

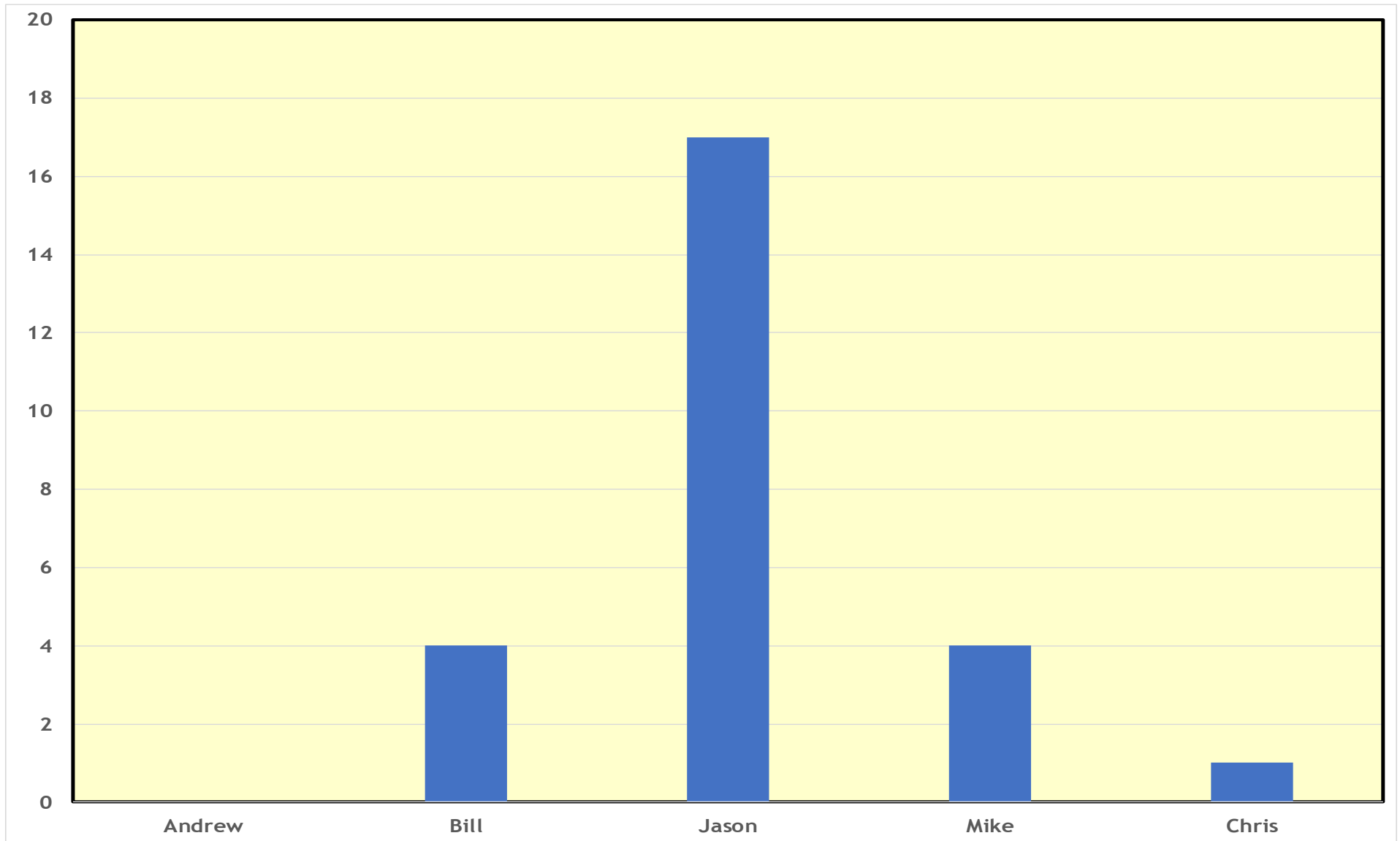
Currency Hedging

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Northfield Conference Stowe

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Quantitative Ice Fishing Analysis



Currency Risk for Portfolios - 1

- The performance of any portfolio holding foreign stocks will be affected by exchange rate movements, otherwise known as Currency Risk
- Foreign exchange rates can be very volatile, and there is often a great deal of unpredictable political risk involved in currency movements
- Currency returns are notoriously hard to predict
- Investment activity (or gambling!?) in currency markets tends to be done mainly by hedge funds and proprietary traders with short investment horizons

Currency Risk for Portfolios - 2

- Most institutional active managers are much better at picking stocks than they are at forecasting foreign currency movements
- Currency Risk is therefore usually an unintended bet
- In order to maximise the impact of their skill on the portfolio's performance, efficient portfolio managers should minimise unintended bets as far as possible
- Sometimes this is hard to do, but for unintended currency bets, this can be done by simply hedging back to the investor's base currency

A Simple Example

	Stock price in GBP		Exchange Rate GBP per USD		Stock price in USD		Exchange Rate USD per GBP
Time T	£100.00		£0.74		\$135.00		\$1.350
Time T+1	£110.00		£0.80		\$137.50		\$1.250
Pct Return	10.00%	+	-7.41%	=	1.85%		8.00%
Ln Return	9.53%	+	-7.70%	=	1.83%		7.70%
	Return on stock in GBP local currency		Return on GBP in USD base currency		Return on stock in USD base currency		Return on USD in GBP currency

Currency Risk for Individual Stocks - 1

- There are two ways to think about currency effects
- The most obvious way is to treat the return to a foreign stock as consisting of the local return to the stock plus the exchange rate gain or loss :-

$$\begin{array}{l} \text{Return on} \\ \text{stock in USD} \end{array} = \begin{array}{l} \text{Return on stock} \\ \text{in foreign currency} \end{array} + \begin{array}{l} \text{Return on foreign} \\ \text{currency in USD} \end{array}$$

- This has the merit of simplicity and clarity
- Note, however, that this simple formulation says nothing about the correlation between the currency return and the stock return in local currency

Currency Risk for Individual Stocks - 2

- If we want to minimise Currency Risk, the important question becomes “How much should we hedge?”
- If the foreign currency returns and the stock returns in local currency were uncorrelated, simply hedging the currency of denomination would obviously eliminate all the Currency Risk
- Some managers like to think of foreign stocks ‘in base currency terms’, and assume that currency effects will wash out in a well-diversified portfolio
- However, this may be a rather heroic assumption

Currency Risk for Individual Stocks - 3

- If we think in terms of a multi-factor model of return (*and therefore risk, since risk = variance(return)*), the currency factors will be the exchange rate gains or losses of the home currencies to the base currency
- All foreign stocks will have a beta of 1.00 to their home currency factor in the formulation above
- However, this is only the end of the matter if the stock's local return is orthogonal to the home currency returns, and this may not necessarily be the case, as some examples will illustrate

Currency Risk for Individual Stocks - 4

- Consider the case of Toyota Motor Company
- On the one hand, this is a Japanese multinational car company whose stock is traded in Tokyo, and whose accounts, earnings and stock price are quoted in Yen
- On the other hand, most of their earnings come from sales outside Japan, so when the Yen appreciates against other currencies, the value of their earnings in Yen falls, and their stock price is also likely to fall
- The stock's local return may well be *inversely correlated* with the strength of their home currency

