Optimal Active and Passive Currency Management

for

Life-cycle Funds

Contents

I. Introduction and Summary

Investing for retirement presents an asset allocation problem that changes with time. At each stage of working life, a typical investor has a tolerance for risk that is dependent, amongst other things, on how close retirement is. The best asset allocation for a young person is focussed on "growth" assets; those with high reward but higher risk. An investor nearing retirement will not have the same amount of time to weather volatility in their portfolio, and should therefore favour lower risk "defensive" assets (Table 1).

Table 1. Defensive and Growth Assets Return and Risk (1994 - 2014)

		Annualised Return	Annualised Risk
Defensive Assets	Domestic Bonds	6.7%	3.6%
	International Bonds (Hedged)	7.7%	3.0%
	Cash	5.3%	0.4%
Growth Assets	Domestic Equities	9.6%	12.9%
	International Equities (Hedged)	8.0%	14.5%
	Domestic Small-cap Equity	8.3%	14.8%
	Global Property*	23.7%	16.6%
	Global Infrastructure**	4.0%	15.8%

** return from 2009 - 2014*

*** return from 2007 -2014*

Optimal currency management through time follows a similar principle. Risk due to unintentional currency exposure through foreign asset allocation is bigger in a young person's portfolio than that of an older person's portfolio, but can be tolerated because there is more time to weather the fluctuations. However, this risk should be reduced in an older person's portfolio through currency hedging. Also, active risk can be added to a young person's portfolio in order to benefit from the attractive returns available through active currency management, but should be scaled back as the investor gets closer to retirement.

According to the FirstChoice Lifestage investment product offered by Colonial First State, a young person should be about 90% invested in growth assets, and only ten percent invested in defensive assets, while someone nearing retirement should be 60% invested in defensive assets and only 40% invested in growth assets (Table 2). The change from one strategic asset

allocation to the other impacts the optimal currency strategy. Decreasing foreign asset allocation means that there is less currency risk in the portfolio as retirement nears, making currency hedging less relevant. Furthermore, the correlations of growth assets with foreign currency, and with currency alpha, are quite different to those of defensive assets which affect the diversification benefits of having them in the portfolio.

The most important factor in determining the optimal currency strategy is the time remaining until retirement. Increased risk aversion in the later stages of investment makes accidental currency risk less tolerable and active currency risk less attractive, while the greater risk appetite which is appropriate for the early stages of investment means foreign currency risk is more tolerable and active currency risk introduced to the portfolio is more desirable.

Finding the right currency management strategy is a question of balancing all of these factors against each other at each point in time.

II. Methodology

In order find the optimal currency strategy through time, we calculate the ideal solution for a mean-variance optimal investor whose risk aversion increases with proximity to retirement. The two tools available to our investor for currency management are currency hedging for portfolio risk reduction, and active currency management around that hedge for return generation (Appendix 4). Everything else is considered exogenous.

The decision of how best to employ these tools must be made within the context of the portfolio as a whole. We assume that our hypothetical investor changes his asset allocation according to the FirstChoice Lifestage strategy (Table 2).

Table 2. Asset Allocation

		Age:	Under 50	50-54	55-59	60 and over
Defensive Assets	Domestic bonds		5%	8%	16%	19%
	International Bonds		3%	5%	10%	11%
	Cash		2%	4%	15%	30%
Growth Assets	Domestic equities		32%	30%	20%	14%
	International Equities		36%	34%	24%	16%
	Global Property		9%	8%	5%	4%
	Small-cap Equity		4%	4%	4%	3%
	Global Infrastructure		9%	8%	5%	4%
	Defensive Asset Allocation		10%	16%	41%	60%
	Growth Asset Allocation		90%	84%	59%	40%
	International Allocation		57%	55%	45%	35%

The asset correlation inputs to the calculation are empirically derived (Table 3).

Table 3. Correlation of Monthly Returns 1994 - Q1 2014

	Domestic Bonds	Domestic Equities	International Bonds (Hedged)	International Equities Hedged	Global Property	Domestic Small-cap Equity	Global Infrastructure	Cash
Domestic Bonds	1.00							
Domestic Equities	-0.01	1.00						
International Bonds (Hedged)	0.67	0.06	1.00					
International Equities Hedged	-0.14	0.79	-0.04	1.00				
Global Property*	-0.40	0.77	0.12	0.86	1.00			
Domestic Small-cap Equity	0.00	0.87	0.11	0.69	0.77	1.00		
Global Infrastructure*	-0.34	0.65	0.05	0.76	0.75	0.59	1.00	
Cash	0.32	-0.11	0.17	-0.15	-0.14	-0.09	-0.19	1.00

