution model has traditionally been used as a generalized approach for the valuation and risk assessment of assets generating uncertain future cash flows. Traditional DCF-models use a point estimate for rental income, i.e., the expected rental rate, and lose all information pertaining to the variance of the rents. Hughes (1995) first replaced point estimates with a Monte Carlo technique to form rent projections using rate variance, providing a path dependent trajectory of possible future cash flows. In addition to Hughes (1995), the models presented in this study build on an approach adopted in two earlier studies, Worzala, Johnson, and Lizieri (1997) and Lizieri, Worzala, and Johnson (1998). In the first study, a Monte Carlo simulation framework was used to compare a single real estate investment in the United Kingdom made by a U.S. investor with no currency hedging to a scenario where a plain vanilla currency swap was used to mitigate the currency risk. The only variable that was allowed to vary in the simulation was the exchange rate.

In the second study, a more realistic scenario framework assumed currency fluctuations around the mean and both positive and negative trends were explored. In both studies, the swap proved to be an effective tool for reducing the volatility associated with the currency adjusted income flows of the investment but the effectiveness of the swap was highly sensitive to changes in the variables determining the terminal value.

This study enhances the realistic nature of the simulation model, particularly as it pertains to the terminal value of the investment. Both the rental growth rate and the capitalization rate are modeled as random variables. The simulation of the rental growth rate series is based on a rolling five-year average growth rate, a more realistic scenario than the quarterly rental growth rate series that were used in the previous studies. In addition, the exchange rate fluctuations are modeled as a random variable but the mean and standard deviation are based on a separate series constructed from the differentials between the exchange rate in one period and the exchange rate for lags of 1, 2, 3...20 periods. Again, this is more realistic than using a simple time series of quarterly exchange rates. Exchange rate volatility increases significantly for longer investment periods. Finally, a risk-free discount rate from the perspective of a U.S. investor is used instead of basing the net present value analysis entirely on return parameters from a U.K. investment perspective. The risk-free rate recognizes that the rental payments are known with relative certainty. Using a U.S. investor's perspective recognizes that the international investor is comparing the international investment performance with alternatives in his/her own domestic country. Previous studies used nominal discount rates from the country where the investment was located.

The remainder of the paper is organized as follows. Section two reviews earlier research on hedging international real estate investments. Section three describes the data and simulation model. Section four reports the empirical results of the various simulations. The final section provides conclusions and implications of the research findings, suggesting areas for future research.

Prior Research on Currency Hedging of International Real Estate Investments

Ziobrowski and Ziobrowski (1993, 1995) and Ziobrowski, Ziobrowski, and Rosenberg (1997) present real estate investments as part of a mixed-asset portfolio and utilize an appraisal-based real estate index returns to proxy the real estate investment. Returns are adjusted on a periodic (generally annual) basis. While this is consistent with reporting standards, the use of such a hedge in effect implies annual repatriation of funds. In practice, while rental income might be repatriated, the capital gain component can only be realized upon sale of the property and is, thus, dependent upon aggregate currency movement over the expected holding period.

Ziobrowski, Ziobrowski, and Rosenberg (1997) suggest that a currency swap may well reduce the risk of currency fluctuations on the income return of foreign property. Hoesli, Lekander, and Witkiewicz (2004) use a forward contract to partially hedge currency exposure: intriguingly, their results show that while performance for U.S. and U.K. investors is not improved by hedging, there are advantages for investors from other countries. Worzala, Johnson, and Lizieri (1997) and Lizieri, Worzala, and Johnson (1998) have argued that results based on portfolio-based indices may be misleading for all but the largest institutional investors. Most investors would be exposed to tracking error and specific risk, given the heterogeneity of private real estate performance and the typically small number of foreign properties held. Moreover, they argue that ex post data is historically contingent and hence ignores uncertainty [this problem is also addressed in Ziobrowski, Caines, and Ziobrowski (1999), who introduce a bootstrapping procedure]. As a result, for individual investors it is appropriate to use a forward-looking simulation approach with realistic expectation and volatility inputs for key variables that impact the risk and return characteristics of the real estate investment.