Currency Risk for Individual Stocks - 5

- As this example illustrates, the local currency return may itself be affected by exchange rate movements
- So hedging by currency of denomination will reduce the exchange rate gain or loss due to foreign stocks being *priced* in foreign currencies, but may not efficiently hedge *all the currency risk* they have
- In fact, as the Toyota example suggests, we may end up going from a position of having unintended bets *on* some foreign currencies (only justified if they go up) to having bets *against* them, if we over-hedge

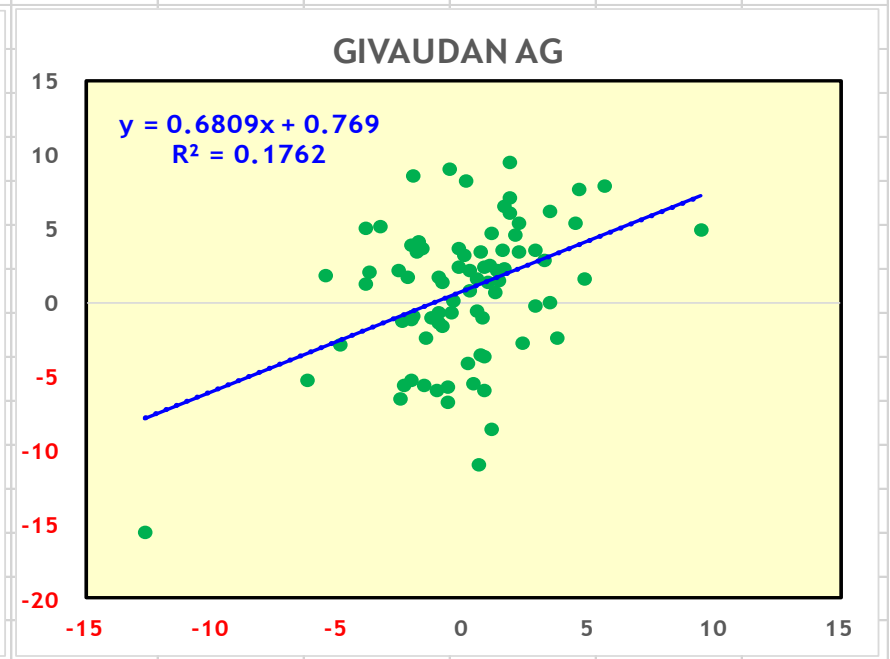
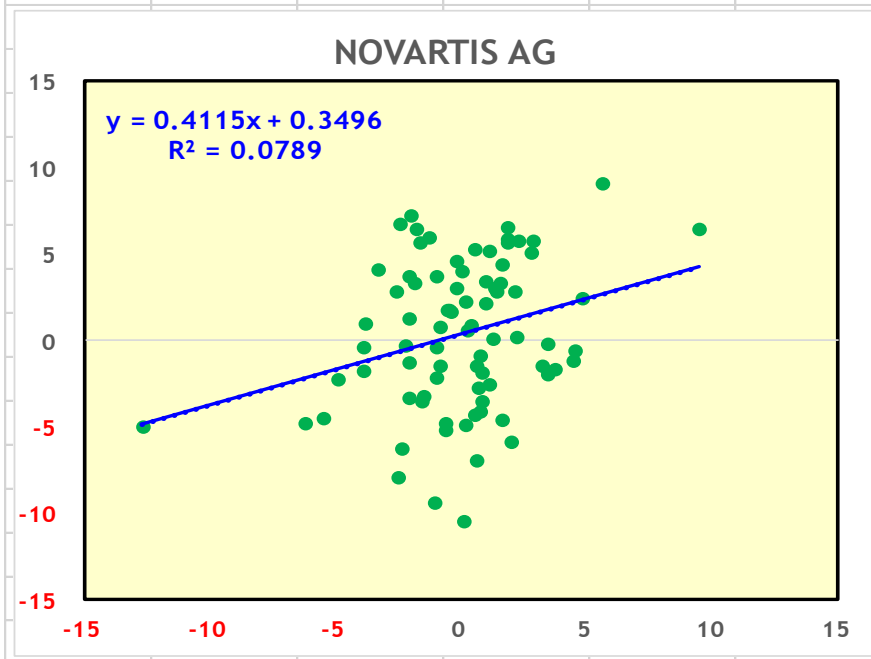
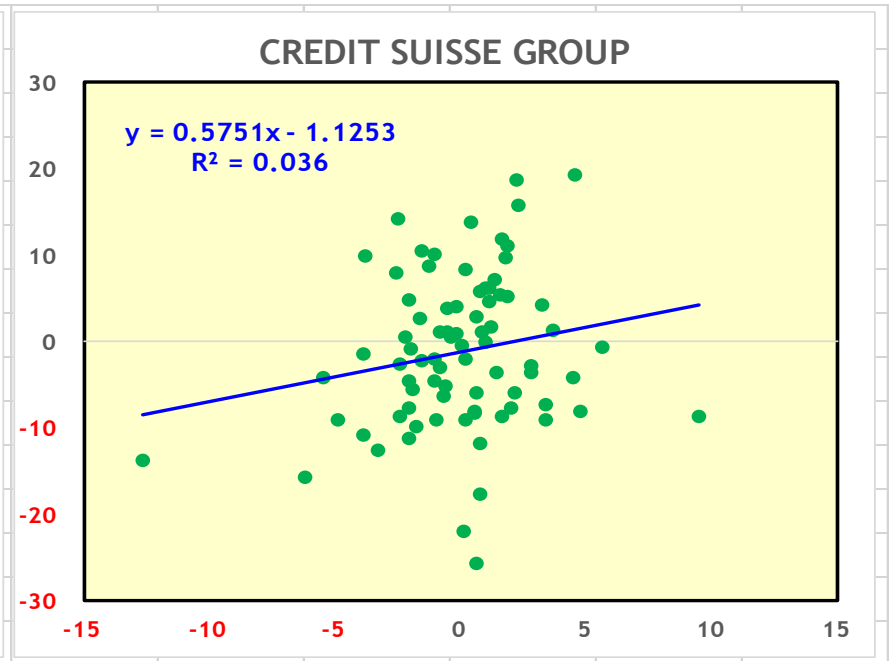
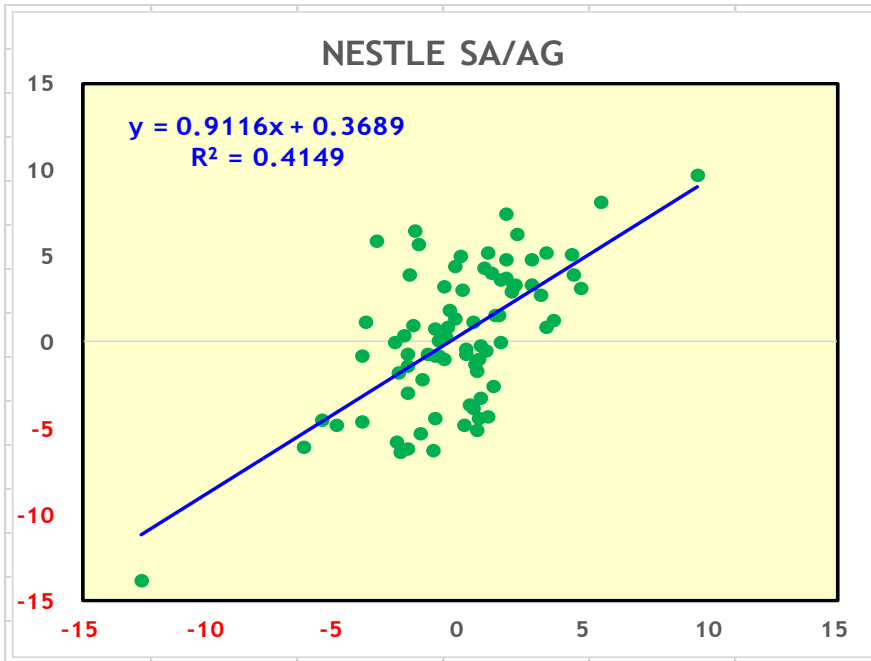
Currency Risk for Individual Stocks - 6

