Free lunch for super funds

Finance theory suggests that in normal circumstances, a reduction in risk will also be associated with a reduction in expected returns. However, this trade-off does not occur in the currency context.

Elizabeth Sheedy *reports that research reveals an unexpected implication for superannuation funds with substantial offshore investments. In currency, it is possible to reduce the risk of loss with no long-term impact on expected returns, hence the so-called free lunch. The analysis also shows that some strategies have a very favourable impact on risk for asset portfolios.*

Market-linked pooled superannuation funds on average invest 26 per cent of assets overseas (according to the December 1992 InTech Asset Allocation Monthly). Several corporate and public sector funds now have offshore assets of around 40 per cent, invested in both global bonds and equities. Obviously, currency movements can have a significant impact on fund performance. Having experienced a very significant depreciation in the Australian dollar in the past year, many fund trustees are now acutely aware of the potential for some reversal in the domestic currency. This could lead to revaluation losses on offshore assets.

A number of strategies can be used to manage the effect of unfavourable currency movements on asset portfolios. The research underlying this article involved the analysis of a range of risk-management strategies and led to some very surprising results including the identification of what could be viewed as a "free lunch" for fund managers.

The analysis of currency returns associated with offshore assets over the period following the December 1983 float focused on Australian dollar movements relative to a basket of currencies which typified holdings in offshore equities. The basket includes the US dollar, Japanese yen, deutschemark and pound sterling.

We compared a strategy of taking no cover with that of consistently taking forward cover on a rolling three-month basis. A third alternative was to consistently purchase "at-the-money-spot" Australian dollar call options with three-month terms to protect against the risk of currency loss.

On an unhedged basis, currency returns have averaged 7.65 per cent annually over the post-float period, reflecting the overall downtrend in the Australian dollar. Interestingly, returns on a hedged basis are broadly similar. By locking in forward cover, investors could take advantage of the generally favourable interest differential between Australia and its trading partners, achieving currency returns of 6.05 per cent a year.

However, the truly surprising result came from the option strategy. Even after allowing for option premium costs, the currency returns under the option strategy remained at the relatively high level of 7.69 per cent. While premium costs were incurred, the options were actually exercised in 18 out of 36 quarters, giving a significant payback to offset the premium. Overall, returns were unchanged despite the significant reduction in risk relative to the unhedged case (see Table 1).

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Table 1: Quarterly currency returns 1Q '84-4Q '92

	Mean returns (%pa)	Standard deviation (%pa)	Maximum return (%pa)	Minimum return (%pa)
Unhedged	7.65	11.92	103.52	-37.57
Forward hedge	6.05	1.58	11.47	1.45
Option strategy	7.69	8.46	83.01	-8.33

However, the question arises: will the historical results discovered be repeated in the future? What is the risk that future currency returns will be adversely effected by the consistent purchase of currency options? The purpose of this paper is to examine these issues.

We used a computer simulation model which randomly generates currency paths according to predetermined specifications. This allows us to consider a much larger sample than would be possible using historical data. We tested the strategy under a range of assumptions about the overall trend in the exchange rate, volatility and interest differentials. For each set of conditions we considered a set of 100 random currency paths over a one-year period, starting with a value of 1.0000. We were then able to compare the "Do Nothing" strategy with the option strategy. The option strategy involved consistently purchasing $A call options with a term of one year and a strike price equal to the spot price at initiation.

Critical assumptions

The most critical assumption in this study relates to the overall trend in the exchange rate relative to the interest differential. Currency options are priced on the assumption that, in the long run, interest-rate parity will apply. That is, if Australian interest rates are 3 per cent higher than those overseas, the Australian dollar will on average depreciate by 3 per cent a year. It turns out that over the post-float period, interest-rate parity has broadly described the overall trend in the $A in basket terms. That is, the dollar has on average depreciated by about 8 per cent as year and the three-month interest differential has averaged around 6 per cent a year..

