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「財務工程模型在資產配置策略之運用」
心得報告

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目　錄

圖表目錄

本次 95 年度國際金融人才培訓計畫「財務工程模型在資產配置策略之運用」，係藉由赴英國倫敦、德國杜塞道夫、以及瑞士蘇黎士，參訪瑞士信貸銀行（Credit Suisse）、瑞士銀行（UBS）、巴克萊銀行（Barclays Capital）、蘇格蘭皇家銀行（The Royal Bank of Scotland）、匯豐銀行（HSBC）、以及 GFTA 顧問公司，針對四大主題：（一）保守型資產配置模型，例如投資組合保險策略；（二）積極型資產配置模型，例如相對價值套利策略；（三）外匯分離管理策略，例如價值策略、趨勢策略、波動度策略等；以及（四）市場風險管理：例如上述策略如何估計市場風險與配置預算等，進行研究。

其中，外匯分離管理策略之價值型策略，又稱遠期匯率偏誤策略，已於 96 年度應用於外匯存底之管理，實地進行操作。本出國報告將結合上述（一）、（三）與（四）主題，實證比較各種動態資產配置模型應用於外匯投資組合之避險績效，以做為 Currency Overlay 中以波動度策略進行避險操作之參考。

動態資產配置模型避險績效之比較研究

摘要

本文實證比較傳統之動態資產配置模型，如位似選擇權避險策略、固定比率投資組合保險策略，與現代以控制風險為基礎之動態資產配置模型，如風險值避險策略、期望損失值避險策略等，共四種策略之避險績效表現。本文將以五種觀點來評比各策略之優劣順序，以投資組合夏普比率與標準差之觀點來看，四種策略之優劣順序相同，固定比率投資組合保險與期望損失值避險策略位居一、二，風險值避險策略位居最後；以改善投資組合報酬率分配之觀點來看，則是期望損失值避險與固定比率投資組合保險策略位居一、二，風險值避險策略仍居最後；以投資組合累積報酬率之觀點來看，期望損失值避險策略位居第一；最後，以週轉率之觀點來看，仍是期望損失值避險策略位居第一。綜合而言，四種策略由優至劣順序為，期望損失值避險、固定比率投資組合保險、位似選擇權避險、風險值避險。

Comparison of Dynamic Asset Allocation Strategies

1. Introduction

Tactical asset allocation is a dynamic process to maximize the final wealth or the risk-adjusted return of a portfolio over a given investment horizon. Portfolio insurance strategy gives investor the ability to limit downside risk while allowing participation in upside markets, which can be regarded as a dynamic asset allocation process. The most popular portfolio insurance strategy is the synthetic put approach of Rubinstein and Leland (1981), also named option-based portfolio insurance (OBPI) strategy. Another simplified approach, not involving complex Greeks, is the constant proportion portfolio insurance (CPPI) strategy developed for equity instruments by Black and Jones (1987) and Perold (1986), and extended to fixed-income instruments by Hakanoglu et al. (1989).

The idea of risk management has become widespread and been applied to strategic asset allocation problem. Bensalah (2002), Campbell et al. (2001) and Lucas and Klaassen (1998) develop portfolio selection models by maximizing expected return subject to the constraint of a Value-at-Risk (VaR) limit. However, a number of problems and limitations associated with VaR have been identified (Acerbi et al., 2001; Artzner et al., 1997, 1999; Jaschke, 2001). Basak and Shapiro (2001) demonstrate that VaR risk managers often optimally choose a larger exposure to risky assets and consequently incur larger losses when such losses occur. They suggest the expectation shortfall (ES) to remedy the shortcomings of VaR and demonstrate the benefits of such an approach. Krokhmal et al. (2002), Rockafellar and Uryasev (2000) and Uryasev (2000) provide algorithms for the portfolio optimization problem in an ES framework. Ho et al. (2008) illustrate the evolution of the optimal portfolio selection during credit crunch period in year 2007 based on three frameworks, namely the mean-variance, mean-VaR and mean-ES, assuming different return distributions, such as normal, historical and extreme value distribution.

Nowadays the risk-based strategic asset allocation technique is also applied to tactical asset allocation problem. Herold et al. (2005) investigate a risk-based total return strategy for fixed-income portfolio. The portfolio duration is adjusted each day so that the shortfall probability, that is, the probability of realizing a return below a pre-specified threshold at the end of investment horizon, does not exceed a target value. The daily control of the shortfall risk of a portfolio can be achieved via adjusting the investment weights between risky assets (bonds) and risk-free assets (cash). Thus, the VaR-based dynamic hedging strategy can be regarded as a tactical asset allocation process and compared to those classic portfolio insurance strategies.