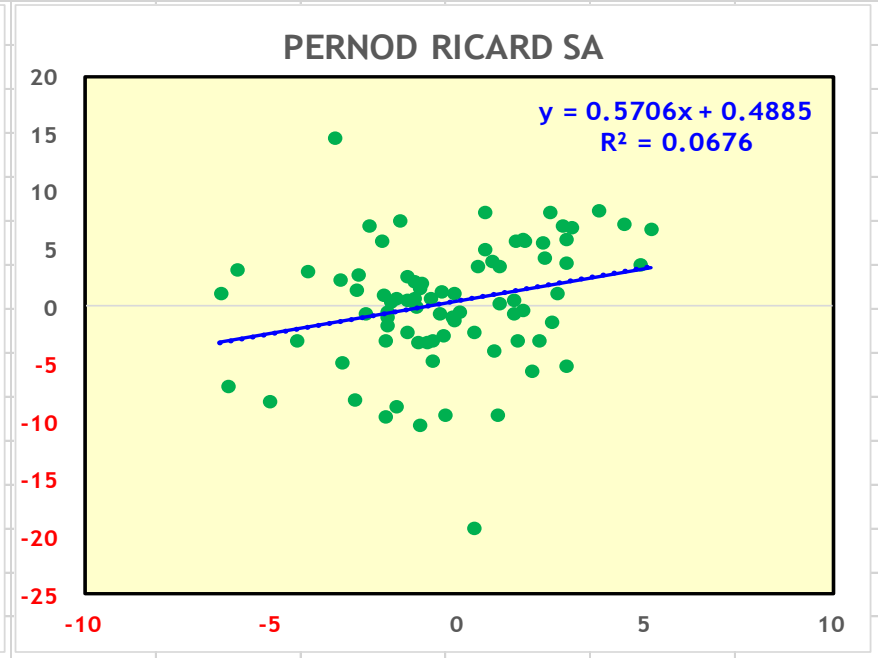
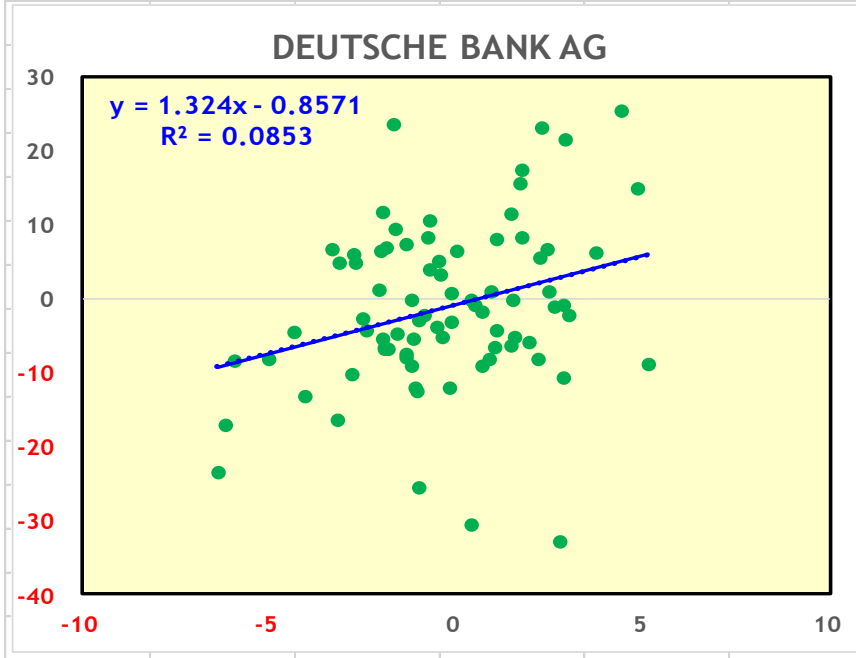
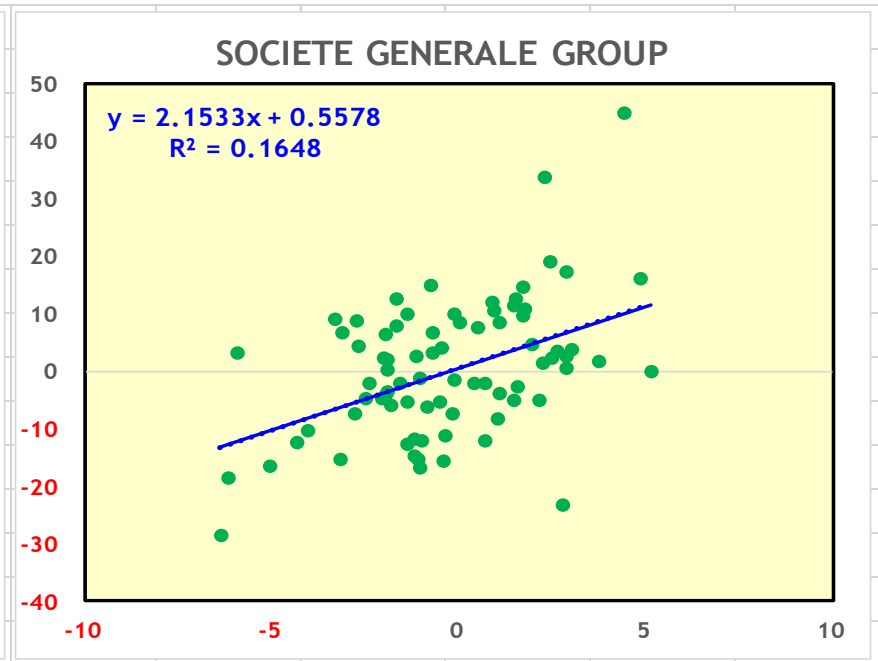
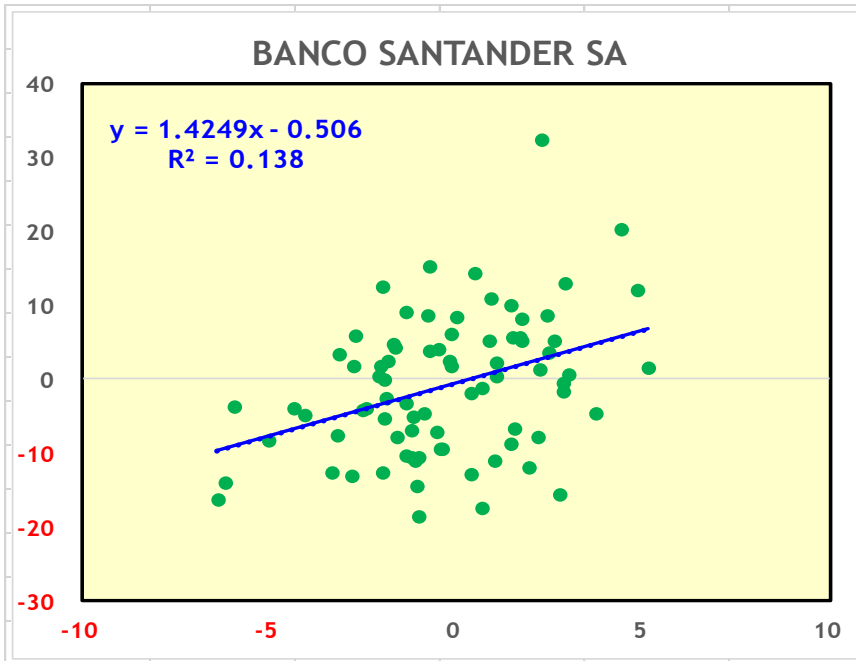
- To minimise the effect of Currency Risk on the performance of the portfolio, we need to hedge the currency exposure
- To estimate that exposure, we can use the following model of the return to a foreign stock in base currency terms:-