We know that interest-rate parity will not necessarily determine exchange rates in the short run with any accuracy. Exchange rates can and do deviate from their interest-rate parity path for periods of several years at a time. However, for modelling purposes, the assumption that interest rate parity will apply is a useful starting point for analysis. The assumptions used for modelling were:

- Option premium cost: 1.34% of principal.
- Exchange rate drift: $A depreciation 6%.
- Interest differential: Australian rates exceed overseas rates by 6%.
- Volatility: 10% per annum.

We ran 100 simulations under these assumptions using a log-normal distribution. The average depreciation in the $A was 6 per cent over the year. However, the range of outcomes varied between a depreciation of 33 per cent and an appreciation of 16 per cent. The $A appreciated in 22 per cent of cases, which meant that the option strategy was exercised in around one case in five. The graph gives a distribution of currency outcomes at the end of the year. This highlights the fact that even within an overall downtrend, currency volatility results in a significant degree of risk for an offshore investor.

We can compare the currency returns under the two strategies as shown in Table 2.

Note that the returns of the two strategies are almost identical, even after allowing for the option premium costs. The main difference lies in the risk profile. The impact of the option strategy is to *reduce the risk of loss*. This is reflected in a reduced standard deviation and the fact that the potential for significant loss is minimised. However, the *skewness benefit* is highlighted

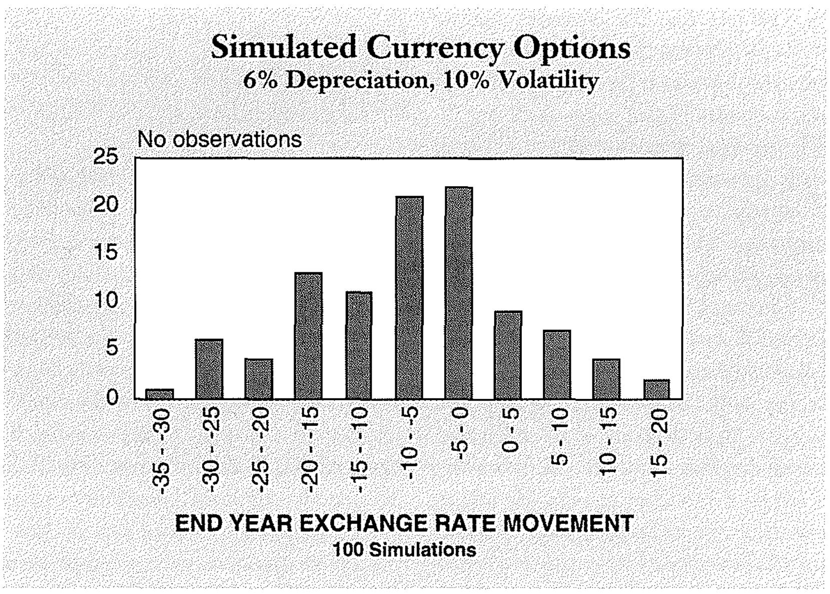

Table 2: Simulated currency returns

Base case

	Mean return (%pa)	Standard deviation (%pa)	Maximum return (%pa)	Minimum return (%pa)
Do nothing	7.05	10.39	33.05	-15.75
Option Strategy	7.00	8.36	31.51	-1.54

by the fact that the potential for significant positive returns is retained. This simulated result is broadly similar to the outcomes achieved under historical analysis.

We repeated the experiment under circumstances where the $A was in a consistent uptrend. That is, we assumed an uptrend of 4 per cent a year, matched by a similar interest differential of 4 per cent in favour of foreign currencies. The option premium costs were greater in this case (5.86 per cent) because of the negative interest differential. However, this cost was offset by an increased probability of exercise.

Overall, the average currency returns under the two approaches (unhedged and option hedging) were virtually identical (-3.13 and -3.40 respectively). Again, it was obvious that the option strategy was far more effective in reducing the risk of a significant loss.

It is clear that regardless of the overall trend in the Australian dollar, the effect of the option strategy will be to reduce risk with no significant impact on returns.

Is there a free lunch?

