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Avoiding Yen Carry Trade Unwind Through Diversification

Abstract

This study compares Markowitz's mean-variance carry trade portfolios with traditional foreign exchange carry trade investments. The strategy generates on average positive yields over the total time frame, including the 2008 yen carry trade unwind, proving the strength of diversification. Recognizing investment opportunities in the USD/HKD currency pair has been a crucial part in obtaining a high return to variance ratio.

Master Thesis, 15 ECTS
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Financial Economics
Spring 2013

Acknowledgements

Dr. Charles Nadeau – University of Gothenburg, School of Business, Economics and Law

For being a supporting and enabling supervisor who has assisted me greatly throughout my thesis process.

Dr. David Hallvig – KTH Royal Institute of Technology and Stockholm University

For his invaluable help in times of need.

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1. Introduction

1.1 Background

Borrowing in a currency yielding a low interest rate and investing in a currency yielding a relatively higher interest rate is a classic investment strategy that is known as a currency carry trade. It has been looked down upon in academic literature and financial press for a long time since according to the current theory of uncovered interest rate parity it should not be possible due to the automatic equalization of the underlying currencies over time. This theory has over time had to stand up to its fair share of scrutinizing since over the past several decades the exact opposite to what it predicts has been observed over and over again (Lothian and Wu 2003). Consequently, this is what makes currency carry trade possible since it essentially is uncovered interest rate arbitrage.

Ever since the mid-nineties Japan's economic woes have pushed down the country's interest rate below 0.5 percent, providing the world's investors with a great base currency for carry trade opportunities. The two most commonly used high interest currencies to trade against has historically been the Australian dollar (AUD) and the New Zealand dollar (NZD) and this thesis focuses primarily on the most popular one, the AUD/JPY carry trade.

1.2 Japan's economic history

In 1985 the Plaza Accord was ratified stating that the United States dollar would be devalued against, among others, the Japanese yen. This would cause a brief recession in Japan called the "Endaka" recession since Japan was heavily dependent on its export sector, forcing the Bank of Japan to engage in many rounds of monetary easing lowering the interest rate from 5 percent down to 2.5 percent in one year. Consequently, this low interest rate would lead to an overheated economy with uncontrolled money supply and credit expansion creating great

inflation in real estate and stock prices. After the New York Stock Exchange crash on Black Monday in 1987, the Bank of Japan realized that an asset price bubble was being created and started several rounds of monetary tightening, increasing the interest rate to 6 percent. In 1992 asset prices officially collapsed bringing difficulties to many financial institutions and moving Japan into its “lost decade”. As a result, Bank of Japan have kept the interest rate between 0 and 0.5 percent ever since, in an attempts to create inflation in the economy, and at the same time providing an excellent opportunity for carry trade investors giving them a comparatively highly valued currency with an exceptionally low interest rate for decades.

1.3 Foreign Exchange Market

The Foreign Exchange Market or Forex for short is the decentralized market that handles the world’s currency exchange transactions. Trading occurs 24 hours per day except weekends since it is geographically dispersed over the whole world. These reasons together with low margins of relative profits and the use of leverage makes it the market closest the ideal of perfect competition. According to the Bank for International Settlements the Foreign Exchange Market had an average daily turnover for the year 2010 of 3.98 trillion US dollars, making it the most liquid market in the world (BIS 2010).

1.4 The Financial Crash of 2008

The big downside to carry trades is the potential enormous crash-risk, or unwind as it is more commonly known, associated with the practice. This implies that in a scenario where the base currency starts to appreciate the open positions of carry trade investors are compromised as they face a huge foreign exchange risk that could erase all previous earnings. Subsequently, this would lead traders to exit their positions as soon as possible and thus putting even more upward pressure on the base currency. Consequently, this leads to a negative spiral which unwinds the carry trade.

Historically, this exact scenario was played out during the financial crisis of 2008 with the AUD/JPY carry trade. Over a period of just over a year the AUD/JPY currency pair went from 105 in late 2007 to not far off 57 in the beginning of 2009. In October of 2008, during the Lehman Brothers bankruptcy, the pinnacle of the financial crisis was seen as the AUD/JPY dropped 28 percent of its value in that month alone.