This paper extends Herold et al. (2005) by applying the ES-based dynamic asset allocation strategy to a currency overlay program, in which the foreign exchange portfolio comprises of a risky currency (AUD) and a risk-free currency (USD), and compares the hedging performance of the modern risk-based strategies with that of the traditional portfolio insurance strategies. We find that the VaR-based dynamic hedging strategy results in a more volatile portfolio return, and hence, lower Sharpe Ratio and more negatively skewed return distribution than others. The performance of the ES-based strategy is superior to that of CPPI in terms of lower turnover and higher cumulative return across years.

The paper is organized as follows. Section 2 summarizes the adjustment process behind various dynamic asset allocation strategies. Section 3 describes the data and constructs a foreign exchange portfolio comprising of AUD and USD deposit position for each strategy. Conclusions are presented in Section 4.

2. Dynamic Asset Allocation Strategies

This section summarizes the mechanism behind various dynamic asset allocation strategies.

2.1 Synthetic Put

If an investor holds a risky currency and buys one at-the-money put option on that currency, the value of the portfolio, V (= S + P), will not be less than the exercise price at expiration. Thus, the investor can effectively hedge the portfolio against downside risk. However, the implied volatility is usually higher than the historical volatility in option markets, which indicates a real option is more expensive than a synthetic one. Therefore, synthetic option is often used as an alternative in practice. A synthetic put can be created by dynamically allocating the portfolio between the risky (foreign) and riskless (domestic) currencies according to the delta of put option,

$$D = e^{-R_f T}\left[N(d_1) - 1\right].$$

According to Black and Scholes (1973), a European put option on foreign currency has a premium of P,

$$P = Xe^{-RT}N(-d_2) - Se^{-R_f T}N(-d_1),$$

where $d_1 = \dfrac{\ln(S/X) + \left(R - R_f + \sigma^2/2\right)T}{\sigma\sqrt{T}}$ and $d_2 = d_1 - \sigma\sqrt{T}$, S is the spot exchange rate, R is the domestic risk-free interest rate, R_f is the foreign risk-free interest rate, σ is the volatility of spot exchange rate return, X is the exercise price, T is the time to expiration, and $N(*)$ is the cumulative standard normal distribution function. Specifically, the investment proportion of the risky currency in the portfolio value can be expressed as:

$$W_{SynPut} = \frac{S + e^{-R_f T}[N(d_1) - 1] * S}{V} = \frac{Se^{-R_f T} N(d_1)}{S + P}.$$

2.2 Constant Proportion Portfolio Insurance

A simplified approach not involving complex formulas but retaining the insurance feature was proposed by Black and Jones (1987). In CPPI, the exposure to risky asset, *E*, is always kept at the cushion times a multiplier, *m*. The cushion, *C*, is the difference between the portfolio value and a protected floor value, *FL*, and the multiplier is constant throughout the investment period[1]:

$C = V - FL,$

$E = m * C.$

The same as synthetic put strategy, the payoff function of CPPI is convex, implying a "buy high and sell low" rule: if the market has decreased you have to sell a fraction of risky assets and buy riskless assets; if the market has increased you have to switch from riskless assets into risky assets and rally with the market. The investment proportion of the risky currency in the portfolio value can be expressed as:

$$W_{CPPI} = \frac{E}{V}.$$

2.3 VaR-based Dynamic Hedging

Herold et. al (2005) investigate a fixed-income portfolio strategy that is designed to generate positive returns. The idea is to permanently control the shortfall risk of the portfolio. The allocation of risky asset is adjusted each day so that the shortfall

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[1] Bertrand and Prigent (2001) apply the extreme value theory to examine the upper bound on the multiplier in CPPI. The upper bound can be regarded as the inverse of the p-th quantile drawdown of portfolio return at a given probability level, p% (typically 99%), and the p-th quantile is estimated by the extreme value approach, $m \le 1/H_{\varepsilon}^{-1}$, where *H* indicates the extreme value distributions. They found the upper bound on the multiplier decreases with the risk aversion of the investor, and the length of the investment period.

probability – the probability of realizing a return that falls below a pre-specified threshold at the end of the investment period – does not exceed a target value. To operationalize the shortfall risk, they use the lower partial moment of order zero, which is equivalent to VaR, and assume a normal distribution of portfolio return, R_P:

$$LPM_0(R_P) = N\left(\frac{\tau - u}{\sigma}\right),$$

$$R_P = W * R_A + (1 - W) * r ,$$

where $N(*)$ denotes the cumulative standard normal distribution, u is the mean, σ the volatility of the return distribution and τ is the minimum return. R_A and r are the returns of the risky and the riskless asset, respectively. Controlling for a fixed shortfall probability, the dynamic allocation process is solving for the weight of the risky asset so that the portfolio return is always higher than the minimum return.