$$RB(i,t+1) = \text{Beta}(i,t) * R(\text{FX},t+1) + RL(i,t+1)$$

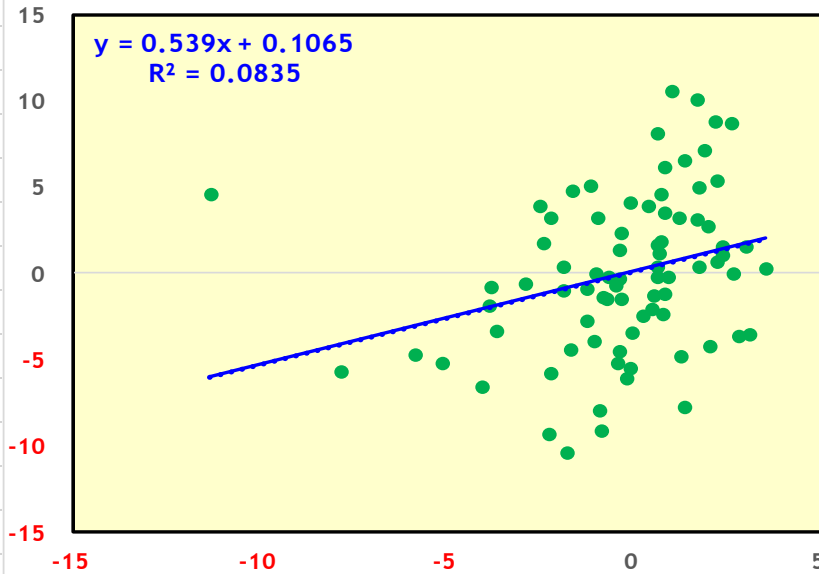
- where
- $RB(i,t+1)$ = the return on the stock in base currency
 - $\text{Beta}(i,t)$ = the (overall) beta of the stock to its home currency
 - $R(\text{FX},t+1)$ = the return on the home currency in base currency
 - and $RL(i,t+1)$ = the home-currency-invariant return on the stock

- The following charts give some Swiss Franc, European Euro, British Pound and Japanese Yen examples