Proxy Definitions in Appendix 1

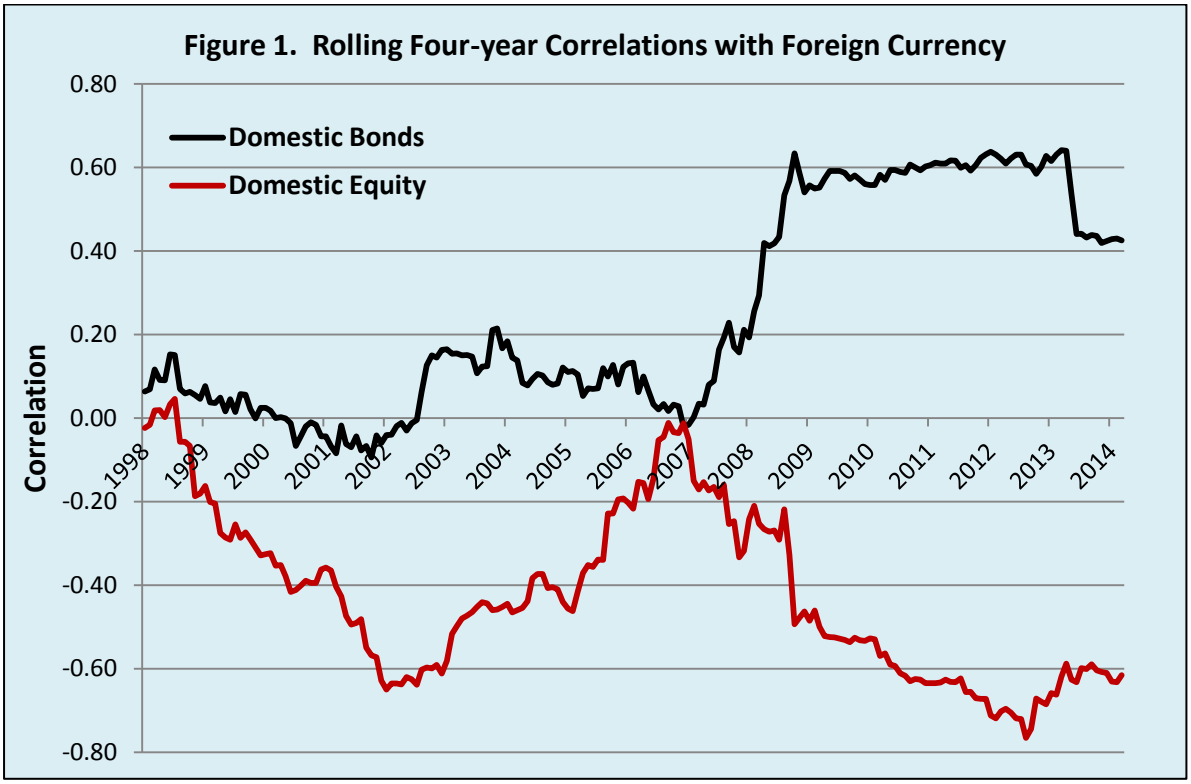
* correlations from 2009 - Q1 2014

The correlation between the assets and the foreign currency exposure from the international investments is of particular interest when deciding what the best currency hedging policy is, as it is a determinant of how much volatility is contributed to the portfolio by currency; this is addressed in the next section.