1.5 Abenomics and the future of the Yen Carry Trade

Carry trades are once more moving into the investor spotlight as the expansionary policies of central banks the world over continue with the United States' quantitative easing and Japan's so called Abenomics enabling money to move from bonds into riskier positions. At the same time the yen has depreciated and the Australian and New Zealand dollars have appreciated resulting in a 4.8 percent and 5.3 percent yield against the Japanese yen respectively for the first month of 2013 alone (Briefs 2013). Thusly, currency carry trades will in all probability be on a rise for the foreseeable future.

1.6 Purpose

The purpose of this thesis is to identify if there is a possibility of diversifying away the few and far between risks of huge carry trade unwinds through modern portfolio theory on a market that is as interconnected and rapidly reacting as the foreign exchange market.

Theory states that uncovered interest rate parity will move the exchange rate to close up any profit possibilities but since carry trades have been a positive yielding strategy for decades there must be some discrepancies not taken into account making this possible. Can these be isolated and utilized? How can the possibilities of carry trades otherwise be explained?

Focus of this thesis will be on comparing the diversified currency carry trade portfolio with the most common carry trade Australian dollar/Japanese yen during the 2008 financial crisis.

1.7 Hypotheses

1.7.1 Hypothesis one – Five to one leverage

A diversified currency carry trade portfolio will be outperformed by the AUD/YEN on a five to one leverage basis sending a margin call after twenty percent devaluation.

1.7.2 Hypothesis two – Ten to one leverage

A diversified currency carry trade portfolio will be outperformed by the AUD/YEN on a ten to one leverage basis sending a margin call after ten percent devaluation.

1.8 Limitations

In the historical data, the bid/ask spread has not been taken into deliberation. However, considering that this thesis processes the currencies with the highest daily turnover in the world the spread should be fairly small and therefore have zero or a negligible impact on the conclusions of this thesis.

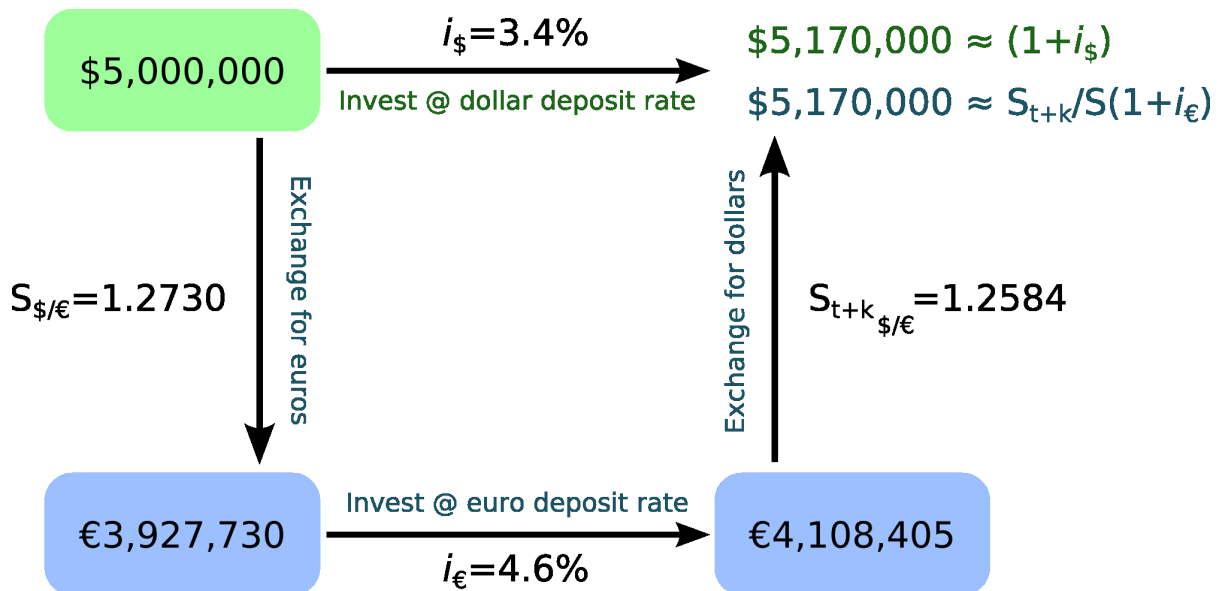
A positive aspect in relation to this is the high liquidity of the biggest currencies in the foreign exchange market making the risk of being unable to exit a position close to non-existent.