Herold et. al (2005) show that the VaR-based model can be regarded as a generalized version of CPPI with a dynamic and time-varying implied multiplier. The VaR of the portfolio expressed in percentage term is given by:

$$VaR(R_P) = u - N^{-1}(\alpha)\sigma ,$$

where $N^{-1}(\alpha)$ is the α-quantile of the standard normal distribution (also denoted as Z_α.). Without the drift term, the VaR can be simplified as:

$$VaR(R_P) = -Z_\alpha * W * \sigma .$$

Solving for W so that $VaR(R_P) = \tau$ yields:

$$W_{VaR} = \frac{\tau}{-Z_\alpha * \sigma} .$$

The implied multiplier of the VaR model is obtained by:

$$m^{impl} = \frac{E}{C} = \frac{W * V}{C} = \frac{C / V}{Z_\alpha * \sigma} * \frac{V}{C} = \frac{1}{Z_\alpha * \sigma} = \frac{1}{VaR(R_P)},$$

where $\tau = -C/V$ is expressed in percentage terms. Thus, the inverse of the CPPI multiplier can be interpreted as the maximum loss or worst case return that is allowed to occur over the next period.

2.4 ES-based Dynamic Hedging

The expected shortfall, defined as the expected value of the loss of a portfolio in a certain percentage of worst cases within a given holding period. Hamidi et al. (2007) propose an alternative to the standard CPPI method based on the determination of a conditional multiple. In their framework, the multiple is conditionally determined in order to keep constant the risk exposure. The risk exposure is defined either by the VaR or by the expected shortfall, which can be expressed as:

$m^{cond} = \frac{1}{VaR_\alpha}$ = (α -quantile of asset return distribution)$^{-1}$, or

$m^{cond} = \frac{1}{ES_\alpha}$ = (expected shortfall for the α -quantile in the lower tail of asset return distribution)$^{-1}$.

They use three different calculation methods to measure the VaR, namely the parametric, semi-parametric and non-parametric approaches. A total number of eight methods of VaR calculation are presented: three parametric methods based on distributional assumptions, four semi-parametric methods based on conditional autoregressive VaR (CAViaR) approach, and one non-parametric method using the historical simulation approach. However, they did not work on the estimation of expected shortfall. This paper tries to fill this gap in the literature.

3. Empirical Simulation

This section applies the above-mentioned dynamic asset allocation strategies to a currency overlay program, in which the foreign exchange portfolio is comprised of a risky asset, Australian dollar (AUD), and a risk-free asset, U.S. dollar (USD) overnight deposit account. For comparison of various strategies, we assume the initial value of

AUD in the portfolio is 25%, short position in AUD is not allowed, but investor can borrow USD to buy AUD. By daily adjusting the allocation between AUD position and USD overnight deposit, the hedging performance is measured by the final dollar value (or return) of portfolio at the end of investment horizon (one year), the volatility of daily portfolio returns and the turnover within investment horizon. The shift of the distribution of portfolio annual return and the cumulative return across years are also examined as an alternative performance measure.

Daily close price[2] of AUD/USD spot exchange rate (S), USD overnight deposit rate (r), and 12-month USD (R) and AUD (R_f) deposit rates from year 2001 to 30th November 2007 are downloaded from Bloomberg. Table 1 shows the summary statistics of AUD asset in each year. Generally speaking, daily return of AUD/USD spot exchange rate is slightly skewed to the left and exhibits leptokurtosis. Assume that the initial portfolio contains 1,000,000 units of AUD. Table 2 shows the performance of buy-and-hold strategy as benchmark. Except for years 2001 and 2005 when AUD depreciated against USD, the annual return (= $S_{\text{year-end}}$ / $S_{\text{year-begin}}$ -1) of AUD in the other years are positive, with an average of 7.54%. The annualized volatility of daily returns of exchange rate is higher than 10% in years 2001, 2003, 2004 and 2007, with an average of 10.85%, and the average of yearly Sharpe Ratio is 0.76.

3.1 Synthetic Put

In order to make the initial value of AUD position in the portfolio equal to 25%, investor needs to create a synthetic put with delta of -0.75 and sell 750,000 units of AUD. The dollar income from AUD sold is kept in an USD cash account and earn overnight deposit rate. As AUD depreciates, the synthetic put is further in-the-money

[2] We assume that the prices within each day are fixed as close price for convenience of calculation. It would not affect the qualitative comparison of various strategies.

and investor sells more AUD; on the contrary, investor withdraws from USD cash account to buy AUD as AUD appreciates. The daily adjustment is determined by the changes of delta.