III. Risk Reduction Through Currency Hedging

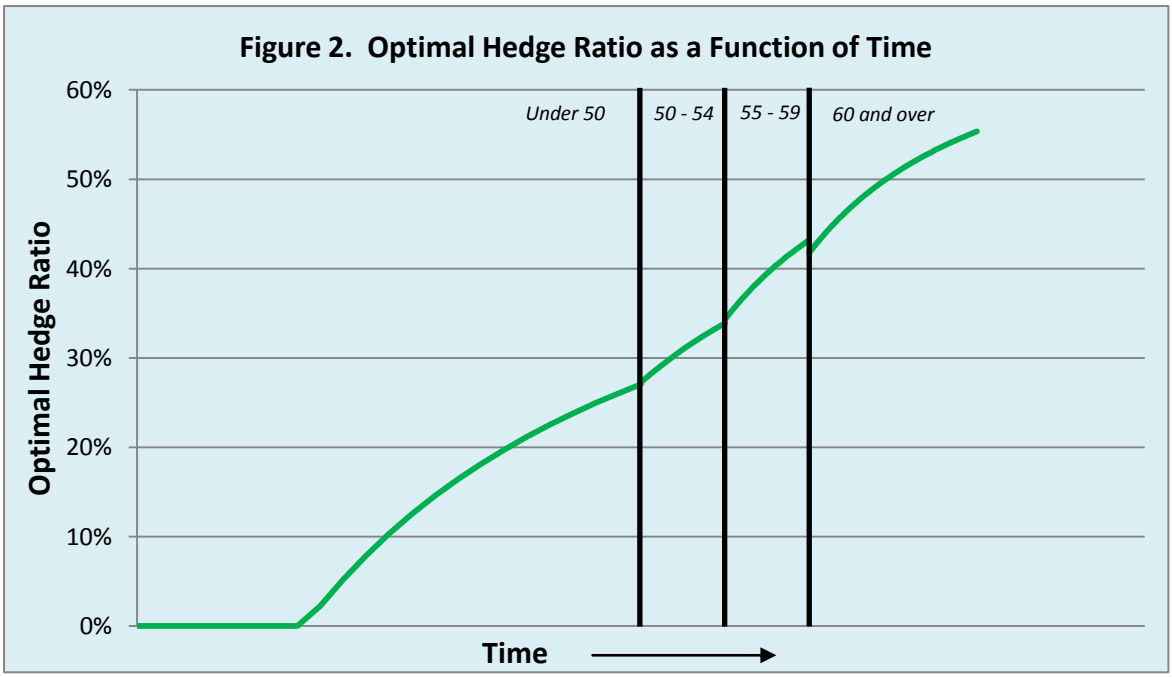
A basket of the currencies of each country in the MSCI All Country World index weighted by their equity market capitalisation had a volatility of 10.5% annualised over the period 1994 – 2014. This is a significant risk; more than double that of a diversified bond portfolio. Unlike a bond portfolio, there is no systematic return to foreign currency, (the basket described above returned -1.7% annualised over the last 20 years.)

These observations might lead to the conclusion that currency should be hedged at all times within an international portfolio, however, the correlation structure of foreign currency (from an Australian perspective) with respect to asset markets indicates otherwise (Fig.1).



The correlation between foreign currency and equity markets has been significantly negative over the past 20 years, (-0.44 with domestic equity,) and therefore exposure to currency would have actually slightly reduced volatility in international equity portfolios over this period. Currency has been significantly positively correlated with bond markets over the same period, (+0.20 with domestic bonds.) These correlations suggest that a young investor with lots of equity in his portfolio has an added incentive to leave foreign currency exposures unhedged, while an older investor with more bond exposure would find the exposures less diversifying.

These correlations have soared (in absolute terms) due to the global financial crisis, but the high levels seen over this period may not be sustained over the long term. Our analysis assumes correlations with reduced absolute values to reflect this uncertainty (Appendix 2). We also assume that there is no expected return to foreign currency in the future.



The optimal hedge ratio for each of the tactical asset allocations in Table 2 are shown below (Table 4).