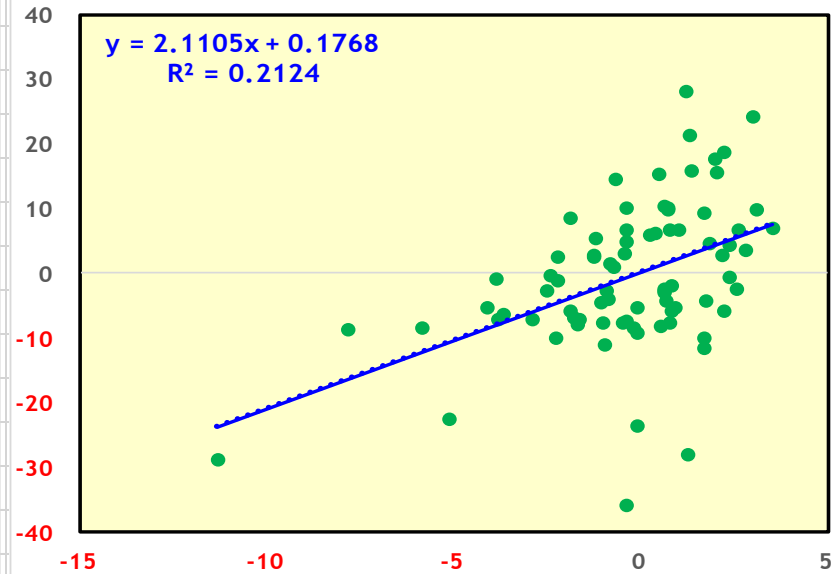




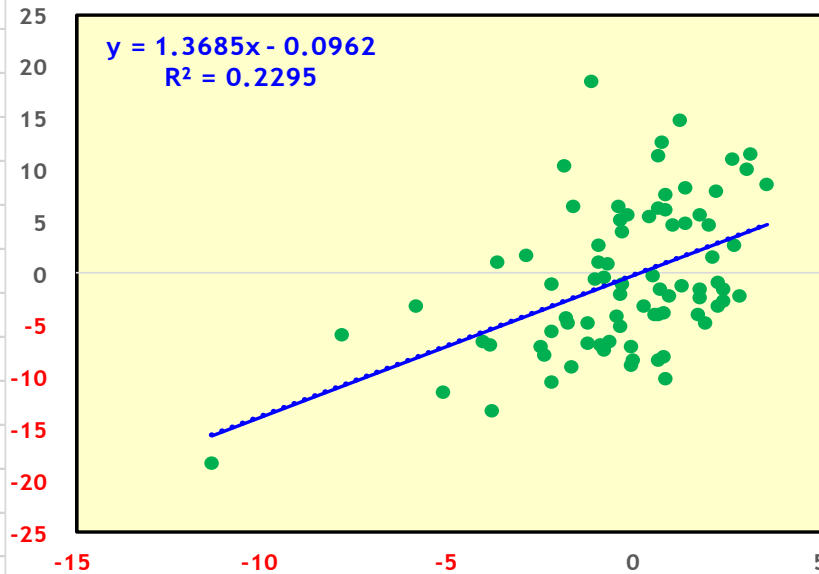
GLAXOSMITHKLINE PLC



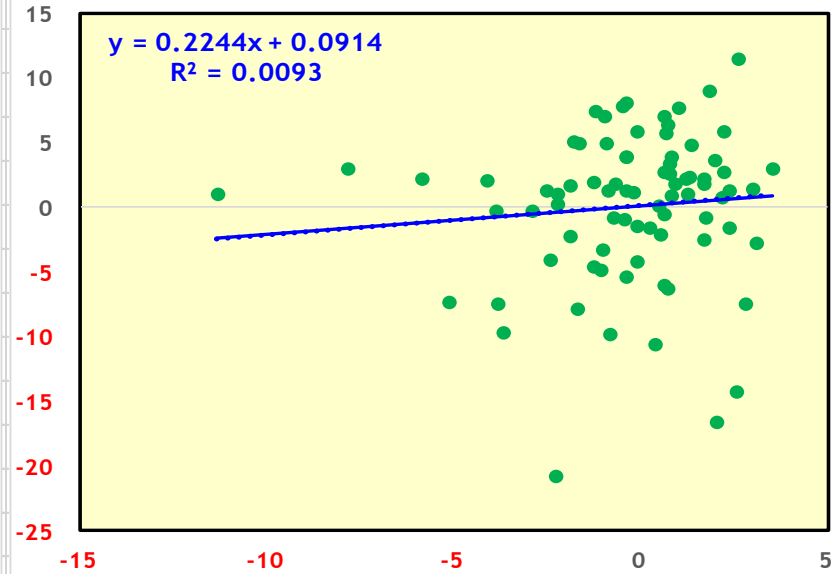
BARCLAYS PLC

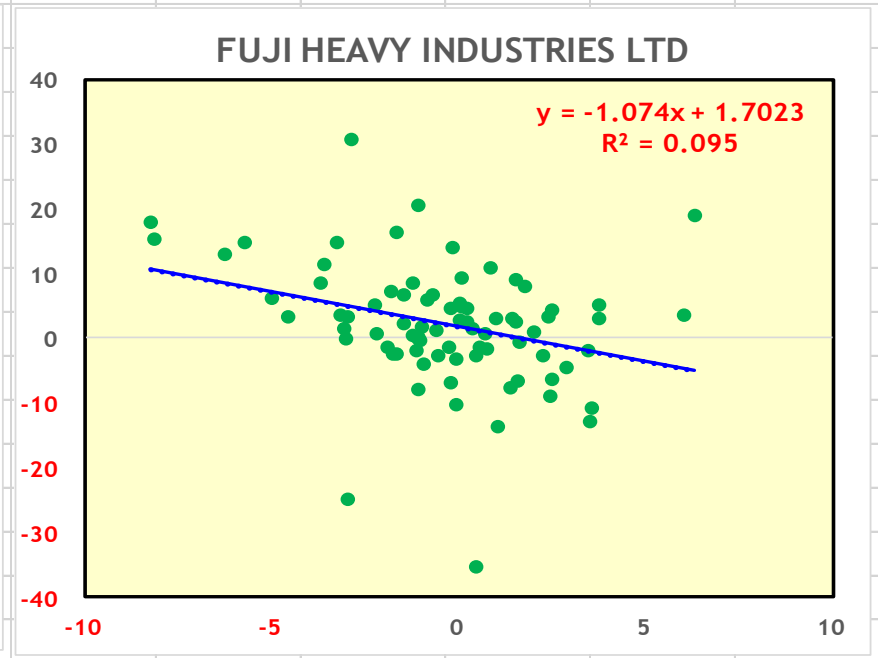
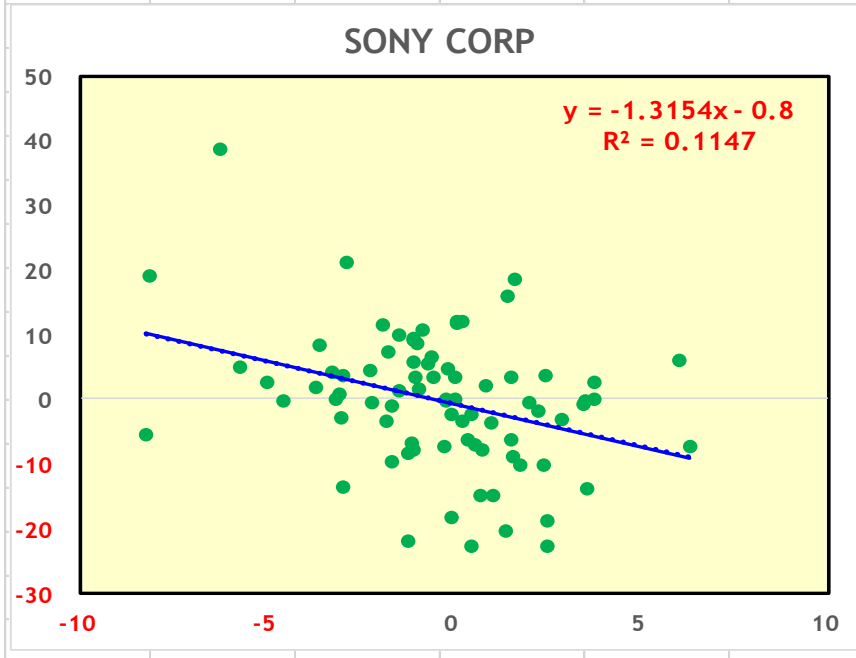
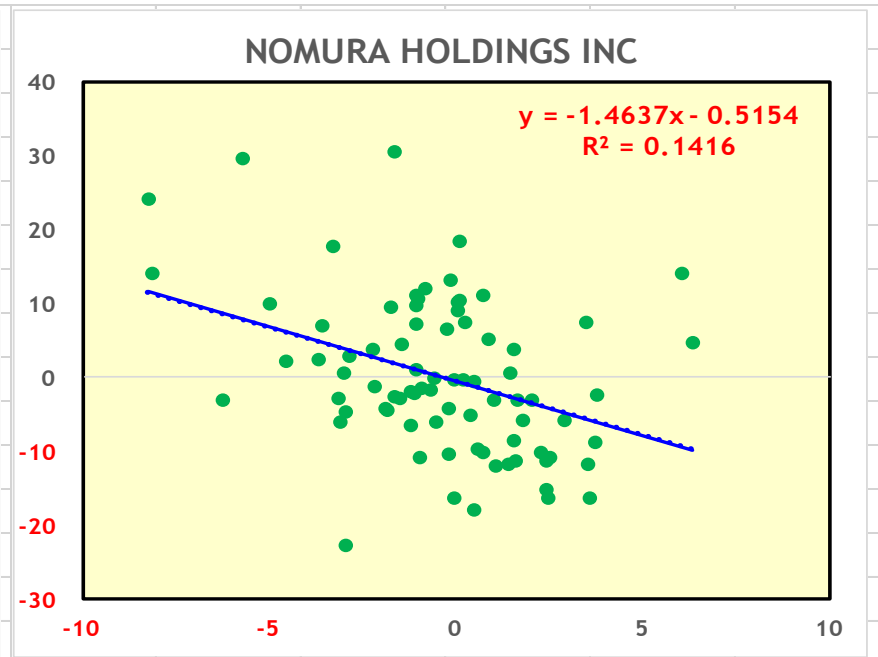
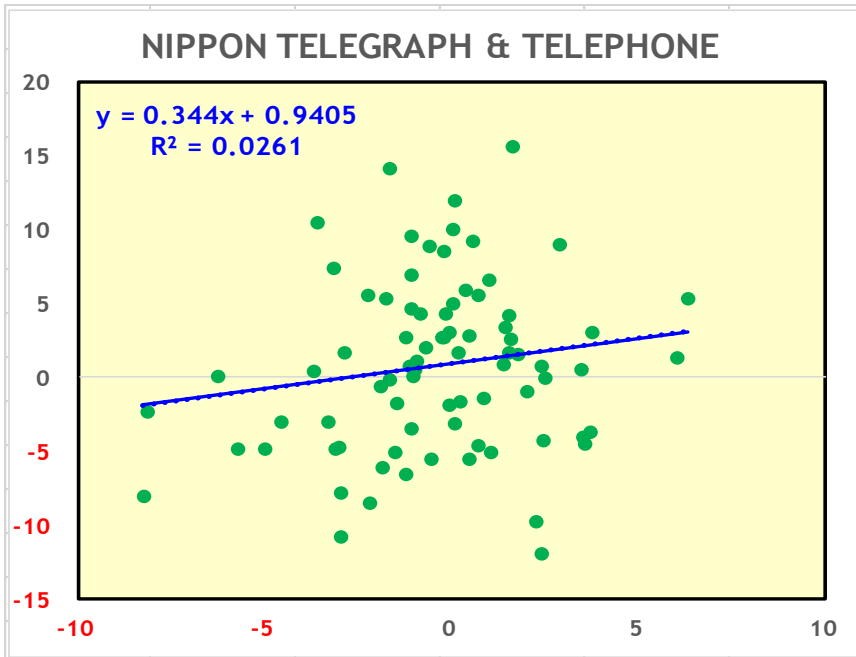