The fact that the currency option strategy reduces risk with no long-run adverse impact on returns (other than transactions costs) was unexpected. The result at first appears inconsistent with standard finance theory, which normally supposes lower returns in exchange for lower risk. Are we indeed getting a "free lunch"?

Currency differs from most other financial assets, such as equities or fixed interest. There is now a considerable body of academic opinion to suggest that *currency is an asset class which does not attract a risk premium*. That is, there is no reward for taking currency risk in the long run. It therefore follows that lower risk is preferable, as it can be achieved with no loss in return. In essence, a free lunch can be obtained by hedging currency risk and thereby reducing risk. (See Perold and Schulman, 1988, "The Free Lunch In Currency Hedging: Implications for Investment Policy and Performance Standards", *Financial Analysts Journal*, May-June.)

This is explained by the fact that currency is a means of exchange between investors in various currencies. Suppose that a risk premium existed for Australians holding currency risk associated with assets in US dollars. This would automatically mean that for US investors holding assets in Australia, there would be a "risk discount" or loss in returns. This condition cannot hold in the long run or no US investor would hold Australian assets. In the long run, neither US or Australian investors can receive a reward for taking currency risk.

It is therefore possible to reduce risk consistently by using a hedging strategy such as options with no long-run adverse impact on returns. This opportunity could be viewed as a "free lunch" although it does not imply any mispricing of options. Further, this opportunity is not likely to diminish in future.

How to measure risk?

Traditional portfolio theory has emphasised mean and standard deviation as the primary tools for analysing investment alternatives. The standard approach has equated risk with standard deviation of returns. However, standard deviation will penalise returns above the mean as much as those below the mean. Plainly, investors are far more concerned about avoiding the risk of an unfavourable return than a favourable return. Alternative risk measures are now being put forward to address this issue. These risk measures are defined thus:

Mean

$$u = E(r) = \int_{-\infty}^{\infty} r.f(r).dr$$

Standard deviation

$$\sigma = \sqrt{E\{(r-u)^2\}} = \sqrt{\int_{-\infty}^{\infty} (r-u)^2 f(r) dr}$$

Downside risk or negative semi-deviation

$$DR = \sqrt{\int_{-\infty}^{u} (r-u)^2.f(r).dr}$$

Upside risk or positive semi-deviation

$$UR = \sqrt{\int_{u}^{\infty} (r-u)^2.f(r).dr}$$

If critical assumptions are violated

Consider the case where volatility varies. If volatility is higher than anticipated, the probability of a significant payback on the option is also greater and the option now has greater value to the investor. Conversely, low volatility will reduce the value of the option to the investor.

If option markets quickly adapt to changed volatility conditions, then the results described earlier will continue to hold. Any change in volatility will be reflected in the cost of the option, and overall currency returns will be left unchanged. If option markets do not quickly adapt, then there may be short-term cases where the option strategy either enhances or detracts from currency returns.

The second possible violation relates to interest-rate parity. What if the $A deviates for long periods from the levels suggested by economic theory? For example, we could consider the case where the $A consistently depreciates further than interest-rate parity would suggest. In this case, the options will tend not to be exercised and the paybacks will not compensate for premium costs. Therefore, the option strategy will tend to have an adverse effect on returns as a trade-off to the benefit of lower risk.

Conversely, the $A could consistently remain stronger than interest-rate parity suggests (as it did from 1988 to 1990). In such circumstances, the option strategy would tend to be exercised unusually frequently, thus giving a payback which more than offsets premium costs. That is, currency returns would be enhanced under the option strategy.