Table 4. Optimal Hedge Ratio

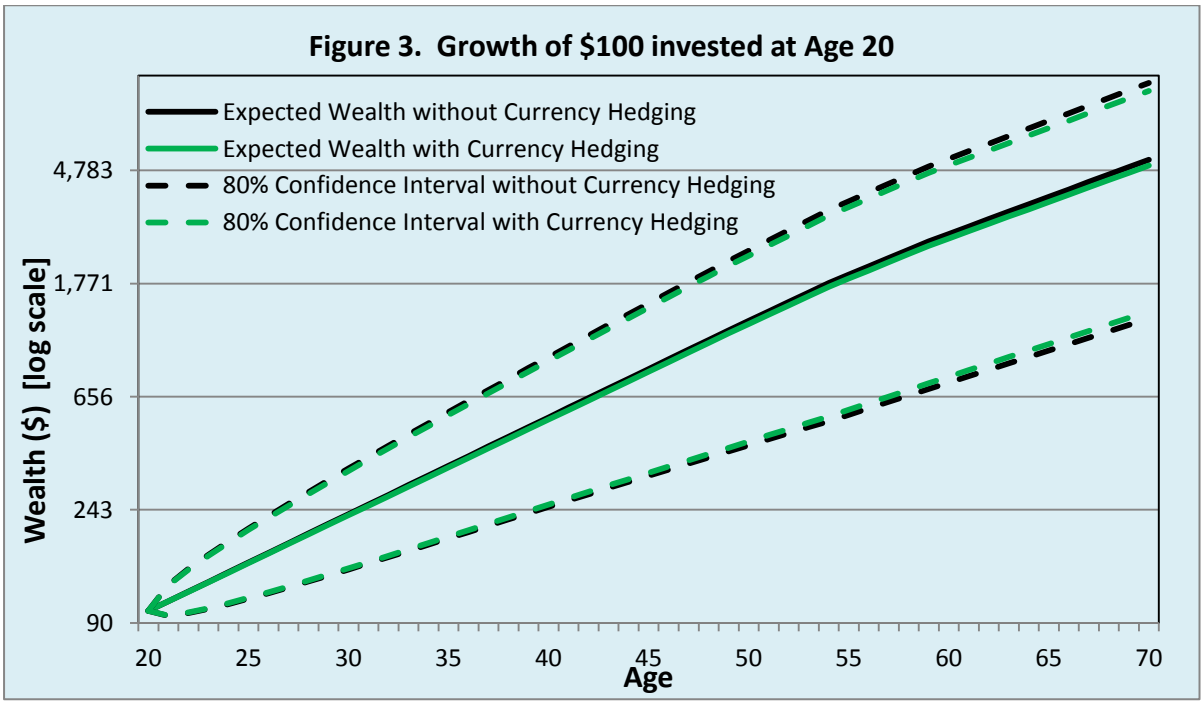
Age:	Under 50	50-54	55-59	60 and over
Defensive Asset Allocation	10%	16%	41%	60%
Growth Asset Allocation	90%	84%	59%	40%
International Allocation	57%	55%	45%	35%
Optimal Hedge Ratio	**26%**	**29%**	**39%**	**46%**

The portfolio of an investor nearing retirement has lower international allocation than a younger investor, and so will have less currency risk in the portfolio; hedging is not as effective at reducing the overall risk of the portfolio and so is less worthwhile. However, an older person's portfolio has less equity exposure and more bond exposure (Table 2), which means that foreign currency is more correlated with the portfolio, and therefore less diversifying, indicating that more hedging is appropriate from this perspective.

The dominant factor in the analysis illustrated above is the time remaining until retirement. When retirement is a long way off currency has time to "wash out" and the investor should save the hedging costs. As an investor gets nearer to retirement, and a more risk averse approach is appropriate, risk should be reduced in the portfolio by hedging currency.

The benefit of hedging foreign currency in the later stages of investment is increased confidence of realising the expected return by retirement.

Figure 3. Growth of $100 invested at Age 20



The chart above (Fig 3) shows the expected growth of $100 invested using the FirstChoice Lifestage strategy for asset allocation, with and without currency hedging. The currency hedging strategy follows that outlined in section III (Table 3), with the hedge ratio starting at 26% and moving up to 46%. Due to the (small) transaction costs incurred by a hedging program, the expected return to a hedged portfolio is slightly lower than that of an unhedged portfolio, but the 80% confidence interval is narrower. The effectiveness of currency hedging as a risk reduction tool is limited by decreasing international exposure near the investment horizon as well as the negative correlation of the currency exposures with global equity markets.

The results of the optimal hedge calculations are dependent on the return and correlation assumptions that are input (Appendix 2). Were we to assume that the correlation relationship between the Australian dollar and growth asset markets will break down then the optimal hedge ratio for each stage of investment would be higher than that shown in Figure 2. Similarly, if we assume that the Australian dollar is overvalued then we could use a positive foreign currency return expectation which would result in a lower optimal hedge ratio. The results are also affected by transaction cost assumptions; higher currency transaction costs mean that hedging is less worthwhile after accounting for them.

The analysis here assumes that all currencies are to be hedged by the same fraction. In fact, a more optimal hedging strategy might recognise that certain groups of currencies, emerging market currencies for example, have different return expectations and correlation structures from other groups, such as developed market currencies. An investor may decide to have different hedge ratios for different groups, or even have a different hedge ratio for each currency. Such an approach is especially useful if an investor's currency return expectation is dependent on interest rate differentials, for example, although such a belief would be better served by the application of active currency management which is the subject of the next analysis.