MARKS & SPENCER GROUP PLC



TATE & LYLE PLC





Summary of Estimated Currency Betas

- We have examples where the beta is close to 1.00, but many cases where it is significantly different
- In some cases the beta can be a lot higher than 1.00, in others it can be a lot lower
- In the Japanese cases, we actually have some betas that are negative, as is also the case for Toyota
- In such cases, holding the stock is already betting against the home currency; hedging the currency of denomination would actually create a bigger bet!
- Note that the R-squareds vary, and remember that these are only estimates of the true currency betas

The Research Project - 1

- If our goal is to minimise the currency risk in an international or global portfolio, the practical question becomes “How much should we hedge?”
- We have two possible methods:-
 1. Hedge by the known currency of denomination
 2. Hedge by the estimated currency exposure
- In the first case, for example, if 15% of our holdings are priced in Japanese Yen, we would short 15% of the portfolio value in Yen, and go long the US dollar
- In the second case we need to know the portfolio beta to the Yen, and use that as our hedge ratio

The Research Project - 2

- We first created a capitalisation-weighted portfolio from the top 1,000 stocks in a Developed Market universe consisting of the USA, Canada, Australia, Japan, the UK, the Eurozone and Switzerland
- We held this portfolio from 30 December 2009, and rebalanced it monthly up to February 2017
- We then looked at both the risk structure and performance attribution of the Unhedged portfolio, the Currency of Denomination hedged portfolio, and the Currency Exposure hedged portfolio

The Research Project - A Few Comments

- This is almost a buy-and-hold portfolio, since it is capitalisation-weighted, and the only turnover comes from stocks going in and out of the top 1,000
- Nonetheless, the portfolios weights by currency of denomination will vary somewhat over time
- The portfolio Currency betas will also vary over time, partly because the holding sizes are varying, but also because the estimated Currency betas vary over time
- The following slides show annual snapshots of the weights, the Currency exposures and the % of risk

Portfolio Weights by Foreign Currency

Portfolio Weights	Dec-09	Dec-10	Dec-11	Dec-12	Dec-13	Dec-14	Dec-15	Dec-16	Averages
Australian Dollar	3.68	3.71	3.33	3.33	2.66	2.19	1.88	2.23	2.88
British Pound	8.71	8.64	8.45	8.21	7.67	6.53	6.38	4.99	7.45
Euro	22.52	19.03	17.32	21.19	21.33	18.89	18.02	15.75	19.26
Japanese Yen	9.78	10.27	9.25	8.18	8.08	7.60	9.04	9.00	8.90
Swiss Franc	4.09	4.33	4.10	4.10	3.79	3.81	5.08	4.36	4.21
US & Canada	51.22	54.03	57.56	54.99	56.48	60.98	59.60	63.67	57.32
Total ex N.A.	48.78	45.97	42.44	45.01	43.52	39.02	40.40	36.33	42.68

- The portfolio weights by Currency of Denomination are relatively stable over time
- In this exercise, we are hedging the Australian Dollar, the Pound, the Euro, the Yen and the Swiss Franc

Portfolio Betas by Foreign Currency

Portfolio Betas	Dec-09	Dec-10	Dec-11	Dec-12	Dec-13	Dec-14	Dec-15	Dec-16	Averages
Australian Dollar	0.063	0.067	0.058	0.057	0.041	0.034	0.025	0.028	0.047
British Pound	0.145	0.150	0.134	0.136	0.102	0.080	0.071	0.043	0.108
Euro	0.414	0.331	0.285	0.357	0.359	0.264	0.094	0.083	0.273
Japanese Yen	0.012	-0.002	0.013	-0.014	-0.041	-0.029	-0.048	-0.025	-0.017
Swiss Franc	0.049	0.053	0.035	0.038	0.029	0.027	0.021	0.016	0.034
US & Canada	0.105	0.119	0.110	0.102	0.072	0.061	0.037	0.058	0.083
Total ex N.A.	0.683	0.603	0.524	0.603	0.572	0.434	0.258	0.195	0.484

- These vary rather more than the Portfolio weights, although they are still reasonably stable over time
- These Portfolio Currency Betas will be the hedge ratios for the Exposure hedging

Portfolio Currency Risk over time - Unhedged

Portfolio Risk %	Dec-09	Dec-10	Dec-11	Dec-12	Dec-13	Dec-14	Dec-15	Dec-16	Averages
Australian Dollar	3.68	4.00	3.78	3.34	2.00	1.46	0.86	1.01	2.52
British Pound	4.28	4.20	3.72	3.85	2.39	1.58	1.36	0.99	2.80
Euro	13.03	11.40	9.60	12.67	11.33	7.02	0.93	0.32	8.29
Japanese Yen	-0.05	0.01	-0.10	0.15	0.63	0.62	1.48	0.70	0.43
Swiss Franc	0.98	1.29	0.73	0.97	0.59	0.50	0.17	0.08	0.66
US & Canada	3.94	4.35	4.42	4.02	2.38	1.95	0.95	1.96	3.00
Total ex N.A.	21.92	20.91	17.73	20.97	16.94	11.18	4.79	3.09	14.69

- These are % contributions to Portfolio Risk over time from the Portfolio's exposure to the Currency factors
- They are very different from the Portfolio Weights, especially for the Euro and the Yen

Portfolio Currency Betas - Denomination Hedged

Portfolio Betas	Dec-09	Dec-10	Dec-11	Dec-12	Dec-13	Dec-14	Dec-15	Dec-16	Averages
Australian Dollar	0.027	0.030	0.025	0.023	0.015	0.012	0.006	0.006	0.018
British Pound	0.187	0.139	0.110	0.144	0.144	0.074	-0.087	-0.076	0.080
Euro	-0.086	-0.105	-0.080	-0.096	-0.121	-0.105	-0.138	-0.115	-0.106
Japanese Yen	0.059	0.064	0.050	0.055	0.025	0.014	0.007	-0.007	0.033
Swiss Franc	0.008	0.010	-0.006	-0.003	-0.009	-0.011	-0.030	-0.028	-0.008
US & Canada	0.105	0.119	0.110	0.102	0.072	0.061	0.037	0.058	0.083
Total ex N.A.	0.367	0.348	0.272	0.321	0.314	0.216	0.268	0.231	0.292