This study adopts that approach and develops a simulation model that employs a forward-looking, expectations framework. A common criticism of the

Exhibit 1
Variables Used in the Simulation Models

Description	Value
Initial Exchange Rate: U.S. dollars per U.K. pound (1975:Q4–2004:Q3, average)	1.78
Net Operating Income	£380,000
Net Operating Income – Swap Cost	£379,050
Net Initial Purchase Price = Outlay in Period 0 for Model 1[a]	£17,249,602
Net Initial Purchase Price + Swap Cost = Outlay in Period 0 for Model 2[a]	£17,422,098
Rent per Square Meter per year	£400
Size in Square Meters	4,000
Management Costs	5.00%
Average 20 Quarter Growth Rate-JLL ERV (1977:Q2–2003Q:4)	17.14%
Std. Dev. 20 Quarter Growth Rate-JLL ERV (1977:Q2–2003:Q4)	20.33%
Initial Capitalization Rate-IPD: London City Offices (1987:Q1–2003:Q4)	8.81%
Exit (reversion) Capitalization Rate-IPD: London City Offices (1987:Q1–2003:Q4)	8.81%
Std. Dev. Exit (reversion) Capitalization Rate-IPD: London City Offices (1987:Q1–2003:Q4)	1.02%
TV: Terminal Value @ Expected Rent Growth Rate	£20,205,654
Swap Origination Fee	1.00%
Swap Cost per Period	0.25%
TV (@ Expected Rent Growth Rate + Swap Cost) = Outlay in Period 0 for Model 3[a]	£20,407,711

Notes;
[a]Acquisition, sales, and marketing costs for the purchase and sale of the property are the same for all models tested. The impact on the outcomes would be minor so they are not explicitly accounted for in the simulations.

currency swap is that the appreciation or depreciation of the investment is not protected. Therefore, the use of two different swap contracts is explored: one that is based on the initial purchase price of the property and a second based on the expected terminal value of the property at the end of the holding period. This second scenario could potentially add volatility to the return from the investment if the actual sales price is different from the expected terminal value. In this case, the project would be over-hedged or under-hedged. However, the impact of the imperfect hedge may be small considering the long-term nature of the investment.

In practice, an investor has to decide whether to repatriate the periodic cash flows or re-invest them in the foreign country until the entire investment is liquidated. For the unhedged scenario, a relatively conservative position was chosen with the quarterly cash flows repatriated every period. Investors making the second choice would face more uncertainty as not only would they have cash from the sale to repatriate, at an unknown exchange rate, but they will also have accumulated foreign currency rental income plus interest earned. With the swap, periodic cash flows are converted into the investors' domestic currency, with only the terminal value subject to exchange rate risk upon repatriation.

Data and Simulation Models

The simulation model has been developed to value the acquisition of a recently rented London-based office building by a U.S. investor, with a target holding period of five years. The exogenous and calculated/estimated values for the real estate investment are detailed in Exhibit 1.

The U.K. data are based on a typical office building in the City of London with the rent set just below the prime, class A rent, at £400 per square meter (~£37 per square foot). "Institutional" leases in the U.K. are unusual in that the rent is agreed upon

at the beginning of the lease and remains fixed for the first five-year period. The rent is then reviewed and adjusted to the higher of the then market rent or the existing contract rent. This is often referred to as the "upward-only rent review clause." Although typical lease lengths have fallen since the 1990s, the average remains around fifteen years, meaning that the investor will sell before lease termination. In this simulation analysis, the first rent review coincides with the investor's five-year holding period. Therefore, a new market rent needs to be estimated over a five-year holding period to be able to estimate the terminal value of the office building.