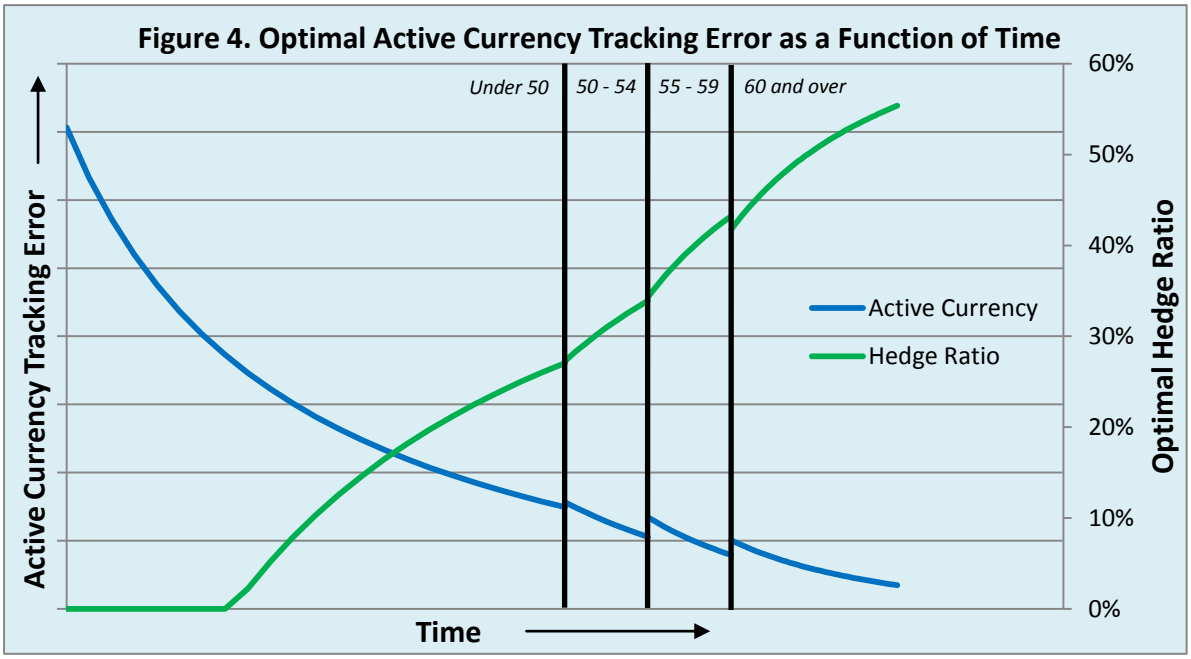
IV. Return Enhancement Through Active Currency Management

Separate to the decision to reduce risk through currency hedging, active currency management can be employed to add return to the portfolio while adding active risk. Currency markets are driven by cross-border differentials in price, expected return to assets

and the relative quality of traded goods. These drivers are very different from those of the other asset classes in a typical investor's portfolio. Currency markets are inefficient; theoretical conditions for efficiency do not exist and there are many academic studies demonstrating specific persistent inefficiencies in the markets (Appendix 3), so currency alpha is to be expected.

Many active currency managers have demonstrated sustainable excess returns from currency markets, and a diverse mix of such managers makes for an attractive alternative asset class which is complimentary to a typical portfolio of traditional assets. Exposure to currency alpha is possible without allocation of capital because currency investment is a zero-investment activity, and this property means that the contribution of risk to the portfolio can be precisely controlled without affecting the rest of the asset allocation.

