Archives of Business Research – Vol.5, No.4
Publication Date: April. 25, 2017
DOI: 10.14738/abr.54.3100.
Addae-Dapaah, K., & Sugumaran, M. (2017). International Portfolio of Real Estate Investment and Hedging: A Revisit. *Archives of Business Research*, 5*(4)*, 124-145.

International Portfolio of Real Estate Investment and Hedging: A Revisit

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ABSTRACT

We use office data from ten cities in the Asia-Pacific region from 4Q2001 to 2Q2012 to propose a forward-looking investment appraisal framework to compare the effectiveness of two currency risk hedging strategies for a portfolio of real estate investments in ten cities of seven Asia-Pacific countries. This is aimed at determining the optimal choice among "unhedged", "artificially" hedged and "natural" hedged options. Analyses based on NPV, IRR, Sharpe Ratio, Jensen's alpha and stochastic dominance were done for 3, 5 and 7-year holding periods. All the results show that the "natural" hedge strategy is the optimal choice as it provides superior returns.

Keywords: Currency risk, international real estate investment portfolio, artificial hedging instrument, natural hedge, mean-variance efficient portfolio, stochastic dominance, optimal hedging strategy.

INTRODUCTION

The integration and deregulation of global financial markets as well as changes in international politics and economic policies have resulted in increased global real estate investment opportunities. Thus international investment in property (both direct and indirect) has increasingly become an important component of the portfolios of institutional funds and high net-worth investors. Given that currency fluctuations can severely affect the risk-return characteristics of international investment, and huge sums of foreign capital being invested in South Eastern Asia in particular, it is important to consider the impact of exchange rate volatility on such investments in order to take appropriate measures to hedge against exchange rate risk where necessary. Although studies thus far have mostly concluded that currency risk does not have statistically significant impact on the performance of international real estate investments, these studies were done before the global financial crisis of 2008. It is therefore necessary to revisit the topic. The paper proposes a forward-looking investment appraisal framework to compare the effectiveness of two strategies in hedging against currency risk in a portfolio of real estate investments in ten cities of seven Asia-Pacific countries, and to determine the optimal choice among "unhedged", "artificially" hedged and "natural" hedged options.

The rest of the paper proceeds as follows. The next section is a review of selected relevant studies on the topic. This is followed by data sourcing and management and the empirical methodology adopted for the study in section three. The results of the data analyses are presented, interpreted and discussed in section four. The last section deals with concluding remarks.

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LITERATURE REVIEW

The extant literature on the effect of currency risk on foreign investments provides us with two main conclusions: that exchange rate volatility has either no or benign, and negative, impact on foreign investments. Addae-Dapaah and Choo (1996), find no statistical significant difference between currency adjusted and unadjusted returns, and their related standard deviation and correlation coefficients at the 0.05 level of significance. These findings are replicated by Addae-Dapaah & Loh (2009). Moreover, Addae-Dapaah and Choo (1996) conclude that the exchange rate volatility had a positive impact on the performance of the portfolio during the period of investigations. It is therefore not surprising that these studies do not deal with hedging of the investment returns. Solnik & McLeavey (2003) state that currency risk decreases with the length of the investment horizon as exchange rates tend to revert to the mean.

However, Ziobrowski and Curcio (1991), show that extreme volatility in exchange rates is the major culprit in increasing foreign investment risk to make domestic investment appear less risky in comparison. Worzala (1995) discovers that accounting for currency fluctuations increases U.K real estate risk by about 145% and decreases the expected return. Chowdury and Sarno (2004) concur with the above findings which are controverted by Solnik (1996) who argues that currency fluctuation has never been the major component of total return on a diversified portfolio over a long period of time because the depreciation of one currency is often offset by the appreciation of another. In contrast, Jacque (1996) states that regardless of the diversification strategy, the return from an international portfolio is exposed to currency risk as a result of the investor owning a claim in s foreign currency-denominated, time-deferred cash flow. While the extant literature (e.g. Baum, 1995; Lizieri & Finlay, 1995; Sirmans & Worzala, 2003) discusses the impact of currency risk on risk-return characteristics of international real estate, several early empirical studies on international real estate tend to tersely deal with currency fluctuations by suggesting that currency risk can simply be hedged away without considering the impact of the cost of hedging on the returns (Sweeney, 1988; Giliberto, 1993). Other studies have documented that a hedge in effect implies annual repatriation of funds. In general, while rental income can be repatriated annually, the capital gain component can only be realized upon sale of the property and is thus affected by the aggregate currency movement over the expected holding period (Worzala et al. 2005).

Currency Hedging

The general concept of hedging is to reduce any substantial losses in an investment by using financial instruments to reduce the investment's exposure to risks. Thus, financial instruments have been developed in the money and capital markets to hedge against losses due to foreign exchange. Ziobrowski and Ziobrowski (1993 and 1995) explore the use of options and forward contracts, utilizing ex-post data, to conclude that no diversification benefits could significantly alter returns. However, no attempt was made to mitigate currency fluctuations. Worzala et al. (2005) use currency swaps to hedge currency risk inherent in international real estate investment to find that currency swaps suppressed most of the exchange rate volatility that beset a US international real estate investor. However, most of the investment strategies used in the above studies generally focus on short-term hedging instruments. Given that real estate is generally illiquid and held over relatively long investment horizon, the use of short term instruments to hedge real estate returns against exchange rate volatility might be inappropriate and thus, provide results that could be misleading. Ziobrowski *et.al* (1997), did attempt to address the inherent problems in modelling real estate, (i.e. illiquid investment and long term holding period) to suggest that a currency swap reduces the risk of currency fluctuations on the income return of foreign property. Madura and Rosenberg (1993) conclude that a currency swap may be an appropriate instrument for hedging overseas real estate

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investments since they are most effective at hedging currency risks for several years rather than months.

Worzala *et al.* (2005) and Lizieri *et al.* (1997) argue that results based on portfolio-based indices may be misleading as the ex-post data is historically contingent and hence ignores uncertainty. Thus, an appropriate test of the efficacy of hedging techniques for individual investors is to use a forward-looking simulation with realistic expectation and volatility inputs for key variables that impact the risk and return characteristics of the real estate investment. Another common criticism is that currency swap does not provide effective hedging for capital appreciation and depreciation in investments. Worzala et al. (2005) use two different swap contracts: one for the initial price of the property and the other for the expected terminal value of the property. The second scenario could potentially increase the volatility of the investment return if the actual sales price is different from the expected terminal value.