This lease effect was modeled by calculating the percentage change in the Jones Lang LaSalle (JLL) index for rolling five-year (twenty quarter) periods. The mean and standard deviation of this series (eighty-seven observations) are used as the basis for the expected growth rate for rents for the next five-year review (17.14%) and the standard deviation of that growth rate (20.33%). The JLL index is based on a portfolio of institutionally-held property in the City of London.

For the entry and exit capitalization rates, the monthly equivalent yield series for London City offices provided by the Investment Property Databank is used. From 1987 through 2003, the average capitalization rate was 8.81% and the standard deviation was 1.02%. The swap origination fees and periodic costs are identified from current products available to U.S. investors. Inflows of capital have driven cap rates downwards since 2004, but this may well prove to be a temporary anomaly.

Three hedging scenarios are simulated:

1. Do not hedge any of the cash flows or terminal value of the project. This serves as a base case scenario to be used to compare with the risk/return characteristics of hedging scenarios.
2. Swap the original investment and the quarterly cash flows and leave the difference between the expected sale price of the property and the swapped purchase cost unhedged.
3. Swap the expected terminal value and the quarterly cash flows. This option essentially converts the expected sale value of the property to be received in foreign currency units, into domestic currency units. The difference between the purchase cost and the terminal value is simply added to the NPV, since it represents swapped value that is not spent on the purchase of the asset. The cost of this hedge is simply the swap origination fee (1%) times the difference between the initial investment cost and the expected terminal value.

The cash flows from the alternative simulations are discounted at the U.S. Treasury security interest rates. Quarterly discount rates are calculated and interpolated from published one, two, four, eight, twelve, and twenty quarterly rates. Risk adjusted discount rates were not used in order to prevent the risk/return characteristics of each hedging scenario from being masked and to avoid potential distortions that can arise with the use of the risk adjusted discount rate approach. Investors can use the Certainty Equivalent Adjustment Technique (CEAT) or similar techniques to compare scenarios with different risk-return characteristics. This paper compares the expected non-risk adjusted NPV from three hedging scenarios with the coefficient of variation (as a measure of relative risk) alongside other risk metrics including the standard deviation of the NPV estimates and the probability of obtaining a negative NPV.

As an extension of the simulation model by Hughes (1995), not only are rents but also exchange rates and capitalization rates are random variables in the Monte Carlo simulation. The assumptions relating to the estimation and construction of these random series are detailed in Exhibit 1.

While the assumptions outlined relate to a specific investment, the advantage of the U.K. lease format is that it allows a focus on the benefits of the swap, without the noise effects of random periodic rental movements. Similarly, tax consequences and exit sale timing issues are not considered, in order to concentrate on the central issues of easing the impact of currency fluctuations on the risk-return characteristics of the investment. The objective is to isolate and analyze the magnitude of risk facing

foreign real estate investors from currency fluctuations and the extent to which that risk can be hedged using currency swap contracts.

To eliminate unnecessary noise, the simulation program was constructed so that all of the randomized cash flow series are identical for all three models. In other words, the exchange rate, cash flow growth rate, and capitalization rate series were randomized and the same values were used to calculate the NPV for each of the three models. This process is repeated for each of the 10,000 sample simulations. Therefore, any difference in risk-return characteristics from the three models can be attributed solely to the hedging strategy employed for that scenario.

To calculate the exchange rate standard deviation factors, quarterly exchange rates between the U.S. dollar and the British pound sterling ($/£) were analyzed from 1975:Q4 through 2004:Q3. Separate series were constructed for the differentials between the exchange rate in one period and the exchange rate for lags of 1, 2, 3, . . .,20 quarters. The standard deviation for each change series (116 observations) was evaluated. The volatility of exchange rate deviations increases significantly as the number of quarters between observations increases, as evidenced in Exhibit 2. The standard deviation of all exchange rate changes one quarter apart (1975:Q4–2004:Q3) was only about 9%. The volatility increased steadily as the number of quarters between exchange rate changes increased, leveling off at just under 40% for exchange rate changes that were sixteen quarters or more apart. This extreme volatility will have a significant impact on the risk associated with investments held for long time-periods, a typical scenario for a real estate investment. To reflect historical currency fluctuations, the exchange rates used to convert quarterly cash flows and the terminal value from British pounds to U.S. dollars were randomized using the estimated standard deviations represented in Exhibit 2.