- The obvious point to note is that the Denomination-hedged Currency betas are not zero, which suggests that the risk model, at least, thinks there is still some Currency exposure left in the portfolio

Portfolio Currency Risk - Denomination Hedged

Portfolio Risk %	Dec-09	Dec-10	Dec-11	Dec-12	Dec-13	Dec-14	Dec-15	Dec-16	Averages
Australian Dollar	1.54	1.80	1.60	1.39	0.67	0.43	0.14	0.15	0.96
British Pound	1.60	1.61	1.18	1.38	0.45	0.17	0.06	-0.10	0.79
Euro	5.01	4.05	2.98	4.24	3.43	1.17	0.66	0.66	2.78
Japanese Yen	0.88	1.28	1.08	1.57	2.83	3.41	5.48	4.44	2.62
Swiss Franc	0.11	0.18	-0.07	-0.05	-0.09	-0.06	0.28	0.23	0.06
US & Canada	4.11	4.61	4.56	4.22	2.32	1.73	0.64	1.51	2.96
Total ex N.A.	9.14	8.92	6.77	8.53	7.29	5.11	6.61	5.38	7.22

- This table shows that there is still Currency Risk in the Denomination-hedged portfolio, although only about half as much as in the Unhedged case
- The Canadian Dollar risk is also somewhat different

Portfolio Currency Betas - Exposure Hedged

Portfolio Betas	Dec-09	Dec-10	Dec-11	Dec-12	Dec-13	Dec-14	Dec-15	Dec-16	Averages
Australian Dollar	0.000	-0.000	-0.000	-0.000	0.000	0.000	0.000	0.000	-0.000
British Pound	-0.003	-0.003	-0.002	-0.002	-0.002	-0.001	-0.000	-0.000	-0.002
Euro	-0.001	-0.001	-0.001	-0.001	0.000	0.000	0.000	-0.000	-0.000
Japanese Yen	0.002	-0.000	0.001	0.001	-0.000	-0.000	-0.000	0.000	0.001
Swiss Franc	-0.000	0.000	0.000	-0.000	0.000	0.000	-0.000	-0.000	-0.000
US & Canada	0.105	0.119	0.110	0.102	0.072	0.061	0.037	0.058	0.083
Total ex N.A.	0.006	0.003	0.003	0.004	0.002	0.001	0.001	0.001	0.003

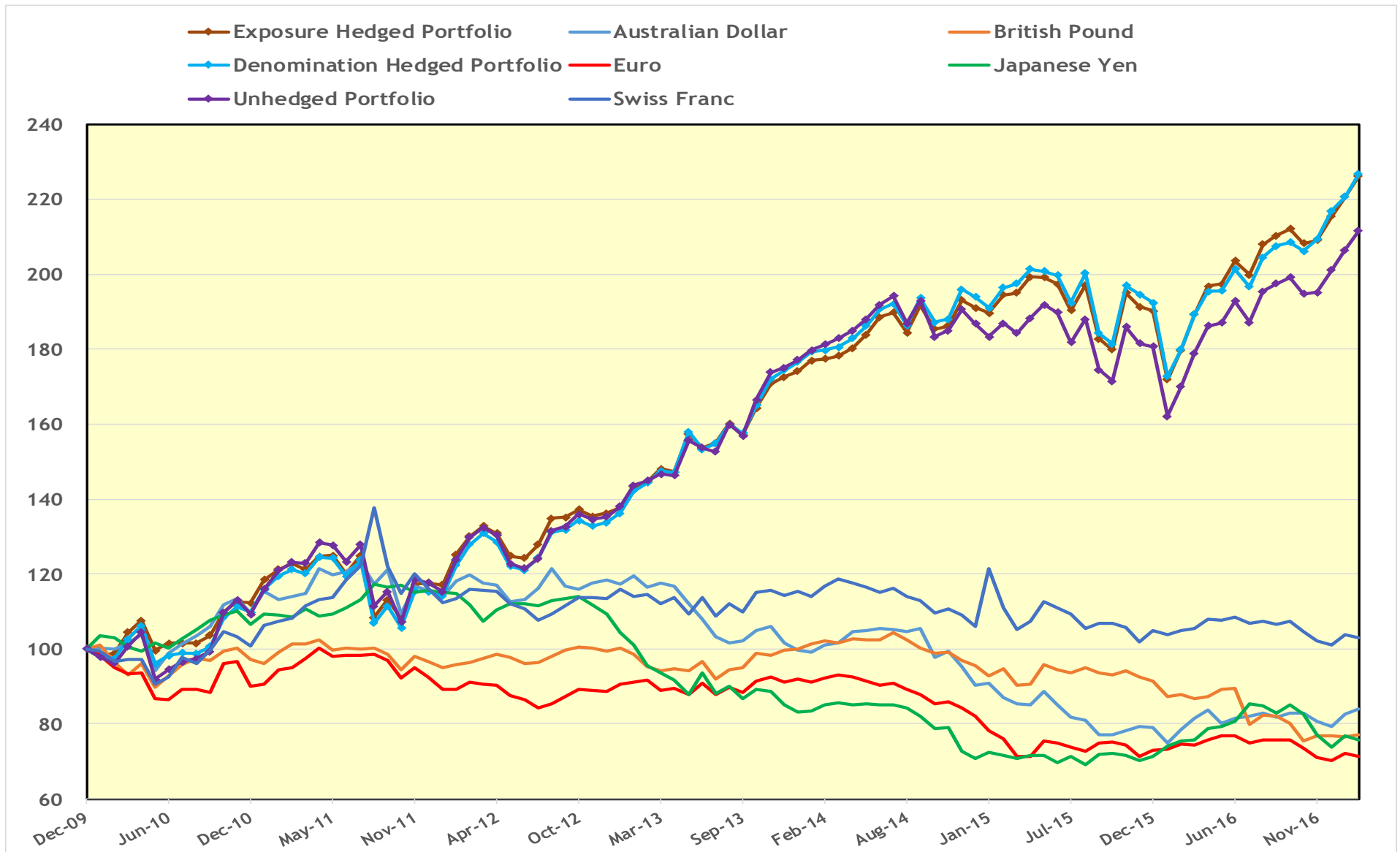
- All the hedged Currency betas are now close to zero
- The Canadian Dollar Currency betas are unchanged
- This should mean most of the Currency Risk has gone