Campbell et al (2010) find that the Euro, Swiss Franc and US Dollar moved against world equity markets over the period of 1975-2005, making them attractive investments for risk averse equity investors. Stepien and Su (2012) studied the benefits of currency hedging for a Polish investor to conclude that a fully currency hedged strategy would have benefited a Polish investor who held an international portfolio between January 1999 and December 2008.

Studies have also been conducted on the effectiveness of hedging other asset classes. Schmittmann (2010) found that full currency hedging is the dominant strategy in bond investment, while the correlation between currencies and equity investment determines the level of currency exposure in equity investment. This may imply that the rental component from real estate investment may benefit from full currency hedging as rental and bond coupons are fixed over a given time. The capital gain from the sale of a property puts the capital return in the category of equity investment. Walker (2008), concludes that currency hedging increased the volatility of returns in a diversified portfolio for investors from Brazil, Chile, Peru, Colombia and Mexico between 1995 and 2005. Currency betas increased during the period due to the rise in international trade in these countries. Exhibit 1 provides a summary of the basic characteristics of commonly used foreign exchange hedging instruments.

Data

The ex-post quarterly office capital and rental values for the sample cities were extracted from three Jones Lang LaSalle sources, namely: Asia Pacific Property Digest, Real Estate Intelligence Service and the Office Rental Index. The quarterly market exchange rates were obtained from Bloomberg Database. The current market values used as inputs for the Monte Carlo Simulation, including capital values, rental values and vacancy rates, were collected from the 2Q 2012 edition of the Jones Lang LaSalle Asia Pacific Property Digest. The three-year, five-year and seven-year swap rates were obtained from Bloomberg Database.

The ten sampled cities from seven Asia-Pacific countries for the study are: Beijing, Hong Kong, Shanghai, Bangkok, Jakarta, Kuala Lumpur, Manila, Singapore, Seoul, Tokyo and Taipei. The study period, constrained by data availability, is from 4Q2001 to 2Q2012. Further analyses for out-of-sample period from 1Q2006 to 2Q2012 are done to see if the results for the in-sample and out-of-sample will be similar. The data are analyzed over 3, 5 and 7-year holding periods.

EMPIRICAL METHODOLOGY

In order to achieve the objective of ascertaining the optimal choice among "unhedged", "artificially" hedged (using currency swap) and "natural" hedge options, we first use the office property data to construct mean-variance efficient portfolios. The main focus will be on "natural" hedge and "artificial hedge – The unhedged portfolio is the "control" portfolio. The portfolios are based on the following assumptions:

- US dollar-denominated rational investor who wants to hold a portfolio of international prime office investments in the central business district of the sampled cities.
- Investor has enough funds for the investment. However, the analyses are based on an investment of US$100 million. This is purely hypothetical to facilitate the analyses. There will be no gearing.
- 3-yearly rent reviews for 5- & 7-year holding periods.
- Vacancy rates are assumed to remain constant at 2Q2012 levels. While this is not accurate, it is more realistic than assuming full occupancy for office space.
- Periodic income will be repatriated annually to US. This is more conservative than repatriating the accumulated periodic income at the end of the holding period together with the sales proceeds because by repatriating periodically, the investment is not unnecessarily exposed to uncertainty in potential currency fluctuations.
- Capital gains tax is assumed to be zero since it is common for the sampled countries to impose no capital gains tax for real estate when sales occur after a defined period. The "net rental" which is repatriated annually is net of all outgoings including property tax.

According to Blavatskyy (2010), the mean-variance approach does not have a natural preference foundation as it is not robust to outliers – extreme deviations are greatly overweighted while small deviations are often neglected. To overcome the limitations of the Mean-Variance criterion, Egozcue and Wong (2010) recommend the use of stochastic dominance (SD). Taylor and Yoder (1999) conclude that SD is a theoretically unimpeachable general model of portfolio choice that maximizes expected utility. Similarly, Kuosmanen (2001) recommend SD as an attractive method because it is effectively nonparametric as no explicit specification of a utility function or probability distribution functional form is required. SD will thus add robustness to the findings of this study.

Stochastic Dominance Criteria

Financial decision making under uncertainty boils down to the following two elements (Bawa, Jr, Rao, & Suri, 1985):

1. Characterization of the choice set of investments by a joint probability distribution of returns, and
2. A preference ordering that ranks the above alternatives by a utility function defined over the probability distribution characterizing the choice set

The Stochastic Dominance (SD) rules are normally stated as first, second, and third criteria denoted by FSD, SSD and TSD respectively [Barucci, 2003], [Levy,1992].

Let:
Fs : Represents the distribution of the currency swap, and
Fn : Represents the distribution of the natural hedge.
The three orders of SD can be explained in the following theorems

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FSD theorem
For any two cumulative distributions of Fs andFn, Fs is preferred to Fn for all utility functions in U1 if and only if:

$$Fs(x) \leq Fn(x) \; \forall \; \text{x} \in \text{R (and } < for\ some \; \text{x} \in \text{R)} \qquad \text{(Eq.1)}$$

Every expected utility maximizer with an increasing utility function will prefer investment S over investment N if S first-order stochastically dominates N.

SSD theorem
For any two cumulative distributions of Fs andFn, Fs is preferred to Fn for all utility functions in U2 if and only if:

$$\int_a^x Fs(t)\, dt \; \leq \; \int_a^x Fn\,(t)\, dt \; \forall \; \text{x} \in \text{R (and } < for\ some \; \text{x} \in \text{R)} \qquad \text{(Eq.2)}$$

All risk-averse expected-utility maximizers prefer investment S over investment N if S second-order stochastically dominates N.

TSD theorem
For any two cumulative distributions of Fs andFn, Fs is preferred to Fn for all utility functions in U3 if and only if:

$$\text{i)} \; \mu s \; \geq \; \mu n \qquad \text{(Eq.3)}$$

$$\text{ii)} \int_a^x \int_a^y Fs\,(t)\; dtdy \; \leq \; \int_a^x \int_a^y Fn\,(t)\; dtdy \; \forall \; \text{x} \in \text{R (and } < for\ some \; \text{x} \in \text{R)} \qquad \text{(Eq.4)}$$

All risk-averse investors looking for positive skewed investments prefer investment S over investment N if S third-order stochastically dominates N.