The terminal value of a commercial real estate investment project is often a major contributor to the overall risk and return associated with the investment. Two sources of random effects on the terminal value of the project are considered in the simulation models:

1. The rental cash flow growth rate for the investment; and
2. The exit capitalization rate used to determine the terminal value or sale price at the end of the investor's holding period.

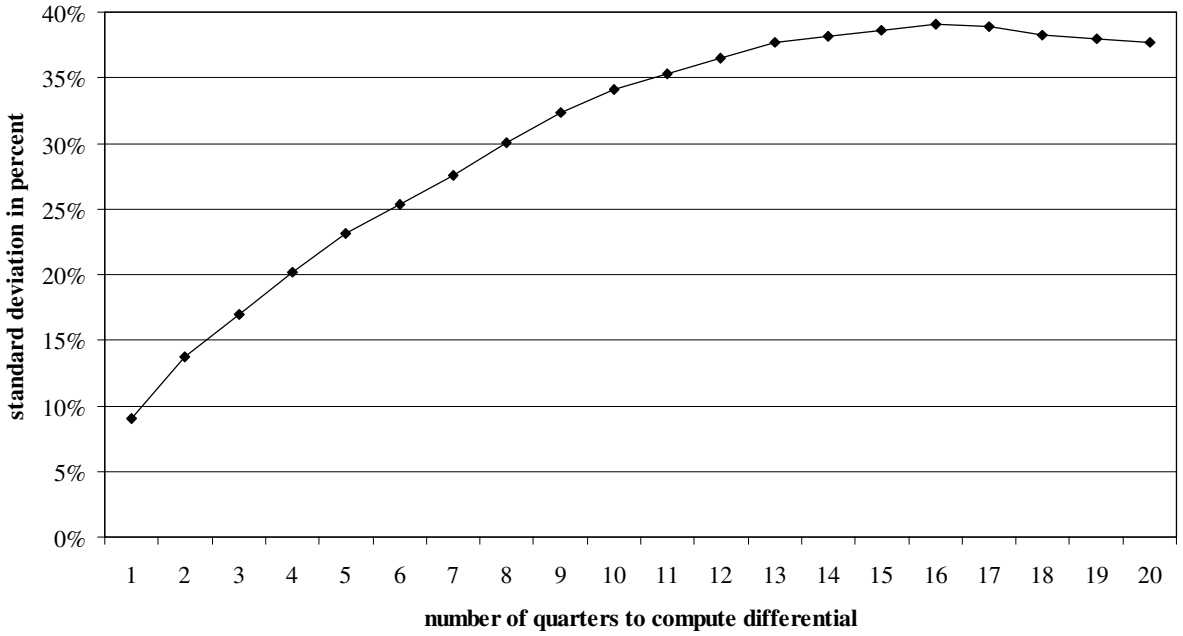
As noted above, the randomized rental growth rate is used to simulate the expected net operating income for the next five-year contract. This is a major determinant for calculating the sales value for the property at the termination of the real estate investment. The expected capitalization rate is also randomized in the simulation by adding a random factor based on the standard deviation of the historical quarterly equivalent yield series. The initial rent and purchase price, however, are not stochastic. The latter is calculated as the initial rental income capitalized at the average equivalent yield.

The swapped quarterly payments are equal to the capitalization rate multiplied by the purchase price of the investment (the principal amount of the swap for Model 2). However, when the terminal value is used as the principal amount of the swap, the swapped quarterly payments represent 7.52% of the principal swap amount. The costs for the currency swap are a 1% origination fee based on the original principal or investment amount and a charge of 25 basis points per quarter on the swap payments. While the actual cost of the swap is influenced by a number of factors, the assumed costs are at the high end of the reported range of actual costs (Kolb, 1994).