Portfolio Currency Risk - Exposure Hedged

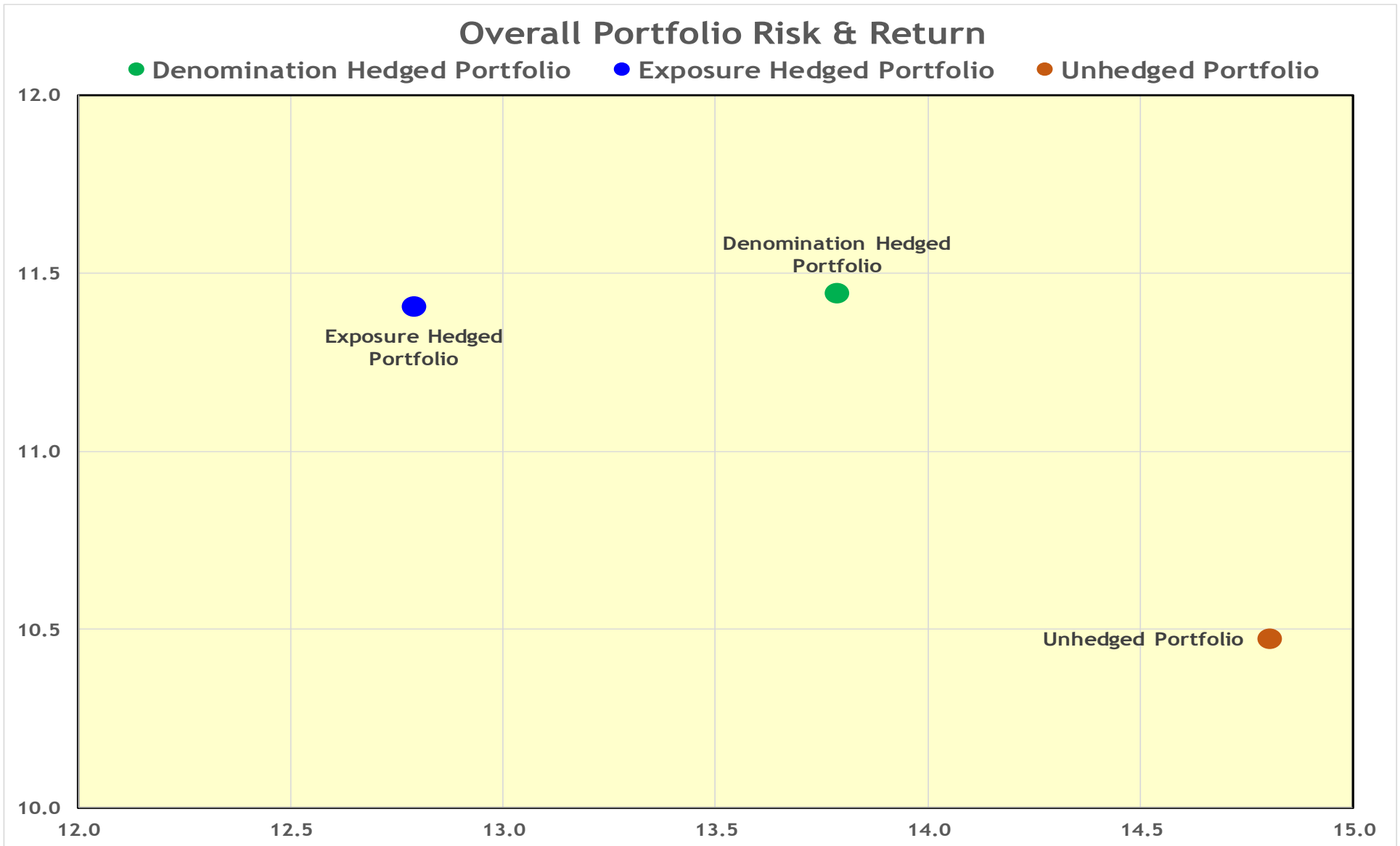
Portfolio Risk %	Dec-09	Dec-10	Dec-11	Dec-12	Dec-13	Dec-14	Dec-15	Dec-16	Averages
Australian Dollar	0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	-0.00
British Pound	0.05	-0.00	0.02	0.02	-0.00	-0.00	-0.00	0.00	0.01
Euro	-0.07	-0.07	-0.05	-0.06	-0.05	-0.02	-0.00	0.00	-0.04
Japanese Yen	0.01	0.01	0.01	0.01	-0.00	-0.00	-0.00	0.00	0.00
Swiss Franc	-0.00	0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00
US & Canada	4.10	4.72	4.62	4.31	2.38	1.82	0.83	1.83	3.08
Total ex N.A.	-0.00	-0.06	-0.02	-0.02	-0.05	-0.02	-0.01	0.00	-0.02

- The Currency Risk in the Exposure-hedged portfolio is very close to zero according to this risk model, although it has not accounted for all Currency risk
- The risk from the Canadian Dollar is still around 3%

Performance of Currencies and Portfolios



Portfolio Risk & Return over the 7 year period



Performance Attribution - Unhedged

	Total Return	Return p.a.	% of Return
Currency Factors	-12.78	-0.14	-17.05
Style Factors	39.13	5.47	52.22
Market Factors	11.41	1.59	15.23
Industry Factors	24.24	3.39	32.35
Factor Returns	62.00	10.32	82.74
Portfolio Alpha	12.93	1.81	17.26
Portfolio Return	74.93	10.47	100.00

- This shows an analysis of the performance over the whole period of the Unhedged Portfolio
- Currency exposures have been a drag on performance

Performance Attribution - Denomination Hedged

	Total Return	Return p.a.	% of Return
Currency Factors	-1.97	-0.02	-2.40
Style Factors	39.13	5.47	47.80
Market Factors	11.41	1.59	13.94
Industry Factors	24.24	3.39	29.61
Factor Returns	72.81	10.43	88.94
Portfolio Alpha	9.05	1.27	11.06
Portfolio Return	81.86	11.44	100.00

- Denomination Hedging significantly reduces the return from Currency movements over the period
- Note that the other returns remain unchanged

Performance Attribution - Exposure Hedged

	Total Return	Return p.a.	% of Return
Currency Factors	-1.57	-0.02	-1.93
Style Factors	39.13	5.47	47.95
Market Factors	11.41	1.59	13.98
Industry Factors	24.24	3.39	29.71
Factor Returns	73.20	10.44	89.71
Portfolio Alpha	8.39	1.17	10.29
Portfolio Return	81.60	11.41	100.00

- Exposure Hedging has about the same effect on the return, but the risk of this portfolio is 1% lower than Denomination Hedged, and 2% lower than Unhedged

Another Perspective on Currency Exposure

	Unhedged	Denomination	Exposure
	Portfolio	Hedged	Hedged
Australian Dollar	0.867	0.710	0.654
British Pound	0.792	0.555	0.467
Euro	0.750	0.424	0.340
Japanese Yen	-0.293	-0.464	-0.361
Swiss Franc	0.170	-0.012	-0.021
Canadian Dollar	1.236	1.039	0.971

- These are betas obtained by regressing the Portfolio returns on Currency returns over the whole period

Why is there still Currency Risk in the Portfolio?

- In this XRD risk model, we estimate each foreign stock's Currency beta by regressing its returns in base currency against the returns to its home currency
- We do not allow multiple Currency betas, as doing so can affect the rest of the model unhelpfully
- As a consequence, all American stocks will appear to have no foreign Currency exposures
- **Clearly, this is not actually true**
- However, all models must reflect the choices that were made as to how to treat the various factors

Summary & Conclusions

- We have shown that Exposure Hedging does a better job of reducing the Currency Risk arising from holding foreign stocks than Denomination Hedging does
- Remember that we wanted to hedge Currency Risk because we had no expected returns on Currencies
- The point of hedging is to minimise the unintended bets in the portfolio, so that its performance will be determined by the deliberate bets (a.k.a. Skill)
- When choosing an appropriate risk model, fund managers should be aware of the choices that have been made in the treatment of the various factors