In addition, Sharp Ratio and Jensen's Alpha are employed in the analyses.

STRATEGY 1 – "HEDGING WITH A CURRENCY SWAP"

$$Rt = \frac{(\mathrm{P_t} - \mathrm{P_{t-1}}) + \mathrm{a_t}}{\mathrm{P_{t-1}}} \qquad \text{(Eq. 5)}$$

Where Rt = Currency-unadjusted rate of return for period *t*
$\mathrm{P_t}$ = Capital value of office investment in period *t*
$\mathrm{P_{t-1}}$ = Capital value of office investment in period *t-1*
$\mathrm{a_t}$ = Capital value of office investment in period *t-1*

The quarterly currency-unadjusted expected returns for each of the countries over each of the three holding periods are calculated as follows:

$$E(R_i) = \frac{\sum_{t=1}^{k} R_{it}}{k} \qquad \text{(Eq. 6)}$$

Where $E(R_i)$ = Expected quarterly rate of return on investment in country i
$\mathrm{R_{it}}$ = Currency-unadjusted investment return in city i in period t
k = Number of periods

Following these steps; MATLAB Optimisation Toolbox is used to construct a mean-variance efficient frontier for the returns of the different holding periods.

For the purpose of this study, the portfolio with the highest rate of return to risk ratio is chosen as the optimal portfolio for the artificial hedge and natural hedge strategies across the three holding periods. A "plain vanilla" currency swap is used to hedge the chosen investment. Hence a cash flow pro-forma is constructed for the analysis of the investment based on conditions as of 2Q of 2012 as stated in the assumptions. The inputs for this cash flow are the swap interest, swap fee, rental fees, rental growth, effective NOI in the local and US dollar currencies, exchange rate and capital value. A Monte Carlo simulation is used to generate different outcomes of future exchange rates. The outputs are the net present value (NPV) and internal rate of return (IRR).

STRATEGY 2 – "HEDGING WITH A NATURAL HEDGE"

In this strategy, the natural hedge comprises of a mean-variance efficient portfolio that incorporates a currency cocktail in its composition and is obtained by projecting currency-adjusted returns as in the following equation.

$$R_{adj} = R_t + X_t(1 + R_t) \quad \text{(Eq. 7)}$$

Where R_{adj} = Currency-adjusted foreign investment returns
R_t = Currency unadjusted rate of return for period t
X_t = Percentage change in exchange rates

MATLAB Optimisation Toolbox is then used to construct a mean-variance efficient frontier for the currency-adjusted returns. As with the first strategy, the portfolio with the highest rate of return to risk ratio is selected as the optimal portfolio. A cash flow pro-forma is constructed for the analysis of the investment as in Strategy 1. However the inputs in this cash flow exclude the swap interest and swap fee. A Monte Carlo simulation is used to generate different outcomes of future exchange rates. The NPV and IRR of the investment are the outputs from the simulation exercise.

CONTROL STRATEGY – "NO HEDGE"

The procedure as in Strategy 2 is repeated but with currency-unadjusted returns. The chosen optimal portfolio will thus be on the same basis as the portfolio for strategy 1. This strategy will be the 'control', representing the "no hedge" strategy.

HYPOTHESIS TESTING

The hypothesis to be tested is:
'Currency swap as a hedging tool, on the basis of better unadjusted risk-return characteristics, is superior to the "natural hedge" of international real estate investments portfolios over any holding period.' To test the hypothesis, the following statistical procedure is performed.

Let μ_1 and μ_2 be the population means NPV of an investment with the swap and "natural" hedge strategies respectively.
$H_0 : \mu_1 - \mu_2 > 0$
$H_1 : \mu_1 - \mu_2 \leq 0$

Level of Significance: 5%
Test: One-tailed standard normal distribution Z-test (since sample size = 1000 is large)

Test statistic: $Z = \frac{(\overline{X_1} + \overline{X_2}) - (\mu_1 - u_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$

Where Z = Test statistic N(0,1)
$\overline{X_1}$ = Mean NPV of investment with currency swap
$\overline{X_2}$ = Mean NPV of investment with natural hedge
S_1^2 = Variance of NPV with currency swap
S_2^2 = Variance of NPV with natural hedge
n_1 = Sample size of NPV with currency swap
n_2 = Sample size of NPV with natural hedge

Rejection region: z < 1.645
If the calculated z value is more than 1.645, then H_0 is accepted at the 5% level of significance. Otherwise, H_0 is rejected in favour of H_1 at the 5% level.

RESULTS

The composition of the unhedged portfolios with the highest return-risk ratios for the three holding periods is presented in Exhibit 2. Beijing, Bangkok, and Kuala Lumpur feature in the portfolios for all three holding periods although with different weightages.

Exhibit 2: Portfolio Composition for 3, 5 & 7-Year Holding Periods – Currency Unadjusted

3 year		5 year		7 year	
City	**Weightage**	**City**	**Weightage**	**City**	**Weightage**
Beijing	19.97%	**Beijing**	20.68%	**Beijing**	4.76%
Bangkok	17.45%	**Bangkok**	2.70%	**Bangkok**	20.83%
Kuala Lumpur	21.29%	**Kuala Lumpur**	62.82%	**Jakarta**	9.81%
Taipei	41.28%	**Seoul**	13.80%	**Kuala Lumpur**	6.96%
Total	100%	**Total**	100%	**Manila**	27.88%
				Taipei	29.76%
				Total	100%

Similarly, the relevant market information as of 2Q2012 is presented in Exhibit 3. The information relate to exchange rate per US dollar, capital value per m^2 in local currency, annual net rent per m^2 in local currency and vacancy rate.