Model Descriptions

Exchange rates ($\widetilde{ER}_t$), cash flow growth rates ($\widetilde{rg}$), and capitalization rates ($\tilde{c}$) are set as random variables in a Monte Carlo simulation of the five-year real estate investment. The simulations are run with 10,000 iterations. Additionally, all scenarios are modeled simultaneously so that results for any given scenario are not an artifact of that particular simulation run. The choice of a large number of iterations was made to ensure that the estimates from the simulation were stable. The equations describing the three models insert a

Exhibit 2
Standard Deviations of Exchange Rate Fluctuations by Quarter



tilde (~) above each variable with a random component.

Model 1: No Hedge for the Currency Risk

$$NPV_{US\$} = \sum_{t=0}^{19} \frac{NOINS_t * \widetilde{ER}_t}{(1+r)^t} + \frac{\widetilde{TV}_{20} * \widetilde{ER}_{20}}{(1+r)^{20}} - P_0 * ER_0, \quad (1)$$

where:

$NPV_{US\$}$ = The net present value of the investment for a U.S. investor;
$NOINS_t$ = Quarterly net operating income (not swapped) in period t;
$\widetilde{ER}_t$ = The \$/£ exchange rate in period t;
$\widetilde{ER}_{20}$ = The \$/£ exchange rate at period 20;
ER_0 = The \$/£ exchange at period 0;
P_o = The initial purchase price in £s;
$\widetilde{TV}_{20}$ = The exit terminal value of the investment; and
r = The quarterly risk free interest rate for U.S. Treasury securities.

$$\widetilde{TV}_{20} = \frac{NOINS_0(1+\tilde{rg})}{\tilde{c}}, \quad (2)$$

where:

$NOINS_0$ = The net operating income not swapped in the first period;
$\widetilde{rg}$ = The five-year cash flow growth rate; and
$\tilde{c}$ = The exit capitalization rate.

Model 2: Hedge the Initial Purchase and Rental Income

$$NPV_{swapUS\$} = \sum_{t=0}^{19} \frac{(NOIS_t * ER_0)_t}{(1+r)^t} + \frac{P_0 * ER_0 + (\widetilde{TV}_{20} - P_0) * \widetilde{ER}_{20}}{(1+r)^{20}} - (P_0 * ER_0) - SC_0, \quad (3)$$

where:

$NPV_{swapUS\$}$ = The net present value of the investment with a currency swap;

$NOIS_t$ = The quarterly net operating income (net of swap cost) in period t (value equal to 8.81% principle swap amount divided by four minus the swap cost);

$(\widetilde{TV}_{20} - P_0)$ = The change in the value of the property in £s;

SC_0 = The costs for originating the currency swap;

P_o = The initial purchase price in £s; and

r = The quarterly risk-free interest rate for U.S. Treasury securities.

Model 3: Hedge the Expected Terminal Value and Rental Income

$$NPV_{SwapTV} = \sum_{t=0}^{19} \frac{(NOIS_t * ER_0)}{(1+r)^t} + \ldots \frac{\overline{TV}_{20} * ER_0 + (\widetilde{TV}_{20} - \overline{TV}_{20} * \widetilde{ER}_{20}}{(1+r)^{20}} - (\overline{TV}_{20} * ER_0) + (\overline{TV}_{20} - P_0) * ER_0 - SC_0, \quad (4)$$

where:

NPV_{swapTV} = The net present value of the investment with currency swap based on the expected terminal value;

$(\overline{TV}_{20} * ER_0)$ = The principle swap amount based on the expected TV;

ER = The exchange rate in the swap contract calculated net of cost;

$\overline{TV}_{20}$ = The expected terminal value in period 20;

SC_0 = The costs for originating the currency swap based on $\overline{TV}_{20}$;

P_o = The initial purchase price in £s;

r = The quarterly risk-free interest rate for U.S. Treasury securities;

$(\overline{TV}_{20} - P_0) * ER_0$ = The portion of the swap not spent on the initial investment; and

$(\widetilde{TV}_{20} - \overline{TV}_{20}) * \widetilde{ER}_{20}$ = The net gain/loss on sale after the swap contract settlement.