Table 3 exhibits the hedging performance of synthetic put strategy. Except for year 2004, the synthetic put strategy generates positive annual portfolio returns with an average of 5.51%. The annualized volatility of daily portfolio returns in each year is reduced compared to those in buy-and-hold strategy, with an average of 4.29%, and the average of yearly Sharpe ratio is increased to 1.17. Figure 3 illustrates the reason of a negative return in year 2004. As AUD depreciated from March to September, the AUD investment weight dropped to a minimum level of 4.3% at 9th September. Even though the weight climbed up sharply to a maximum level of 59.2% at 25th November, it dropped severely again to a level of 8.8% at 10th December, and then increased a little to a level of 22.8% at the end of the year. The dramatic evolution of weights makes both the AUD position and the USD cash account not able to accumulate wealth. On the contrary, when controlling normal VaR (which will be elaborated later), the AUD investment weight dropped dramatically from 25% at the end of April and then kept at around 2% to 5% till the end of year 2004, the huge amount of USD cash account was able to accumulate accrual interests, thus resulted in a positive return at that year. Figure 2 demonstrates the protection effect of the synthetic put strategy on the portfolio value in a downtrend risky asset market in year 2005.

3.2 CPPI

In a portfolio of securities, the floor is usually set as the discount price of a zero-coupon bond, which approaches to par value at the end of investment horizon. In a currency portfolio, the floor is set as the forward rate, with a maturity equal to the investment horizon, that appreciates with time, $F_t = F_0 * \exp(R*t)$, where F_0 =

S_0*exp((R-R_f)*T). Note that when domestic risk-free rate is higher than foreign risk-free rate, the forward rate is at premium, which would result in short-sell of risky asset at the beginning of the investment period, that is, $C = V – FL = Amount * (S – F) < 0$. In order to make the initial value of AUD position in the portfolio equal to 25%, a discount factor (DF) is needed (95% is used in each year), and the multiplier also needs to be trimmed at the beginning of each year. Thus, the synthetic floor is set as:

$F_t = DF * F_0 * \exp(R*t)$.

Table 4 shows that CPPI strategy generates positive annual portfolio return in all the years, even when AUD depreciated in years 2001 and 2005. The average of annual portfolio returns is 4.48%, the average of annualized volatility of daily portfolio returns is 2.72%, and the average of yearly Sharpe ratio is 1.53. The lower average volatility and higher average Sharpe ratio compared to those in the synthetic put indicates CPPI a good insurance strategy. The range of AUD investment weights in each year is much narrower than that in the synthetic put, which explains the stability of CPPI strategy. Figure 1 also confirms this point. In the buy-and-hold strategy, the relationship between the portfolio returns and the exchange rate returns is along a positive 45^o straight line, while in the CPPI strategy, the relationship is along a much flatter straight line. The multiplier used in each year is around 3 to 5, which is consistent with general practice.

3.3 VaR-based Dynamic Hedge

The VaR-based dynamic hedge is to adjust the investment weight of AUD so that the probability of realizing a portfolio annualized return below minus half of the USD overnight deposit rate at each day does not exceed a target percentage, α (say 5%). The threshold value set as minus half of overnight rate is for USD cash account to be able to cover the loss (the more aggressive investor may set as minus overnight rate).

The 95% confidence level VaR can generally be expressed as follows:

$Prob(R_P < -r/2) \leq 5\%$.

When the asset return distribution is assumed to be normal, the dynamic allocation process is solving for the weight of AUD so that at each day the portfolio annualized return is always higher than minus half of the average of USD overnight deposit rates during the past year:

$$N\left(\frac{-u_t(r)/2 - u_t(R_P)}{\sigma_t(R_P)}\right) \leq 5\%,$$

$$NVaR_\alpha(R_P) = u_t(R_P) - N^{-1}(\alpha)\sigma_t(R_P),$$

where $u_t(R_P)$ is the mean of daily portfolio annualized returns given a certain weight of AUD at date t, $u_t(R_P) = W * u_t(R_A) + (1\text{-}W) * u_t(r)$, which is composed by the annualized average of daily AUD exchange rate returns during the past year at date t ($u_t(R_A)$) and the average of daily USD overnight rates during the past year at date t ($u_t(r)$); $\sigma_t(R_P)$ is the exponentially weighted volatility of daily portfolio annualized returns at date t with a decay factor of 0.97 that gives the more updated returns more weights to capture the heteroskasticity,

$\sigma_t(R_P) = \sqrt{W^2 * \sigma_t(R_A)^2 + (1-W)^2 * \sigma_t(r)^2 + 2 * W * (1-W) * Cov_t(R_A, r)}$. At first, we impose a cap of 100% and a floor of 0% on solving for the AUD weight each day within the investment horizon. Then, we scale up or down the original weight series in order to make the initial value of AUD position in the portfolio equal to 25%.

Table 5 shows the hedging performance of controlling normal VaR (NVaR) strategy. When AUD depreciated in year 2001, the NVaR-based strategy resulted in a slightly positive annual portfolio return of 0.34%, which is better than -8.87% in the buy-and-hold strategy. However, when AUD depreciated in year 2005, the NVaR-based strategy resulted in a negative annual portfolio return of –6.93%, even worse than –5.81% in the buy-and-hold strategy. In the other years, the annual portfolio return is reduced, with an average of 4.04%, compared to the average of 7.54% in the buy-and-hold strategy. The average of annualized volatility of daily portfolio returns is also reduced to 4.36%, compared to 10.85% in the buy-and-hold strategy. The average of yearly Sharpe ratio is 0.94, which is lower than those in the synthetic put and the CPPI strategies. This indicates the drawback of using VaR as a risk measurement in the literature. Figure 1 clearly illustrates how controlling NVaR turns out to be a very volatile strategy, the relationship between the portfolio returns and the exchange rate returns scatters rather than along a straight line.