Exhibit 3: Relevant Market Data as at 2Q2012

	Beijing	Bangkok	Jakarta	Kuala Lumpur	Manila	Taipei	Seoul
Exchange Rate (Local currency per USD)	6.3089	31.6068	9363.300	3.1923	42.239	29.91	1156.74
Capital Value (Local currency per m2)	RMB 93,354.14	Bht 73,330.64	IDR 24,992,761.92	MYR 7,190.74	PHP 84,960.95	NTD 344,252.24	KWR 5,340,427.05
Annual net rent (Local currency per m2)	RMB 6,129.88	Bht 5,519.84	IDR 2,009,001.67	MYR 550.65	PHP 9,328.42	NTD 12,249.39	KWR 581,543.98
Vacancy rate	6.80%	18.80%	2%	18%	3.60%	10.20%	8%

The 5 year and 7 year investments are subject to rental reviews every three years, in line with market practice. The increase in rental rates are based on the average change in rental values over three year rolling periods between Q4 2001 and Q2 2012. These are: Beijing (9.58%), Bangkok (21.89%), Jakarta (21.80%), Kualar Lumpur (2.21%), Manila (44.24%), Tapei (1.90%) and Seoul (3.16%).

Given the data in Exhibits 2 and 3, the allocation of funds to office investment in each relevant city for the three holding periods is presented in Exhibits 4a-4c.

Exhibit 4a: Allocation of Funds to Currency-Unadjusted Portfolio – 3-Year Holding Period

City		Capital Allocation (USD)	Exchange rate (local currency/USD)	Local currency required
Beijing		19.97M	6.3089	RMB 125.99M
Bangkok		17.45M	31.6068	Bht 551.54M
Kuala Lumpur		21.29M	3.1923	MYR 67.96M
Taipei		41.28M	29.91	NTD 1,234.68M
Total		100.00M		

Exhibit 4b: Allocation of Funds to Currency-Unadjusted Portfolio – 5-Year Holding Period

City	Capital Allocation (USD)	Exchange rate (local currency/USD)	Local currency required
Beijing	20.68M	6.3089	RMB 130.47M
Bangkok	2.7M	31.6068	Bht 85.34M
Kuala Lumpur	62.82M	3.1923	MYR 200.54M
Seoul	13.80M	1156.74	KWR 15,963.01M
Total	100.00M		

Exhibit 4c: Allocation of Funds to Currency-Unadjusted Portfolio – 7-Year Holding Period

City	Capital Allocation (USD)	Exchange rate (local currency/USD)	Local currency required
Beijing	4.76M	6.3089	RMB 30.03M
Bangkok	20.83M	31.6068	Bht 658.370M
Jakarta	9.81M	9363.300	IDR 91,853.97M
Kuala Lumpur	6.96M	3.1923	MYR 22.22M
Manila	27.88M	42.2390	PHP 1,177.62M
Taipei	29.76M	29.91	NTD 890.12M
Total	100.00M		

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A "plain vanilla" currency swap has been chosen for the various portfolios. At the initiation of the hedge, the investor exchanges U.S dollars for the amount of the various currencies required in the 3 various portfolios. Taking the example of the three-year portfolio, the investor swaps a total of USD 19.97M for RMB 125.99M, USD 17.45M for Bht 551.54M, USD 21.29M for MYR 67.96M and USD 41.28M for NTD 1,234.68M for the 3 year portfolio according to the exchange rates as at the 2Q of 2012. This is also applied to the 5- and 7-year holding periods.

The cost of the swap is assumed to be 1% origination fee for the USD 100 million principal swapped for the 3 portfolios. This is considered acceptable and conservative by Worzala et al. (2005)

Thus, the total outlay for each of the three investments will be:
= USD 100M + 0.01(USD 100M)
= USD 101,000,000

Annual Income

The annual rental income from the investments is presented in Exhibit 5a-c. To peg the exchange rate for the annual repatriation of the rental income, the investor is required to pay an annual swap interest in the respective local currencies as shown in Exhibits 6a-c.

Exhibit 5a: Annual Rents – 3-Year Currency-Unadjusted Portfolio

		Beijing	**Bangkok**	**Kuala Lumpur**	**Taipei**
i)	**Area owned (m2)** = $\frac{Capital\ (local\ \$)}{CV\ (local\$\ psm)}$	1,349.58	7,521.26	9,451.61	3,586.57
ii)	**Annual net rental (Local $ per m2)**	RMB 6,129.88	Bht 5,519.84	MYR 550.65	NTD 12,249.39
iii)	**Occupancy rate = (1 – Vacancy rate)**	0.932	0.812	0.820	0.898
i*ii*iii	**Total annual rent**	RMB 7,710,206.52	Bht 33,711,106.13	MYR 4,267,713.62	NTD 39,452,100.03

Exhibit 5b: Annual Rents – 5-Year Currency-Unadjusted Portfolio

		Beijing	Bangkok	Kuala Lumpur	Seoul
i)	**Area owned (m2) = $\frac{\text{Capital (local \$)}}{\text{CV (local\$ psm)}}$**	1,397.56	1,163.75	27,888.69	2,989.09
ii)	**Annual net rental (Local $ per m2) Year (1 – 3)**	RMB 6,129.88	Bht 5,519.84	MYR 550.65	KWR 581,543.98
iii)	**Annual net rental (Local $ per m2) Year (4 – 5)**	RMB 6,717.12	Bht 6,728.13	MYR 562.82	KWR 599,920.77
iv)	**Occupancy rate = (1 – Vacancy rate)**	0.932	0.812	0.820	0.920
i*ii*iv	**Total annual rent Year (1 – 3)**	RMB 7,984,330.04	Bht 5,216,045.07	MYR 12,592,661.81	KWR 1,599,223,812
I*iii*iv	**Total annual rent Year (4 – 5)**	RMB 8,749,228.86	Bht 6,357,837.34	MYR 12,870,959.63	KWR 1,649,459,886