Simulation Results

The models are intended to test whether a currency hedging strategy based on swapping the capital sum (either the initial purchase price or the expected terminal value) and the periodic rental income results in superior risk adjusted performance to not hedging against the currency exposure. To judge the swap a success, one would look for the mean (or median) net present value (NPV) from the simulations to be relatively similar to the no-hedge strategy, while the appropriate risk metrics should be lower. The standard risk metric used to compare performance results is the standard deviation (and, in simultaneously considering returns, the coefficient of variation). This measure, however, treats upside and downside risk as equally important. Most investors are likely to be more concerned with potential downside risk. Therefore, as a proxy for the potential risk of losing money, the percentage of times the simulation produced a negative NPV is also reported.

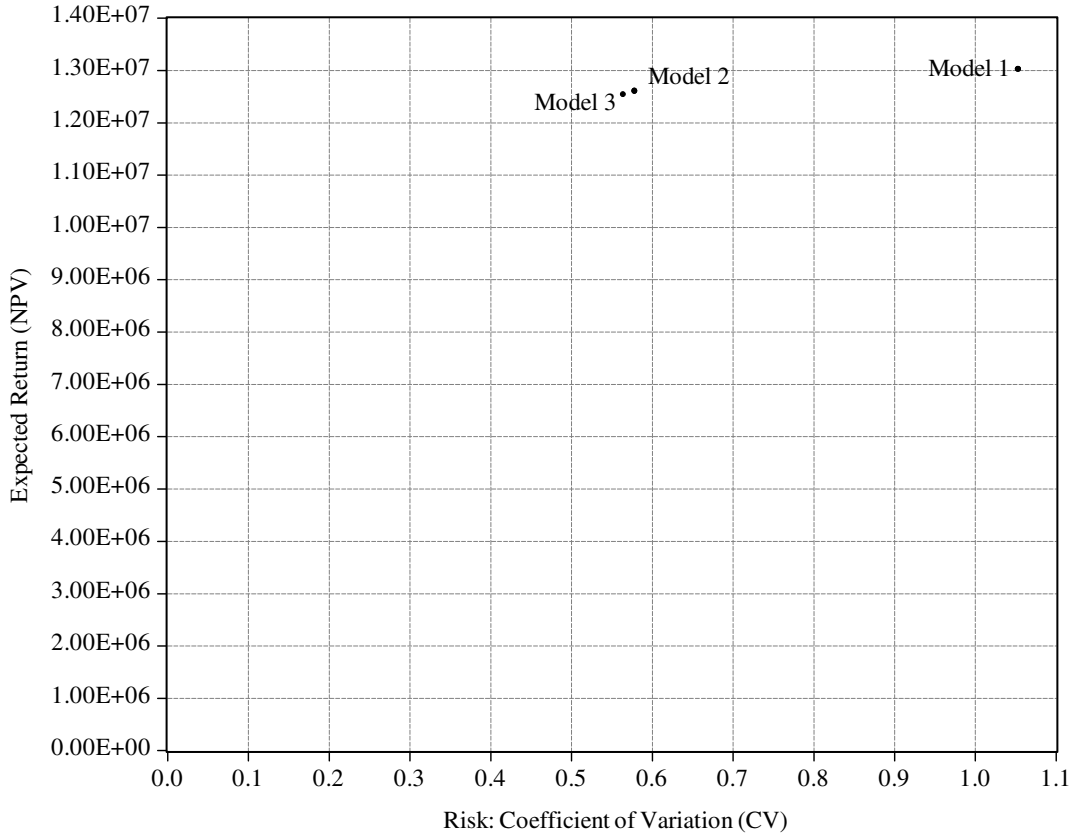
Exhibit 3 summarizes the results from the simulation process for the three models, while Exhibit 4 shows the risk-return profile of the three models graphically. Full details of the results for each model including a histogram of return distributions are shown in Exhibits 5. It is immediately evident that, while the swaps reduce the expected cash return on the investment somewhat, they greatly reduce the volatility of the cash flows. The currency swaps produce very favorable risk-adjusted returns. As expected, the swap does reduce the upside potential of the investment and the swapped returns are much more peaked around the mean value. However, the major benefit for the investor of foregoing high potential gains is the very sharp reduction in downside risk. The probability of a negative NPV is reduced from over 16% in the unhedged scenario to less than 3% in Model 2.