As illustrated in Table 1, the AUD exchange rate returns is slightly away from normal distribution. Therefore, in addition to controlling the normal VaR, we also control the historical VaR (HVaR) as an alternative. The dynamic allocation process is solving for the weight of AUD so that at each day the α^{th} (say 5^{th}) percentile of portfolio annualized returns is always higher than minus half of the USD overnight deposit rate:

$$HVaR_{\alpha}\left(R_P\right) = Percentile\left(R_{P_{t-260}}, \ldots, R_{P_t}; 0.05\right) \geq -r/2,$$

where $R_{P_{t-260}}, \ldots, R_{P_t}$ indicates the daily portfolio annualized return series given a certain weight of AUD during the past year at date *t*; $R_{P_t} = W * u_t\left(R_A\right) + \left(1 - W\right) * r_t$ is comprised of the annualized average of daily AUD exchange rate returns during the past year at date *t* ($u_t(R_A)$) and the USD overnight rate at date *t* (r_t). We also initially impose a cap of 100% and a floor of 0% on solving for the AUD weight each day within the investment horizon; then, scale up or down the original weight series in order to make the initial value of AUD position in the portfolio equal to 25%.

Table 6 shows that the historical VaR-based strategy generates positive annual return in all the years, the same as CPPI strategy. The average of annual portfolio return in each year is 6.85%, higher than 4.48% in CPPI. Besides, the average of annualized volatility of daily portfolio returns in each year is 3.77%, also higher than 2.72% in CPPI. Thus, the average of yearly Sharpe ratio is 1.50, which is slightly inferior to 1.53 in the CPPI strategy. Figure 1 illustrates again how controlling HVaR turns out to be a volatile strategy compared to the CPPI, the relationship between the portfolio returns and the exchange rate returns scatters rather than along a straight line.

Two evidences in Figure 1 indicate that controlling the historical VaR would result in more stable portfolio returns than controlling the normal VaR. Firstly, the slope of the scattered points in the HVaR-based strategy is flatter than that in the NVaR-based strategy. When returns of AUD exchange rate deteriorate, the portfolio returns reduce less in the HVaR-based strategy; on the other hand, when returns of AUD improve, the portfolio returns also increase less in the HVaR-based strategy. Secondly, the range of AUD investment weights is generally contracted in the HVaR-based strategy across the years, with average maximum and minimum weights of 38.4% and 21.3%, respectively, compared to 91.1% and 13.6% in the NVaR-based strategy.

3.4 ES-based Dynamic Hedge

The ES-based dynamic hedge is to adjust the investment weight of AUD so that at each day the mean of the portfolio returns that have fallen in the α-quantile (say 5%) of the left tail of distribution is kept above minus half of the USD overnight deposit rate. The prescribed threshold value is again for the USD cash account to cover the expected loss (the more aggressive investor may set at an even lower level). As noted in the literature (Ho et al., 2008), when asset return distribution is assumed to be normal, the expected shortfall and the VaR are scalar multiples of each other because they, themselves, are scalar multiples of the standard deviation. And there will be no differences across portfolio strategies employing variance, VaR and ES risk measures when normal distribution is assumed. Therefore, the expected shortfall is only measured by adopting the empirical distribution in this paper. The 95% confidence level historical ES (HES) can be expressed as follows:

$$HES_\alpha(R_P) = E\left[R_P \middle| R_P < -HVaR_\alpha(R_P)\right] \geq -r/2,$$

where $E[*]$ is the expectation operator; $HVaR_\alpha(R_P)$ is the 1-α% confidence level historical VaR of the portfolio annualized returns at each day.

Table 7 shows that the historical ES-based strategy generates positive annual return in all the years, the same as the CPPI and the HVaR-based strategies. Note that the average of annual portfolio return in each year is 7.28%, even higher than those in the CPPI and the HVaR-based strategies. Although the average of annualized volatility of daily portfolio returns in each year is 3.91%, also higher than both the other two strategies, the average of yearly Sharpe ratio is 1.49, which is close to 1.53 (1.50) in the CPPI (HVaR-based) strategy. The average maximum and minimum AUD investment weight is 40.2% and 21.1%, respectively, which are close to 38.4% and 21.3% in the HVaR-based strategy. Figure 1 illustrates how controlling HES results in an equivalently stable performance to the CPPI strategy. The relationship between the portfolio returns and the exchange rate returns almost stands along the same straight line in all the years. Figure 2 and 3 also identify how similar the final value and the evolution of AUD investment weights among the three strategies across the years.