Exhibit 5c: Annual Rents – 7-Year Currency-Unadjusted Portfolio

		Beijing	Bangkok	Jakarta	Kuala Lumpur	Manila	Taipei
i)	**Area owned (m2) = $\frac{Capital\ (local\ \$)}{CV\ (local\$\ psm)}$**	**321.68**	**8,978.10**	**3,675.22**	**3,089.86**	**13,860.76**	**2,585.67**
ii)	**Annual net rental (Local $ per m2) Year (1-3)**	**RMB 6,129.88**	**Bht 5,519.84**	**IDR 2,009,001.67**	**MYR 550.65**	**PHP 9,328.42**	**NTD 12,249.39**
iii)	**Annual net rental (Local $ per m2) Year (4-6)**	**RMB 6,717.12**	**Bht 6,728.13**	**IDR 2,446,964.03**	**MYR 562.82**	**PHP 13,455.32**	**NTD 12,482.13**
iv)	**Annual net rental (Local $ per m2) Year (7)**	**RMB 7,360.62**	**Bht 8,200.92**	**IDR 2,980,402.19**	**MYR 575.26**	**PHP 19,407.95**	**NTD 12,719.29**
v))	**Occupancy rate = (1 – Vacancy rate)**	**0.932**	**0.812**	**0.980**	**0.820**	**0.964**	**0.898**
i*ii*iii	**Total annual rent (Year 1 - 3)**	**RMB 1,837,785.83**	**Bht 40,240,821.81**	**IDR 7,243,242,051**	**MYR 1,395,175.52**	**PHP 124,644,272**	**NTD 28,442,211.65**
I*ii*iv	**Total annual rent (Year 4 -6)**	**RMB 2,013,845.71**	**Bht 49,049,537.71**	**IDR 8,822,268,818**	**MYR 1,426,008.90**	**PHP 179,868,898**	**NTD 28,982,613.67**
I*ii*v	**Total annual rent (Year 7)**	**RMB 2,206,154.24**	**Bht 59,786,481.51**	**IDR 10,745,523,420**	**MYR 1,457,523.70**	**PHP 259,324,622**	**NTD 29.533,283.33**

Exhibit 6a: Annual Cost of 3-Year Swap

	Beijing	Bangkok	Kuala Lumpur	Taipei
Annual interest rate for a 3 year swap	2.6275%	2.3500%	2.4500%	0.8944%
Annual swap interest payment (Local currency)	RMB 202,585.68	Bht 792,210.99	MYR 104,558.98	NTD 352,859.58
Cost of swap = 1% of swap interest (Local currency)	RMB 2,025.86	Bht 7,922.11	MYR 1,045.59	NTD 3,528.60

Exhibit 6b: Annual Cost of 5-Year Swap

	Beijing	Bangkok	Kuala Lumpur	Seoul
Annual interest rate for a 5 year swap	2.8000%	2.6000%	2.6800%	1.8148%
Annual swap interest payment (Local currency) (Year 1 -3)	RMB 223,561.24	Bht 135,617.17	MYR 337,483.34	KWR 29,022,713.73
Annual swap interest payment (Local currency) (Year 4-5)	RMB 244,978.41	Bht 165,303.77	MYR 344,951.72	KWR 29,939,931.49
Cost of swap = 1% of swap interest (Local currency) (Year 1 -3)	RMB 2,235.61	Bht 1,356.17	MYR 3,374.83	KWR 290,227.14
Cost of swap = 1% of swap interest (Local currency) (Year 4-5)	RMB 2,449.78	Bht 1,653.04	MYR 3,449.42	KWR 299,398.31

Exhibit 6c: Annual Cost of 5-Year Swap

	Beijing	Bangkok	Jakarta	Kuala Lumpur	Manila	Taipei
Annual interest rate for a 7 year swap	2.9850%	2.8000%	6.2500%	3.0500%	4.1000%	1.0948%
Annual swap interest payment (Local currency) (Year 1 - 3)	RMB 51,458.00	Bht 2,515,051.36	IDR 220,918,882.50	MYR 57,702.20	PHP 5,110,415.16	NTD 311,385.33
Annual swap interest payment (Local currency) (Year 4-6)	RMB 56,387.68	Bht 3,065,596.11	IDR 269,079,198.90	MYR 58,466.36	PHP 7,371,262.83	NTD 317,301.65
Annual swap interest payment (Local currency) (Year 7)	RMB 61,789.62	Bht 3,736,655.095	IDR 327,738,464.30	MYR 59,758.47	PHP 10,632,309.50	NTD 323,330.39
Cost of swap = 1% of swap interest (Local currency) (Year 1-3)	RMB 514.58	Bht 25,150.51	IDR 2,209,188.83	MYR 572.02	PHP 51,104.15	NTD 3,113.85
Cost of swap = 1% of swap interest (Local currency) (Year 4-6)	RMB 563.88	Bht 30,655.96	IDR 2,690,791.99	MYR 584.66	PHP 73,712.63	NTD 3,173.02
Cost of swap = 1% of swap interest (Local currency) (Year 7)	RMB 617.90	Bht 37,366.55	IDR 3,277,384.64	MYR 597.58	PHP 106,323.10	NTD 3,233.30

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The investor in turn receives swap interest payments in U.S. dollars at comparable rates, such that the swap interest payments and the receipts cancel out. The annual net cash flow for the 3 portfolios are tabulated in Exhibits 7a-c.

Exhibit 7a: Annual net cash flow for 3 year currency unadjusted portfolio

	Beijing	**Bangkok**	**Kuala Lumpur**	**Taipei**
Annual rent receivable (Local Currency)	RMB 7,710,206.52	Bht 33,711,106.13	MYR 4,267,713.62	NTD 39,452,100.03
Cost of Swap	RMB 2,025.86	Bht 7,922.11	MYR 1,045.59	NTD 3,528.60
Net cash inflow (Local Currency)	RMB 7,708,180.67	Bht 33,703,184.02	MYR 4,266,668.03	NTD 39,448,571.43
Exchange rate	6.3089	31.6068	3.1923	29.91
Net cash inflow (USD)	1,221,794.71	1,066,326.99	1,336,549.83	1,318,909.11

Exhibit 7b: Annual net cash flow for 5-year currency unadjusted portfolio

	Beijing	**Bangkok**	**Kuala Lumpur**	**Seoul**
Annual rent receivable (Local Currency) (Years 1-3)	RMB 7,984,330.04	Bht 5,216,045.07	MYR 12,592,661.81	KWR 1,599,223,812
Annual rent receivable (Local Currency) (Years 4-5)	RMB 8,749,228.86	Bht 6,357,837.34	MYR 12,870,959.63	KWR 1,649,459,886
Cost of Swap (Years 1 - 3)	RMB 2,235.61	Bht 1,356.17	MYR 3,374.83	KWR 290,227.14
Cost of Swap (Years 4 - 5)	RMB 2,449.78	Bht 1,653.04	MYR 3,449.42	KWR 299,398.31
Net cash inflow (Local Currency) (Years 1 - 3)	RMB 7,982,094.43	Bht 5,214,668.90	MYR 12,589,286.97	KWR 1,598,933,584
Net cash inflow (Local Currency) (Years 4 - 5)	RMB 8,746,779.07	Bht 6,356,184.30	MYR 12,867,510.22	KWR 1,649,459,886
Exchange rate	6.3089	31.6068	3.1923	1156.74
Net cash inflow (USD) (Year 1 – 3)	1,265,211.75	164,986.30	3,943,641.57	1,382,275.69
Net cash inflow (USD) (Year 4 – 5)	1,386,419.04	201,101.80	4,030,796.05	1,425,955.60