The benefits of Model 3, where the expected terminal value rather than the purchase price is

Exhibit 3
Descriptive Statistics of the (NPVs) for the Simulations

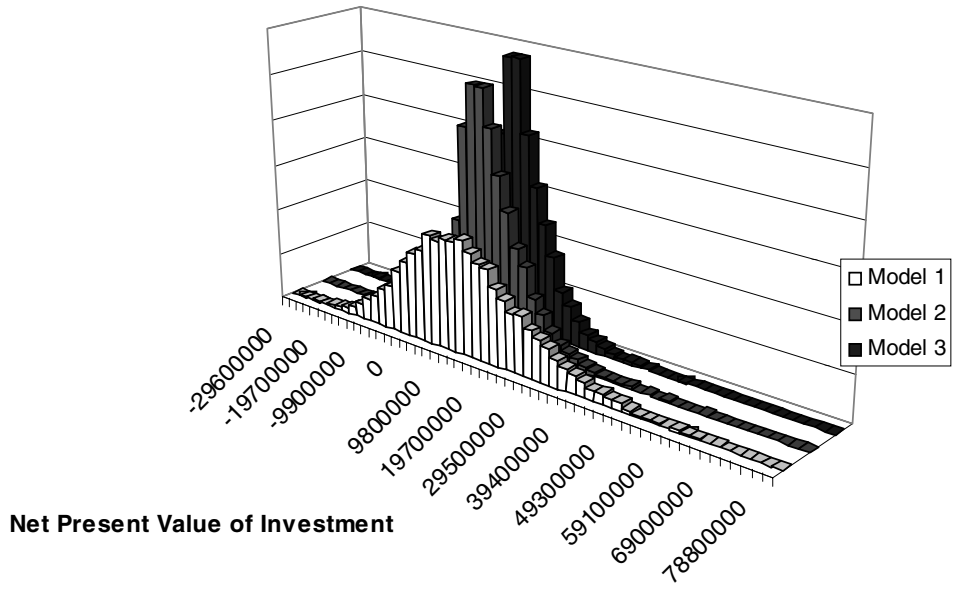
Descriptive Statistic	No Hedge	Hedge the Initial Purchase Price	Hedge the Expected Terminal Value
Mean NPV	$13,019,178	$12,604,436	$12,536,700
Median NPV	$11,939,672	$11,534,114	$12,120,244
Maximum NPV	$79,985,368	$59,657,058	$56,294,869
Minimum NPV	−$29,579,956	−$19,606,864	−$24,125,032
Std. Dev. NPV	$13,712,198	$7,290,032	$7,073,287
Coefficient of Variation	1.05	0.58	0.56
Chance of a Negative NPV	16.53%	2.90%	3.36%
Std. Dev. of Semi-variance	$9,069,111	$4,158,770	$4,734,620
Skewness	0.47	0.85	0.45
Kurtosis	3.41	5.00	4.93
Jarque-Bera	433	2,860	1,891

Exhibit 4
Comparison of Expected Return (NPV) with Risk (CV) for the Alternative Simulations



swapped, are similar to Model 2 but not as good. While the median NPV is higher than that of both Model 1 and Model 2, the mean value is lower. In addition, there is a truncation of upside potential (that is the benefits of currency gain are dampened) and the downside risk is higher by over $5 million. Finally, the risk of a negative NPV is slightly higher (3.36%). Given the complexities of

Exhibit 5
Risk Impacts from Hedging



estimating and establishing the Model 3 swap structure, the gains seem marginal.