3.5 Comparison of Various Strategies

Table 8 summarizes the results from Table 2 to Table 7 and compares the hedging performance of various strategies across years from five perspectives. The first two perspectives are from the Sharpe ratio and the volatility of portfolio returns, which can be been in the first two columns in Table 8. Both performance measures lead to the same rankings of strategies. The CPPI has the highest Sharpe ratio and the lowest volatility, which ranks as the number 1, while the HVaR-based strategy ranks the last, the same as buy-and-hold.

The 3rd and the 4th columns in Table 8 show the maximum and the minimum annual return that a strategy has ever resulted during the 7 investment horizons. For example, if buy and hold AUD currency, the maximum (minimum) annual return of 33.81% (-8.87%) occurred in year 2003 (2001); if controlling the historical ES, the maximum (minimum) annual return of 29.72% (1.08%) occurred in year 2003 (2001 and 2005). Thus, from the perspective that the return distribution of the hedged portfolio is changed and shifted to the right, the HES strategy ranks as the number 1 compared to the buy-and-hold strategy. Fourthly, from the perspective of cumulated portfolio returns, the 5th column shows the cumulated annual portfolio returns from year 2001 to 30th November 2007. The HES strategy also ranks as the number 1.

Finally, the 6th column compares the average of yearly turnovers among these strategies. The synthetic put and the CPPI strategies adjust the AUD investment weight according to the delta and the floor value each day, which are doomed to adjust almost everyday within investment horizon. On the contrary, the historical VaR and ES are more stable at each day within an investment horizon, thus, the HVaR- and HES-based strategies result in much less frequent adjustments. This can benefit from reducing a lot of transaction costs.

To sum up the above five perspectives, the last column in Table 8 shows the overall rankings among various strategies. The historical ES and the CPPI strategies are ranked as the top two; the VaR-based strategies perform the worst and are ranked as the bottom two.

4. Conclusion

This paper compares the traditional portfolio insurance strategies, such as OBPI and CPPI, with the modern risk-based dynamic asset allocation strategies. The hedging performance of five strategies are evaluated and ranked in terms of five perspectives. According to Sharpe ratio and the volatility of portfolio returns, the CPPI and the ES-based strategies perform the top two, while the VaR-based strategies is the worst. From the point that the return distribution of the hedged portfolio is changed and shifted to the right compared to the buy-and-hold strategy, the ES-based strategy ranks as the number 1. In view of cumulated portfolio returns, the ES-based strategy ranks as the number 1. Furthermore, the ES-based strategy results in lower turnover within investment horizon, which saves a lot of transaction costs. In sum, the ES-based strategy is superior to the CPPI, while the VaR-based strategy performs the worst.

Table 1. Summary Statistics of Asset Returns

	Year-begin Interest Rate			AUD Spot Exchange Rate			
	USD O/N Deposit (p.a.%)	USD 12M Deposit (p.a.%)	AUD 12M Deposit (p.a.%)	Average of Daily Return (p.a.%)	Volatility of Daily Return (p.a.%)	Skew	Kurt
2001	6.813	6.000	5.800	-8.3	13.3	0.00	3.24
2002	2.000	2.443	4.379	10.1	8.9	-0.41	4.57
2003	1.350	1.449	4.708	29.6	10.0	-0.38	4.27
2004	1.070	1.457	5.715	4.6	13.4	-0.46	3.35
2005	2.275	3.100	5.473	-5.9	9.1	-0.02	2.95
2006	4.295	4.839	5.708	7.7	8.6	-0.10	3.06
2007*	5.280	5.329	6.618	13.2	12.6	-1.22	7.72
Average				7.3	10.8	-0.37	4.16

* Till November 30, 2007.

Table 2. Performance of Buy and Hold (B&H) Strategy

	Initial Value (US$)	Final Value (US$)	Return (p.a.%)	Volatility (p.a.%)	Sharpe Ratio
2001	559,100	509,500	-8.87	13.31	-0.67
2002	509,600	561,600	10.20	8.87	1.15
2003	562,000	752,000	33.81	10.01	3.38
2004	751,200	780,300	3.87	13.39	0.29
2005	778,000	732,800	-5.81	9.15	-0.64
2006	733,200	788,600	7.56	8.65	0.87
2007	789,400	884,400	12.03	12.58	0.96
Average			7.54	10.85	0.76