The above analysis enables the following observations about long-run currency returns:

- Provided interest-rate parity applies over the long run, the effect of the option strategy appears to reduce risk with no significant impact on returns (apart from transaction costs). This effect will occur regardless of the overall trend in the $A. This opportunity could be described as a "free lunch" available for exploitation by offshore investors.
- The "free lunch" is available re-

Table 3: Simulated risk profiles

Strategy	Standard deviation % pa	Maximum return % pa	Minimum return % pa	Positive semi % pa	Negative semi % pa
a. Unhedged	9.7	27.1	-19.7	9.8	9.7
b. 1/3 forward cover	6.4	18.3	-12.6	6.5	6.4
c. Option (5% out-of-the-money)	7.9	25.6	-6.5	9.5	6.4

gardless of the level of volatility over the period. This conclusion relies on the fact that options can be purchased at a fair value which reflects the actual level of volatility. If this is not the case, there may be short periods where volatility mispricing can either enhance or detract from returns.

▪ Periods of several years may occur where interest-rate parity does not hold. For example, if the $A is stronger than interest-rate parity suggests, then the option strategy will enhance returns as well as reducing risk. This occurs because option pricing assumes that interest-rate parity applies.

▪ Conversely, if the $A is weaker than interest-rate parity suggests, then the option strategy will still reduce risk but with an expected long-run sacrifice in expected returns.

What about risk?

Portfolio theory tends to measure risk using standard deviation. However, this is a poor measure in cases where option strategies are used to reshape risk. Standard deviation does not take into account the fact that upside risk is far more valuable to clients than downside risk. Therefore techniques which separately measure the potential for upside and downside risk are preferable.

The potential for upside risk can be measured by "positive semi-deviation", which focuses solely on the occasions when returns are greater than the mean. It measures the variability

Continued page 24

Are currency options mispriced?

The so-called "free lunch" which is identified in the article raises obvious questions about the pricing of options. If a holder of offshore assets can consistently reduce risk with no adverse impact on returns by taking option hedge cover, does this imply that currency options are mispriced? Does it mean that the counterparties to these options are consistently losing money? The answer to both these questions is no.

Interest-rate parity tells us that the long-run currency return from holding foreign assets will simply be the interest differential between Australia and its trading partners (ie, $r_d - r_f$). That is, in the long run, the Australian dollar will depreciate to the extent that our interest rates exceed those overseas (or vice versa).

That is, expected currency return (unhedged) = $r_d - r_f$

We will call this asset 1.

We know, too, that the currency return from holding offshore assets hedged with forwards is also the interest differential between Australia and its trading partners. This is because forward hedging by definition locks in a forward premium or discount which reflects the interest differential.

That is, expected currency return (hedged) = $r_d - r_f$

We will call this asset 2.

A quick review of option theory will remind us that it is possible to replicate an option by holding a partial position in the underlying asset (ie, a delta hedge) and a risk-free security. In the case of foreign exchange, an $A put option could be created by taking a delta position in the forward market (which is effectively the risk-free strategy) and the underlying asset (ie, currency unhedged). This would simply be a combination of assets 1 and 2 above. As the expected currency return of each asset is $r_d - r_f$, then it follows that the expected return of any combination of the two assets must also be $r_d - r_f$.

Therefore the expected currency return of an $A put = $r_d - r_f$

This expression defines the fair value cost of replicating an $A put option. (Note that by option put-call parity it can be shown that an $A put option is equivalent to holdings of foreign currency offset by an $A call option.)

Would a superannuation fund be prepared to pay more than fair value for currency options? The answer to this question should probably be yes, since in a risk-averse world most investors are prepared to sacrifice some return for risk reduction. However, due to the pricing mechanism described above, there is no reason for an investor ever to pay more than fair value for an option (with the exception of transaction costs). Any unfulfilled demand for options can be met by granters of options who will hedge their risk through a delta position as described above. They will do so until the price of the option falls to its fair value.

Therefore it can be seen that the "free lunch" identified here does not imply any option mispricing, nor does it mean that option counterparties will consistently lose money.

A more theoretical explanation of this concept can be found in *Options Markets*, by Cox and Rubinstein, Prentice-Hall 1985, pp 188-9. The authors derive a relationship which relates the expected returns on an option to the expected excess returns on the underlying asset. In the case of currency, we know that as an asset class it does not earn a risk premium (ie, there is no expected excess return on the underlying asset).

In that case it is unlikely that an option on currency would earn a risk premium. ■