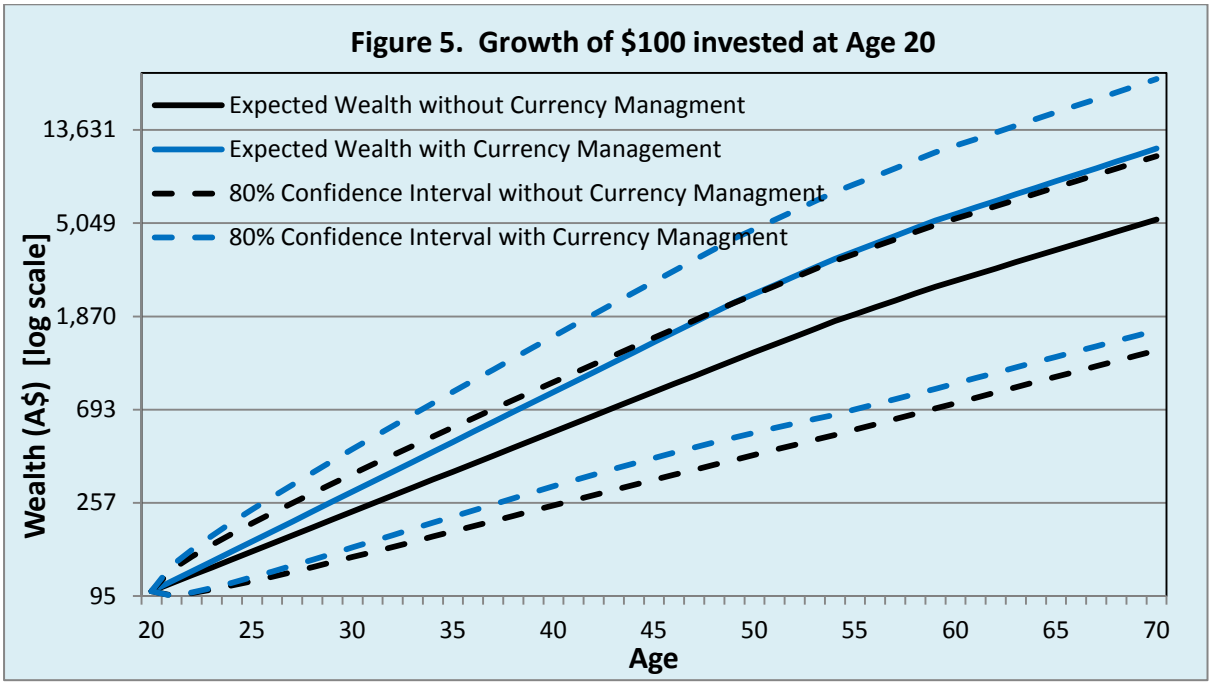
Currency alpha, especially alpha deriving from the risk premium associated with interest rate differentials, is often positively correlated with global equity markets (≈ 0.4) and uncorrelated with bond markets. This makes it more complementary to an older person's portfolio, (which contains more bonds,) than a young person's portfolio. However, a young person has more time to weather the extra volatility introduced by active currency than someone close to retirement.



Our analysis shows that currency alpha is more desirable at the beginning of the investment period when retirement is a long way off, and that this risk should be reduced steadily as retirement approaches (Figure 4). We see that changes in strategic asset allocation that

increase bond holdings also increase the amount of active currency risk that is optimal at a given point in time.

Adding active currency to the portfolio increases the expected return and leads to a better risk/return profile due to the added diversification.



The currency program above (Fig 5.) uses the hedging strategy outlined in section III (Table 2). It also includes an active currency program with 6% tracking error up until the age of 50, a 3% tracking error up to 55, a 2.5% tracking error until 60 and 1.5% tracking error from then on. A small amount of active currency is desirable in the latter stages of investment because currency alpha is uncorrelated with the defensive assets which make up 60% of the portfolio at this stage. The active currency program has an assumed information ratio of 0.4.

Such a strategy would significantly increase the expected return of the portfolio in the early stages when extra return impacts expected final wealth most, and combined with the risk reduction effects of hedging lifts the lower limit of the 80% confidence interval above that of an investment strategy that does not manage currency.

V. Conclusion

An investor in the early stages of saving for retirement should engage a group of currency managers with high information ratios and diverse strategies to add alpha to the portfolio. The tracking error of the program should initially be high. Foreign currency hedging is not worthwhile at this stage, as there is time for currency effects to wash out.

In his forties and fifties, an investor should decrease active currency exposure to a mid-level tracking error, and begin hedging foreign currency between 30-40% to decrease the risk of the portfolio and increase the certainty of realising the portfolio's expected return at retirement. When retirement is approaching, currency hedging should be increased to 45-55%, and currency alpha should be dialled down to a minimum tracking error or stopped altogether.

The optimal currency hedging strategy is dependent on the investor's risk, return and correlation expectations, as well as any expectation of the long-term return to foreign currency. Whatever these long-term currency views are, some currency hedging is appropriate as a risk control in the latter stages of saving for retirement to increase the confidence of attaining the expected return at retirement.

Separate to the hedging decision, currency alpha can both significantly increase the expected final wealth of the portfolio and raise the confidence interval for the possible return over the long term, reducing the risk of underperforming the investment target at retirement. No capital is needed to gain access to these returns, so the added portfolio risk can be controlled precisely without affecting the asset allocation.

By using currency hedging to strategically control risk, and active currency management to add returns to an internationally invested portfolio at the optimal time, the expected portfolio return can be significantly increased over the long term while the uncertainty of those returns can be reduced, providing a better outcome for investors.