Table 3. Hedging Performance of Synthetic Put (SynPut) Strategy

	Final Value (US$)	Return (p.a.%)	Volatility (p.a.%)	Sharpe Ratio	Turnover (Days)	Weight of AUD		
						End	Max	Min
2001	570,120	1.97	1.22	1.62	260	0.0	30.0	0.0
2002	518,912	1.83	3.58	0.51	260	79.4	97.4	17.7
2003	707,167	25.83	9.09	2.84	242	106.3	106.9	25.0
2004	740,484	-1.43	3.33	-0.43	261	22.8	59.2	4.3
2005	794,291	2.09	1.30	1.61	259	0.0	28.2	0.0
2006	760,634	3.74	2.46	1.52	259	70.6	79.1	9.1
2007	825,161	4.53	9.04	0.50	239	98.4	105.4	13.3
Average		5.51	4.29	1.17	254		72.3	9.9

Table 4. Hedging Performance of CPPI Strategy

	Final Value (US$)	Return (p.a.%)	Volatility (p.a.%)	Sharpe Ratio	Turnover (Days)	Multiplier	Weight of AUD		
							End	Max	Min
2001	566,729	1.36	1.73	0.79	260	5.19772	1.7	27.6	1.7
2002	528,505	3.71	2.57	1.44	260	3.66475	29.8	35.0	24.2
2003	627,610	11.67	3.69	3.16	260	3.10739	50.7	50.7	25.0
2004	763,116	1.59	3.08	0.51	261	2.79009	25.3	28.8	18.4
2005	786,374	1.08	2.02	0.53	259	3.45908	18.4	26.2	17.8
2006	772,983	5.43	2.13	2.55	259	4.29425	27.2	28.4	19.9
2007	841,084	6.55	3.79	1.73	239	4.02197	30.1	38.9	22.1
Average		4.48	2.72	1.53	257			33.6	18.4

Table 5. Hedging Performance of Controlling Normal VaR (NVaR) Strategy

	Final Value (US$)	Return (p.a.%)	Volatility (p.a.%)	Sharpe Ratio	Turnover (Days)	Weight of AUD		
						End	Max	Min
2001	560,987	0.34	3.01	0.11	260	20.6	32.1	17.8
2002	533,864	4.76	5.19	0.92	257	152.4	153.3	0.0
2003	654,367	16.44	6.07	2.71	93	69.4	69.4	19.4
2004	756,616	0.72	2.03	0.35	198	3.4	26.1	1.4
2005	724,099	-6.93	6.87	-1.01	259	50.9	190.8	19.6
2006	783,524	6.86	3.73	1.84	259	121.8	125.1	25.0
2007	837,681	6.12	3.65	1.68	178	13.0	40.6	11.7
Average		4.04	4.36	0.94	215		91.1	13.6

Table 6. Hedging Performance of Controlling Historical VaR (HVaR) Strategy

	Final Value (US$)	Return (p.a.%)	Volatility (p.a.%)	Sharpe Ratio	Turnover (Days)	Weight of AUD		
						End	Max	Min
2001	564,972	1.05	2.58	0.41	56	15.1	25.1	14.2
2002	530,008	4.00	2.51	1.60	20	29.7	30.9	24.8
2003	712,513	26.78	8.83	3.03	23	92.3	92.3	25.0
2004	766,321	2.01	3.29	0.61	0	25.5	26.1	23.2
2005	786,448	1.09	2.20	0.49	9	16.4	25.4	16.4
2006	774,515	5.63	1.93	2.92	28	22.4	25.0	21.2
2007	847,831	7.40	5.03	1.47	39	42.3	43.8	24.5
Average		6.85	3.77	1.50	25		38.4	21.3

Table 7. Hedging Performance of Controlling Historical ES (HES) Strategy

	Final Value (US$)	Return (p.a.%)	Volatility (p.a.%)	Sharpe Ratio	Turnover (Days)	Weight of AUD		
						End	Max	Min
2001	565,154	1.08	2.52	0.43	60	14.8	25.0	13.9
2002	529,965	4.00	2.47	1.62	16	27.8	30.1	24.8
2003	729,005	29.72	9.74	3.05	27	101.5	101.9	25.0
2004	766,321	2.01	3.29	0.61	0	25.5	26.1	23.2
2005	786,395	1.08	2.18	0.49	17	14.6	25.4	14.6
2006	774,491	5.63	2.00	2.82	19	22.9	25.4	22.0
2007	847,934	7.42	5.19	1.43	45	45.7	47.1	24.5
Average		7.28	3.91	1.49	26		40.2	21.1

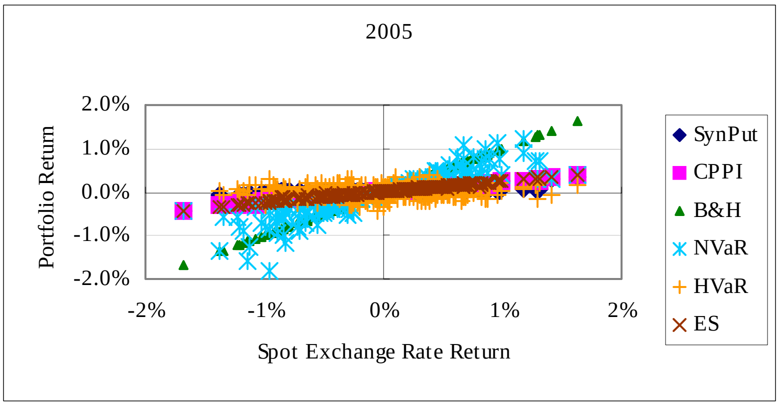
Table 8. Comparison of Performance of Various Strategies across Years