Exhibit 7c: Annual net cash flow for 5-year currency unadjusted portfolio

	Beijing	Bangkok	Jakarta	Kuala Lumpur	Manila	Taipei
Annual rent receivable (Local Currency) (Years 1 – 3)	RMB 1,837,785.83	Bht 40,240,821.81	IDR 7,243,242,051	MYR 1,395,175.52	PHP 124,644,272	NTD 28,442,211.65
Annual rent receivable (Local Currency) (Years 4 - 6)	RMB 2,013,845.71	Bht 49,049,537.71	IDR 8,822,268,818	MYR 1,426,008.90	PHP 179,868,898	NTD 28,982,613.67
Annual rent receivable (Local Currency) (Years 7)	RMB 2,206,154.24	Bht 59,786,481.51	IDR 10,745,523,420	MYR 1,457,523.70	PHP 259,324,622	NTD 29.533,283.33
Cost of Swap (Year 1 – 3)	RMB 514.58	Bht 25,150.51	IDR 2,209,188.83	MYR 572.02	PHP 51,104.15	NTD 3,113.85
Cost of Swap (Year 4 - 6)	RMB 563.88	Bht 30,655.96	IDR 2,690,791.99	MYR 584.66	PHP 73,712.63	NTD 3,173.02
Cost of Swap (Year 7)	RMB 617.90	Bht 37,366.55	IDR 3,277,384.64	MYR 597.58	PHP 106,323.10	NTD 3,233.30
Net cash inflow (Local Currency) (Years 1 – 3)	RMB 1,837,271.25	Bht 40,215,671.30	IDR 7,241,032,862	MYR 1,394,603.50	PHP 124,593,168	NTD 28,439,097.79
Net cash inflow (Local Currency) (Years 4 -6)	RMB 2,013,845.71	Bht 49,049,537.71	IDR 2,446,964.03	MYR 1,425,424.24	PHP 179,786,898	NTD 28,982,613.67
Net cash inflow (Local Currency) (Years 7)	RMB 2,206,772.13	Bht 59,786,481.51	IDR 2,980,402.19	MYR 1,457,523.70	PHP 259,324,622	NTD 29,533,283.33
Exchange rate	6.3089	31.6068	9363.300	3.1923	42.2390	29.9100
Net cash inflow (USD) (Years 1 -3)	291,218.95	1,272,374.02	773,341.97	436,864.80	2,949,718.70	950,822.39
Net cash inflow (USD) (Years 4 -6)	319,117.73	1,550,896.70	941,930.52	446,519.51	4,254,674.25	968,888.02
Net cash inflow (USD) (Years 7)	349,689.21	1,890,387.99	1,147,271.37	456,387.59	6,136,942.14	987,296.89

Capital Value upon Sale

The capital value at the end of the holding period is fixed on the basis of an assumed annual growth rates (Exhibit 8) over three year rolling periods between Q4 2001 and Q2 2012. The capital value at the end of the holding period will not be simulated as the study is aimed at comparing the two strategies of hedging exchange rate volatility, across different investment horizons. As long as the same growth rate for a particular city is applied for both hedging strategies across the different portfolios, a fair comparison can be made.

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Exhibit 8: Annual Capital Value growth Rate

3 year		5 year		7 year	
City	**Annual Capital Value Growth Rate**	**City**	**Annual Capital Value Growth Rate**	**City**	**Annual Capital Value Growth Rate**
Beijing	7.93%	**Beijing**	7.27%	**Beijing**	7.43%
Bangkok	6.70%	**Bangkok**	6.02%	**Bangkok**	6.31%
Kuala Lumpur	0.46%	**Kuala Lumpur**	1.33%	**Jakarta**	8.13%
Taipei	4.56%	**Seoul**	4.65%	**Kuala Lumpur**	8.73%
				Manila	5.55%
				Taipei	5.55%

Assuming constant annual capital value growth, the capital value at the end of each of the 3 holding periods are given by:

$$CV_{ei} = CV_{bi} * (1 + g_i)^3 \quad \text{(Eq. 8)}$$
$$CV_{ei} = CV_{bi} * (1 + g_i)^5 \quad \text{(Eq. 9)}$$
$$CV_{ei} = CV_{bi} * (1 + g_i)^7 \quad \text{(Eq. 10)}$$

where
CV_{ei} = Capital value of investment in country i at the end of the holding period
CV_{bi} = Initial capital value of investment in country i
g_i = Annual capital value growth rate of investment in country i

At the end of the holding periods and the maturity of the respective swaps, the parties re-exchange the initial amounts swapped. Thus taking the example of the 3 year unadjusted currency portfolio, the investor has to return RMB 125.99M, Bht 551.54M, MYR 67.96M and NTD 1,234.68M, which was received at the initiation of the hedge in exchange for the USD 100 million paid.

The currency swap stabilizes the U.S. dollar income every year and is supposed to reduce the uncertainty of the reversionary value at the end of the holding period. The swap however does not hedge against currency risk for any capital appreciation realized at the end of the holding period, i.e. the capital value is at the mercy of the volatility of the exchange rate, which is simulated using Monte Carlo Simulation.

The preceding analyses and computations (except relating to currency swap) are repeated for the currency-adjusted returns to facilitate the evaluation of the natural hedge strategy.

Simulated Results

The results for the 3 and 7-year holding periods for full sample are presented in Exhibits 9 and 10. The results for the 5-year holding period (not presented but available on request) are similar to those shown.