Appendix

Appendix 1. Empirical Asset Correlations

Table 5. Correlation of Monthly Returns 1994 - Q1 2014

	Domestic Bonds	Domestic Equities	International Bonds (Hedged)	International Equities Hedged	Global Property	Domestic Small-cap Equity	Global Infrastructure	Cash	Foreign Currency
Domestic Bonds	1.00								
Domestic Equities	-0.01	1.00							
International Bonds (Hedged)	0.67	0.06	1.00						
International Equities (Hedged)	-0.14	0.79	-0.04	1.00					
Global Property*	-0.40	0.77	0.12	0.86	1.00				
Domestic Small-cap Equity	0.00	0.87	0.11	0.69	0.77	1.00			
Global Infrastructure*	-0.34	0.65	0.05	0.76	0.75	0.59	1.00		
Cash	0.32	-0.11	0.17	-0.15	-0.14	-0.09	-0.19	1.00	
Foreign Currency	0.20	-0.44	-0.08	-0.55	-0.73	-0.47	-0.60	0.14	1.00

* correlations from 2009 - Q1 2014

Asset Market Proxies

Domestic Bonds: *UBS Australia Composite All Maturities*
Domestic Equities: *S&P / ASX 200*
International Bonds: *Barclays Global Aggregate (Hedged A$)*
International Equities: *MSCI All Countries World Ex Australia (Hedged A$)*
Global Property: *FTSE EPRA/NAREIT Developed*
Domestic Small-cap Equity: *S&P ASX Mid/Small Cap*
Global Infrastructure: *SPDR S&P Global Infrastructure Index*
Cash: *UBS Australian Bank Bill All Maturities*

Appendix 2. Optimisation Calculation Inputs

The risk and return expectations used in the mean-variance optimal calculation are:

Table 6. Risk/Return Inputs

	Return (%)	Risk (%)
Domestic Bonds	5.0	4.0
Domestic Equities	9.0	14.0
International Bonds (Hedged)	6.0	4.0
International Equities Hedged	9.0	15.0
Global Property (Hedged)	7.5	12.0
Domestic Small-cap Equity	10.0	16.0
Global Infrastructure (Hedged)	9.0	15.0
Cash	4.5	1.0
Active Currency	0.4	1.0
Foreign Currency	0.6	11.0

Note that our analysis requires arithmetic returns. The foreign currency expected return corresponds to 0% geometric return, (the arithmetic return is therefore half the variance of currency.)

Table 7. Correlation Inputs

	Domestic Bonds	Domestic Equities	International Bonds (Hedged)	International Equities Hedged	Global Property (Hedged)	Domestic Small-cap Equity	Global Infrastructure (Hedged)	Cash	Active Currency	Foreign Currency
Domestic Bonds	1.00									
Domestic Equities	-0.01	1.00								
International Bonds (Hedged)	0.67	0.06	1.00							
International Equities Hedged	-0.14	0.79	-0.04	1.00						
Global Property (Hedged)	-0.40	0.77	0.12	0.86	1.00					
Domestic Small-cap Equity	0.00	0.87	0.11	0.69	0.77	1.00				
Global Infrastructure (Hedged)	-0.34	0.65	0.05	0.76	0.75	0.59	1.00			
Cash	0.32	-0.11	0.17	-0.15	-0.14	-0.09	-0.19	1.00		
Active Currency	0.00	0.40	0.00	0.40	0.40	0.40	0.40	0.00	1.00	
Foreign Currency	0.10	-0.20	0.00	-0.20	-0.20	-0.20	-0.20	0.00	0.00	1.00

The transaction cost associated with currency hedging is set at 10bps.

Appendix 3. Academic Evidence for Inefficiency of Currency Markets

What follows is a list of articles selected from the vast literature on various types of currency market inefficiency.

Macroeconomic Modelling of Exchange Rates:
1: "Empirical Exchange Rate Models of the Seventies – Do they fit Out of Sample?", Rogoff et al, Journal of International Economics, 1983.
2: "Empirical Exchange Rate Models of the Nineties – Are any Fit to Survive?", IMF, 2004.
3: "The PPP Debate", Taylor et al, The Journal of Economic Perspectives, 2004.

Forward Rate Bias:
4: "Trading the Forward Rate Puzzle", Momtchil Pojarliev, The Journal of Alternative Investments, 2009.
5: "Carry Trade: The Gains of Diversification", Burnside et al, European Economic Association, 2008.
6: "The Returns to Currency Speculation in Emerging Markets", Eichenbaum et al, NBER Working Paper 12916, 2007.
7: "Do Peso Problems Explain the Return to the Carry Trade?", Burnside et al, NBER Working Paper 14054, 2008.