Conclusion

Many investors considering direct international real estate acquisitions make piecemeal investments, exposing themselves to specific risks associated from both the real estate cash flow and from unexpected currency fluctuations. Such investors cannot use conventional hedging techniques designed for multi-asset portfolios or for securities markets. However, most individual hedging techniques are ill-suited for lengthy multi-period cash flows such as those found in real estate markets. This research uses a Monte Carlo simulation framework to demonstrate the benefits of employing currency swaps to hedge the exchange rate exposure in a single international real estate investment. Unlike earlier studies that often rely on period-by-period adjustments for currency fluctuations, this study assumes only quarterly rental cash flows are repatriated as received. These rental cash flows, along with the original purchase price, are hedged initially with a plain vanilla currency swap. Then, the expected appreciation of the investment is partially hedged by swapping the anticipated terminal value of the investment at the point of acquisition.

The results suggest that, for individual investors, the swap strategy is highly effective in dampening downside risk from the combination of property market and currency market fluctuations. Not only is the standard deviation far lower in the two swap models, the risk of negative NPVs is reduced considerably. Of course, there are costs involved with this strategy. In addition to the direct negative impact of the swap costs on NPV, the returns are more tightly grouped around the mean value reducing the upside potential from favorable exchange rate movements. Nonetheless, proxy measures of the risk-adjusted returns suggest that the swapped strategies are superior—for the initial investment at least. It is less clear that the swap strategy based on the expected terminal value of the building is superior to the more conventional swap based on the acquisition cost and rental income.

As the interest in international real estate investment continues to grow and the fluctuations of the currency markets remain relatively uncertain and

difficult to predict, there are a number of additional issues that could be explored and potentially provide very fruitful ground for further research. The U.K. lease structure used in this analysis is somewhat unusual and the resultant stable income pattern is well-suited for a currency swap. An extension might examine the impact of analyzing a more volatile set of cash flows resulting from a multi-tenanted building with annually fluctuating rents. In addition, the full implications of using this hedging technique in a portfolio context have not been explored. Theoretically, the rationale for investing internationally is to gain diversification benefits for the whole portfolio. The scenarios modeled in this paper apply to an investor making restricted and specific real estate investments in different countries, rather than considering the overall impact on that investor's end wealth. While the analysis here may be valuable in informing the individual investment decision (and survey evidence suggests that many investors are chasing returns rather than seeking diversification benefits), an extension to consider wider impacts could be revealing.

Finally, an investor in real estate still has to face the uncertainty involved with the holding period. Market conditions may not be good for the property to be sold at the end of the five years. If the property was not sold, gains or losses from the swap contract would be realized without the accompanying cash flow. Even if the property was sold, illiquidity might lead to a divergence between timing of sale and expiry of contract (see Bond et al., 2004) for a review of liquidity in U.K. commercial real estate markets). To protect an international investor with an uncertain holding period, alternative hedging tools, such as an option, may be more successful in protecting the investor from this additional uncertainty. However, as noted above, existing option markets seem to be relatively thin for contract maturities that are greater than one year. So, options would probably be costly and ill-suited for a direct real estate investment.

All of these issues, along with the accounting exposure of holding an international real estate investment can be explored in future research. This paper, in examining realistic cash flows with fluctuating exchange rate scenarios based on meaningful historic rates of variation and fully incorporating transaction costs, demonstrates that some elements of exchange rate risk faced by individual investors can be hedged. In particular, a currency swap contract results in improved, risk-adjusted performance for an individual international real estate investment.

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