Exhibit 9: Simulation Results: 3-Year Holding Period

Ex Rate Volatility	Statistics	NPV			IRR		
		Swap	N Hedge	No Hedge	Swap	N Hedge	No Hedge
Low Variation	Mean	$2,884,214.35	$5,101,378.95	$3,815,184.48	9.149%	10.025%	9.530%
	Std Dev	$829,864.58	$755,408.14	$822,908.88	0.329%	0.294%	0.328%
	CV	0.288	0.148	0.216	0.0360	0.0293	0.0344
	Sharpe Ratio				5.56	6.14	5.87
	Jensen's Alpha				0.065	0.073	0.067
Medium Variation	Mean	$2,941,027.23	$5,216,835.73	$3,880,702.06	9.169%	10.066%	9.554%
	Std Dev	$1,344,361.46	$1,687,108.51	$1,361,087.03	0.531%	0.656%	0.540%
	CV	0.457	0.323	0.351	0.0579	0.0651	0.0565
	Sharpe Ratio				6.51	8.25	6.94
	Jensen's Alpha				0.064	0.072	0.064
High Variation	Mean	$3,129,520.24	$5,509,624.34	$4,095,199.95	9.237%	10.172%	9.632%
	Std Dev	$2,587,330.80	$2,974,721.04	$2,585,424.37	1.017%	1.152%	1.020%
	CV	0.827	0.540	0.631	0.1101	0.1133	0.1059
	Sharpe ratio				10.89	14.70	11.57
	Jensen's Alpha				0.062	0.071	0.058

Exhibit 10: Simulation Results: 7-Year Holding Perio

Ex Rate Volatility	Statistics	NPV			IRR		
		Swap	N Hedge	No Hedge	Swap	N Hedge	No Hedge
Low Variation	Mean	$30,192,878.90	$53,500,537.55	$31,184,228.76	13.140%	16.710%	13.341%
	Std Dev	$4,920,699.09	$10,382,261.02	$4,898,108.30	0.760%	1.445%	0.759%
	CV	0.163	0.194	0.157	0.0578	0.0865	0.0569
	Sharpe Ratio				25.63	38.08	26.26
	Jensen's Alpha				0.089	0.118	0.091
Medium Variation	Mean	$30,210,430.48	$53,633,609.23	$31,211,774.11	13.142%	16.727%	13.345%
	Std Dev	$4,965,742.87	$10,631,659.70	$5,014,747.18	0.765%	1.475%	0.776%
	CV	0.164	0.198	0.161	0.0582	0.0882	0.0581
	Sharpe Ratio				25.99	35.70	27.21
	Jensen's Alpha				0.089	0.117	0.091
High Variation	Mean	$30,464,814.68	$53,995,849.13	$31,590,249.76	13.176%	16.773%	13.400%
	Std Dev	$5,451,758.00	$11,208,969.59	$5,555,439.61	0.833%	1.545%	0.851%
	CV	0.179	0.208	0.176	0.0632	0.0921	0.0635
	Sharpe ratio				30.77	31.39	32.98
	Jensen's Alpha				0.089	0.118	0.091

All the metrics for comparison: NPV, IRR, Shape's Ratio and Jensen's alpha, clearly shows that the natural hedge strategy is far better than both the currency swap hedge and unhedged strategy over the 3-year holding periods regardless of the exchange rate volatility (Exhibit 9). For example, during high exchange rate volatility when hedging should be intuitively appealing, the natural hedge strategy provides NPV of US$5,509,624 compared to US$3,129,520 for hedged strategy.

Another startling result is that the swap hedge, instead of reducing risk, increased risk as measured by the coefficient of variation which is a better measure than the standard deviation given different expected returns. The result concurs with Walker (2008). The swap hedge, however, reduced risk over the 7-year holding periods. Notwithstanding, the NPV, IRR, Sharpe Ratio and Jensen's Alpha show that the natural hedge is superior to currency swap hedge (Exhibit 10). Furthermore, the out-of-sample results (Exhibit 11) confirm the superiority of the

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natural hedge to swap hedge. Moreover, the hypothesis test result in Exhibit 12 show that apart from low currency volatility for 3 and 5-year holding periods, the null hypothesis that currency swap as a hedging tool for international real estate investment is superior to natural hedge is rejected at the 0.05 level of significance in the remaining cases. In other words, natural hedge performs better than currency swap hedge. The superiority of the natural hedge is further confirmed by stochastic dominance results presented in Exhibits 13 and 14 – The natural hedge exhibits first degree dominance over currency swap hedge.

Exhibit 11: Risk-Return Ratios – GFC Period (Out-of-Sample)

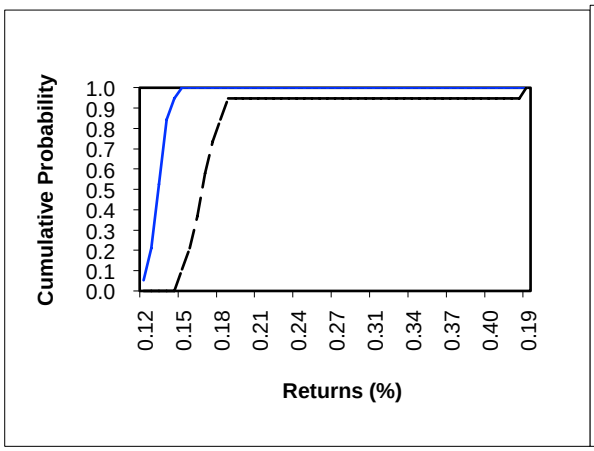
3-Year	Intensity of Exchange Rate Volatility	Sharpe Ratio	Jensen's Alpha
Currency Unadjusted (Swap Hedge)	Low	6.98	0.085
	Medium	8.03	0.086
	High	13.77	0.092
Currency Adjusted (Natural Hedge)	Low	7.18	0.091
	Medium	8.16	0.092
	High	18.07	0.098
Control	Low	7.29	0.089
	Medium	8.40	0.090
	High	14.36	0.096