Trends:
8: "The Significance of Technical Trading-Rule Profits in the Foreign Exchange Market: A Bootstrap Approach", Thomas et al, NBER Working Paper W3818, 1994.
9: "Do Momentum Based Strategies Still Work in Foreign Currency Markets?", Okunev et al, Journal of Financial and Quantitative Analysis, 2001.
10: "Do Momentum Based Strategies Still Work in Emerging Currency Markets?", Chong et al, Pacific Basin Finance Journal, 2007.
11: "Do Foreign Exchange Markets Still Trend?", Levich et al, The Journal of Portfolio Management, 2007.

Value/Mean Reversion:
12: "The Carry Trade and the Fundamentals: Nothing to Fear but FEER Itself", Jorda et al, NBER Working Paper 15518, 2009.
Also see number 3.

Appendix 4. Optimisation Mathematics

As described in section II, we are interested in finding out the optimal currency strategy for a mean-variance optimal investor whose risk aversion increases with time. In general, the expected return of as internationally diversified portfolio is as follows:

$$E[r_{PF}] = \boldsymbol{w}'\boldsymbol{\mu} + (1 - hr)w_{int}r_c - w_{int}.tc.hr$$

Where,

$$\boldsymbol{w} = vector\ of\ asset\ weights$$
$$\boldsymbol{\mu} = vector\ of\ expected\ asset\ returns$$
$$hr = hedge\ ratio$$
$$w_{int} = total\ weight\ of\ foreign\ assets$$
$$r_c = expected\ return\ to\ foreign\ currency$$
$$tc = transaction\ cost\ of\ hedging$$

With some arithmetic, this can be rearranged as:

$$E[r_{PF}] = \boldsymbol{w}'(\boldsymbol{\mu} - \boldsymbol{i_{int}}tc) + h(r_c + tc)$$

Where,

$$\boldsymbol{i_{int}} = \begin{cases} 1, foreign\ asset \\ 0, \quad otherwise \end{cases}$$
$$h = (1 - hr)w_{int}$$

This arrangement separates the hedged asset returns from the currency return, with the variable *h* as the remaining foreign currency exposure after hedging. Adding a set of active currency programs with weights $\boldsymbol{w_c}$ with expected returns $\boldsymbol{\mu_c}$ the expected return becomes:

$$E[r_{PF}] = \boldsymbol{w}'(\boldsymbol{\mu} - \boldsymbol{i_{int}}tc) + \boldsymbol{w_c'\mu_c} + h(r_c + tc)$$

The variance of the portfolio is:

$$Var(r_{PF}) = \boldsymbol{w}'\boldsymbol{\Sigma}\boldsymbol{w} + 2\boldsymbol{w}'\boldsymbol{\Sigma_{ac}}\boldsymbol{w_c} + \boldsymbol{w_c'}\boldsymbol{\Sigma_c}\boldsymbol{w_c} + 2h\boldsymbol{w}'\boldsymbol{\Omega_a} + 2h\boldsymbol{w_c'}\boldsymbol{\Omega_c} + h^2{\sigma_c}^2$$

Where,

$$\boldsymbol{\Sigma_{ac}} = Cov(\boldsymbol{\mu_a}, \boldsymbol{\mu_c})$$
$$\boldsymbol{\Sigma_c} = Cov(\boldsymbol{\mu_c}, \boldsymbol{\mu_c})$$

$$\boldsymbol{\Omega_a} = Cov(\boldsymbol{\mu_a}, r_c)$$
$$\boldsymbol{\Omega_c} = Cov(\boldsymbol{\mu_c}, r_c)$$
$$\sigma_c = \sqrt{Var(r_c)}$$

The utility function for a mean-variance optimal investor is:

$$f(\boldsymbol{w_c}, h) = E[r_{PF}] - \frac{A}{2} Var(r_{PF})$$

Where *A* is the risk-aversion parameter, and is a function of the time remaining until retirement. For a given parameter *A* we can maximise *f* with respect to the active currency program weights and desired foreign currency exposure. The optimisation is subject to the constraints:

$$w_c^i \geq 0 \; for \; all \; i$$
$$0 \leq h \leq w_{int}$$

To estimate the functional form of *A* with respect to time, we assume that the asset-mix defined by the Fistchoice Lifestage asset allocation strategy (Table 2) is mean-variance optimal, and use perturbative analysis around each portfolio to get a distribution for *A* in the region of time for which each portfolio is defined. We then took the expectation value of these distributions as defined points on *A* and linearly interpolated between them, as shown below (Fig. 6):