The possibilities concerning ways of designing and calculating portfolios are endless. The type of data; intra-day, daily, weekly or monthly. The types of assets; spot prices, forwards, swaps, futures or options. The types of interest rates; over-night, intra-bank or three-month Treasury Bill rates. How often the portfolio is being recalculated as well as what theory the calculations are based upon. All of these factors can be adjusted to produce other variants on portfolios that will reflect other possibilities.

2. Theory

2.1 Uncovered Interest Rate Parity (UIP)

The condition of interest rate parity states that there is equilibrium where an investor is indifferent between making a domestic or foreign bank deposit, even though interest rates differ. This equilibrium occurs because the foreign investment is exchange rate-adjusted over the investment time, thus arbitrage profits are impossible. In case of a higher interest rate on a foreign deposit compared to a domestic, this difference will be negated by a weaker exchange rate at maturity. (Krugman and Obstfeld 2008)



(Shandy 2011)

Uncovered interest rate parity refers to the version of interest rate parity where the investor is exposed to foreign exchange risk which is the relevant version regarding carry trades. The following equation shows the connection between interest rates and foreign exchange spot prices.

$$1 + i_t = \frac{S_{t+1}}{S_t} (1 + i_t^*)$$

2.2 Currency Carry Trade

Currency carry trade is a strategy of selling a currency with a relatively low interest rate and using the same resources to invest in a currency with a relatively high interest rate. As long as there is no fluctuation in the currency rates the investor will earn the interest rate difference between the currencies which can be substantial. Most professional investors then use leverage to increase their gains substantially which is a double edged sword. The strategy relies on relatively stable currency prices since an adverse movement can easily destroy the previous gains in a very short time. (FTL n.d.)

2.3 Mean Variance Portfolios

Within Modern Portfolio Theory (MPT) the objective is to maximize the expected return on a portfolio for a given amount of risk or vice versa by prudently selecting the proportions of the different assets therein. Harry Markowitz, the father behind the theory realized that clever use of diversification between assets can lead to a lowered total risk than the individual assets can provide, which awarded him the Nobel Memorial Prize in Economic Sciences in 1990. This is done by taking the correlation between the individual assets into account to build an optimal portfolio where for every level of return, the risk averse investor will prefer the combination of assets yielding the lowest level of risk (Markowitz 1952). Such points of lowest possible risk for a given level of return form a hyperbola of investment opportunities on which the upper limit is carrying the combinations with the highest risk-return relationship and is therefore known as the Efficient Frontier.

Expected portfolio return

$$\mu_t^p = E \left[\left(1 - \sum_{i=1}^n w_t^i \right) r_t^d + \sum_{i=1}^n w_t^i \frac{S_{t+1}^i}{S_t^i} r_t^i \right]$$

$$\mu_t^p = \left(1 - \sum_{i=1}^n w_t^i \right) r_t^d + \sum_{i=1}^n w_t^i r_t^i$$

$$\mu_t^p = \sum_{i=1}^n w_t^i (r_t^i - r_t^d)$$

Portfolio Standard Deviation

$$\sigma_p = \sqrt{w^T \Sigma w}$$

2.4 Capital Allocation Line (CAL)

The Capital Allocation Line is a line onto which the investor makes his portfolio investment decision. It forms a straight line from the risk-free rate and then tangent the efficient frontier. A point on the line between the risk-free rate and the efficient frontier tangent constitutes lending of the portfolio and any point past the tangent constitutes borrowing or in this case leveraging. The slope of this line is also known as the “reward-to-variability ratio” which is synonymous with the Sharpe Ratio.

$$E(R_c) = R_f + \sigma_c \frac{E(R_p) - R_f}{\sigma_p}$$

In a carry trade the investor will have to pay the interest rate of the asset being sold as well earn the interest on the asset being bought. Consequently, there is no need for a risk-free asset and the capital allocation line will be drawn from the origin to the tangent on the efficient frontier and beyond.