Exhibit 12: Hypothesis Test Results

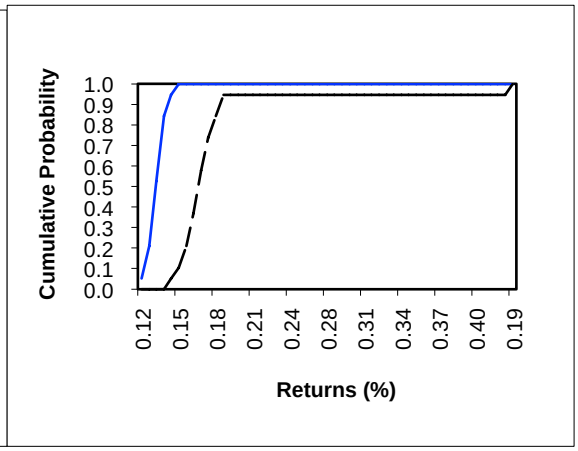
	Z-Score		
	3 Years	5 Years	7 Years
Low Currency Variation	6.582	4.461	0.983
Medium Currency Variation	0.705	0.876	-0.022
High Currency Variation	-2.259	-2.789	-0.886

Exhibit 13: Stochastic Dominance Test Results
3-Year Swap vs. Natural Hedge

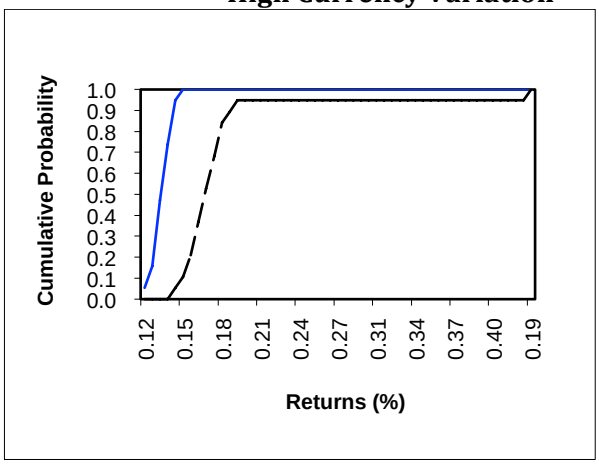
Low Currency Variation



Medium Currency Variation



High Currency Variation



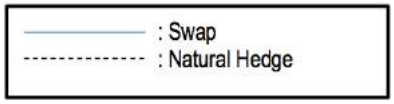
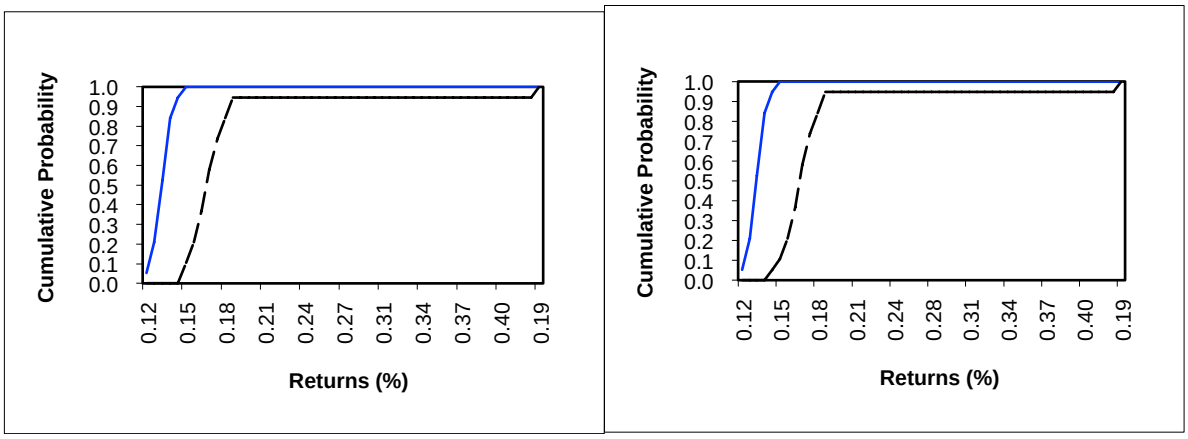
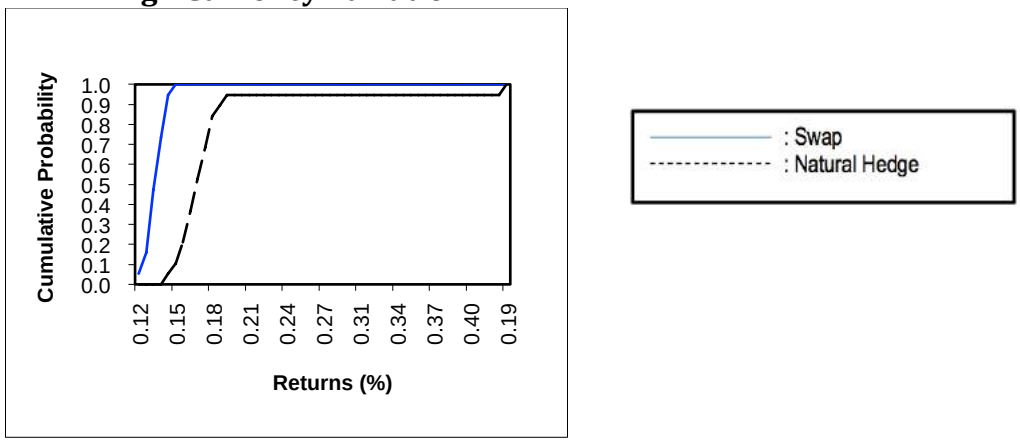


Exhibit 14: Stochastic Dominance Test Results
7 Year Swap vs. Natural Hedge

Low Currency Variation **Medium Currency Variation**



High Currency Variation



CONCLUSION

We set out to propose forward-looking investment appraisal framework to compare the effectiveness of two strategies in hedging against currency risk in a portfolio of real estate investments in ten cities of seven Asia-Pacific countries, and to determine the optimal choice among "unhedged", "artificially" hedged and "natural" hedged options. Analysis of the data for the in-sample and out-of-sample periods based NPV, IRR, Sharpe Ratio, Jensen's alpha and stochastic dominance reveal that the natural hedge strategy is the optimal choice. It provides superior returns to swap hedge and the control strategy over all the three holding periods. Furthermore, the superiority of the natural hedge is confirmed by hypothesis test results. Thus, investors who invest in real estate in the sample countries may seriously consider the natural hedge strategy to improve their investment returns.

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