	Sharpe Ratio	Vol. (p.a.%)	Return (p.a.%)			Turnover (Days)	Overall Rank
			Max.	Min.	Cum.[b]		
B&H	0.76 (5)[a]	10.85 (5)	33.81	-8.87 (5)	58.4 (2)	0 (0)	
SynPut	1.17 (3)	4.29 (3)	25.83	-1.43 (3)	42.6 (3)	254 (4)	(3)
CPPI	1.53 (1)	2.72 (1)	11.67	1.08 (2)	35.4 (4)	257 (5)	(2)
NVaR	0.94 (4)	4.36 (4)	16.44	-6.93 (4)	30.1 (5)	215 (3)	(5)
HVaR	0.76 (5)	10.85 (5)	33.81	-8.87 (5)	58.4 (2)	25 (1)	(4)
HES	1.49 (2)	3.91 (2)	29.72	1.08 (1)	59.5 (1)	26 (2)	(1)

a. The number in bracket indicates the rank of the strategy, with 1 the highest rank.

b. The abbreviation indicates the cumulated annual returns from year 2001 to 30th Nov. 2007.

Figure 1. The Relationship between Portfolio Returns and Spot Exchange Rate Returns



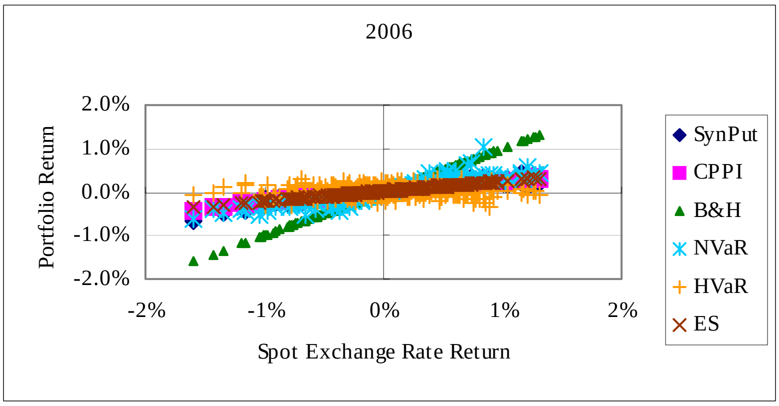
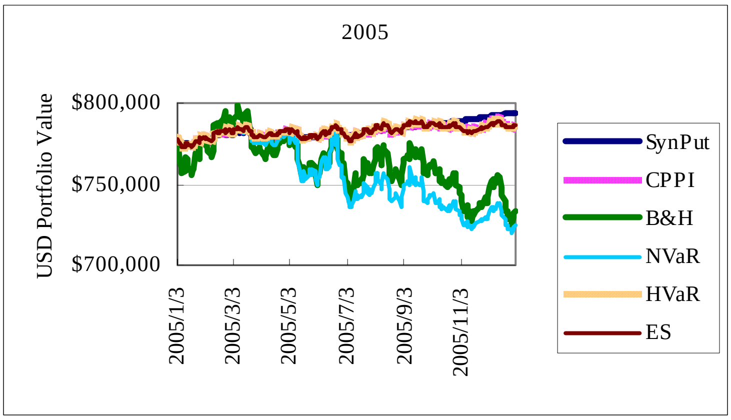


Figure 2. The Final Value of Portfolio



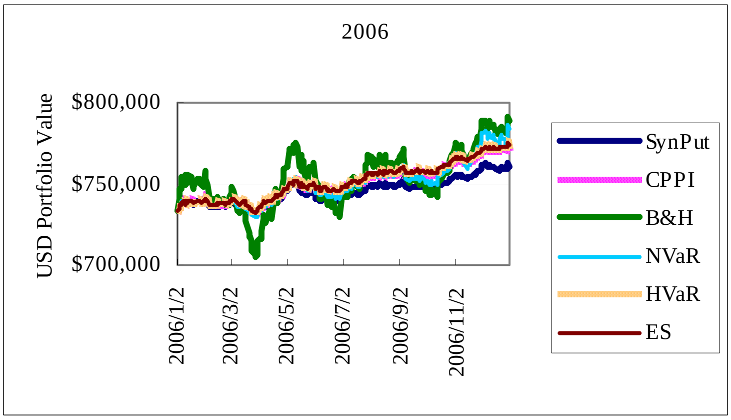


Figure 3. The Evolution of AUD Weights within Investment Horizon