2.5 Sharpe Ratio

The Sharpe Ratio first calculates the excess return by taking the expected return ($E(r_i)$) of an asset less the risk free return (r_f). The excess return is then divided by the standard deviation of the asset to produce the Sharpe Ratio. The standard deviation (σ) represents total risk, both systematic and non-systematic (Sharpe Fall 1994).

$$\text{Sharpe Ratio} = \frac{E(r_i - r_f)}{\sigma} = \frac{E(r_i - r_f)}{\sqrt{\text{var}(r_i - r_f)}}$$

2.6 Literature Review

The major issue concerning carry trade is the forward premium anomaly, also known as the UIP puzzle, which is a well-documented empirical finding that states that when the domestic nominal interest rate is relatively high compared to foreign rates, the domestic currency will appreciate. Despite economic theory and intuition suggesting the opposite; a foreign investor would demand higher interest rates on a currency that is expected to depreciate. Finding empirical support for uncovered interest rate parity has been a daunting task, forcing more focus on the examination of the underlying reasons behind its failure, which in many cases have not yielded any definite results (Korajczyk 1985). The empirical evidence shows that foreign exchange rate movements resemble a random walk in the short run and thus granting the carry trade strategy positive expected returns, which can only be attributed to errors in the models, while still facing foreign exchange rate risk (Meese and Rogoff 1983).

However, there has been consistent empirical support for a negative UIP slope providing the investor with both the interest rate spread as well as a forward premium on the currency appreciation during the holding period. Two possible explanations for the excess return have been put forward by Verdelhan (2010) arguing for a time-varying risk premium and exceptional errors. It has been shown that the premiums on returns are not correlated with

standard risk factors and cannot even be explained by standard stochastic discount factor models further arguing that the positive average payoffs of the carry trade reflects peso event risk constituting of rare and unexpected changes in the market and that these events, if properly recognized, can be hedged against by the use of currency options (Burnside, et al. 2008).

Further research has found a robust empirical relationship between carry trade excess returns and exchange rate volatility, which is both realized and implied. Specifically showing that a Fama regression of the realized exchange rate depreciation on the lagged interest rate differential produces a negative slope coefficient is an artifact of the volatility regime. Furthermore, an intuitive and significant co-movement between currency risk premium and risk premia in yield curve factors that drive bond yields, in countries that comprise carry trade pairs, are recognized as well as a link between carry trade returns and the Chicago Board Options Exchange Market Volatility Index (VIX) (Clarida, Davis and Pedersen 2009).

This notion is expanded further upon arguing that currency crashes are strongly linked to the sudden unwinding of carry trades. Currency crashes have also been positively correlated with increases in implied stock market volatility (VIX) and the spread between interest rates on interbank loans and short-term U.S. government treasury bills (TED spread). Controlling for this effect reduces the foreign exchange return predictability of interest rates and would therefor help to resolve the UIP violation. Finally, it can also be shown that currencies with similar interest rates co-move with each other which further suggest that carry trades affects exchange rate movements. Overall results show that illiquidity and capital immobility lead to short-run currency under-reaction to changes in fundamentals and occasional currency crashes due to liquidity crises (Brunnermeier, Nagel and Pedersen 2009).

3. Data and Methodology

3.1 Data

The data has been collected using Bloomberg Terminal, which is a computer system that is provided by Bloomberg L.P. It is one of the most known and widely used industry standards regarding monitoring and analyzing real-time movements in the financial market data as well as being an electronic trading platform and news service.

This data contains historical daily close of business valuations of currency pairs of the twelve largest currencies in the world, measured in turnover. The average values have been used and bid/ask spreads have not been taken into consideration. Furthermore, the overnight interest rate of the twelve currencies have been used together with the currency pair valuation to calculate the actual rate of return using uncovered interest rate parity. All earnings have been reinvested.

3.1.1 Asset description

The twelve currencies are; United States Dollar (USD), Eurozone Euro (EUR), Swiss Franc (CHF), Japanese Yen (JPY), United Kingdom Pound Sterling (GBP), Australian Dollar (AUD), New Zealand Dollar (NZD), Hong Kong Dollar (HKD), Singapore Dollar (SGD), Canadian Dollar (CAD), Swedish Krona (SEK) and Norwegian Krone (NOK). This generates a total of 66 currency pairs. The data contains daily historical close of business values and daily overnight interest rates for the separate currencies, starting from 2006 and covering the end of 2009.

Two proxies for the Yen Carry Trade that are both based on the AUD/JPY currency pair have been created. Levels of leverage that can be observed on currency positions can reach all the way to 200:1, but the average is somewhere slightly above 10:1. With this in mind the two

leverage levels of the proxies are 10:1 and a more modest 5:1, which would produce a margin call at a loss of 10% and 20% respectively. The one with a leverage level of 5:1 will be the official level that the mean variance portfolio must outperform since it would be the most resilient in a yen carry trade unwind.

3.1.2 Normal distribution of data

The data is normally distributed but with some signs of negative kurtosis. This is very important since the risk variable (variance) is calculated with the assumption that the data is normally distributed. For reference, see graph in appendix.

3.1.3 Assumptions

In addition to the before mentioned requirement of the data being normally distributed there are a few assumptions that modern portfolio theory relies upon. Investors must be interested in maximizing the mean for a given variance and correlations between assets must fixed and constant forever. The later one is slightly adjusted for by recalculating the correlations each year. All investors must also seek to maximize their economic utility as well as being rational and risk averse price takers. They must also have accurate conceptions of possible returns as well as access to the same information at the same time. No taxes or transaction costs can exist. Risk and volatility of assets are known in advance or are constant and assets must be able to be divided into parcels of any size. Finally, when leverage enters the equation it is assumed that the investor can lend and borrow unlimited amounts at the risk free rate of interest.

3.2 Methodology

The research has been concluded using deductive reasoning and empirical data to either reject or confirm the hypothesis that the use of a mean variance portfolio in modern portfolio theory would have saved a carry trade investor from the 2008 yen carry trade unwind.

Taking into consideration that the a carry trade is essentially uncovered interest arbitrage, the way the carry trade returns have been calculated is via uncovered interest rate parity between the currency pairs and their respective overnight interest rates.

These returns have then been used to calculate Mean Variance Portfolios and their respective Efficient Frontiers, on top of which Capital Allocation Lines have been created, onto which the investment decisions have been made. To decide the level of risk for the investment decision on the Capital Allocation Line the Yen Carry Trade proxy at a 5:1 leverage has been used.

This calculation for the mean variance portfolio has been recalculated for every year using the previous year's data to build up a historical data set of how such a portfolio would have performed in a real situation. Parallel to this, the risk of the Yen Carry Trade proxy has also been calculated using the last year's data to establish the risk level for the Capital Allocation Line decision.

These returns have then been indexed from the same starting date so as to make the Mean Variance Portfolio and the Yen Carry Trade proxy with a 5:1 leverage comparable to each other and making it possible to note where and when a possible margin call of 20% would have been sent out. Besides the 5:1 leverage proxy will be a riskier but possibly higher yielding 10:1 leverage proxy to illustrate the vulnerability in being exposed with leverage to fluctuations in the foreign exchange market while being in a carry trade investment.

3.2.1 Calculation of return data

The daily return data has been calculated by analyzing every single time period in the data for the lowest interest rate within the currency pair and then formulating together with the overnight rates the daily return using the uncovered interest rate arbitrage formula.

$$IF FX1_{low\ i} < FX2_{high\ i} \text{ then } \left(\frac{FX2}{FX1_{t_1}} / \frac{FX2}{FX1_{t_0}} \right) \left(\left(\frac{FX2_{high\ i} - FX1_{low\ i}}{100 * 365} \right) + 1 \right)$$

3.2.2 Solving for Optimal Portfolios using Sharpe Ratios

In the process of solving for the optimal yearly portfolios the key performance measure to maximize is the Sharpe Ratio, i.e. the reward-to-variability ratio. The reason for this being that this is the point on the efficient frontier where the capital allocation line tangent.

3.2.3 Constructing Portfolios

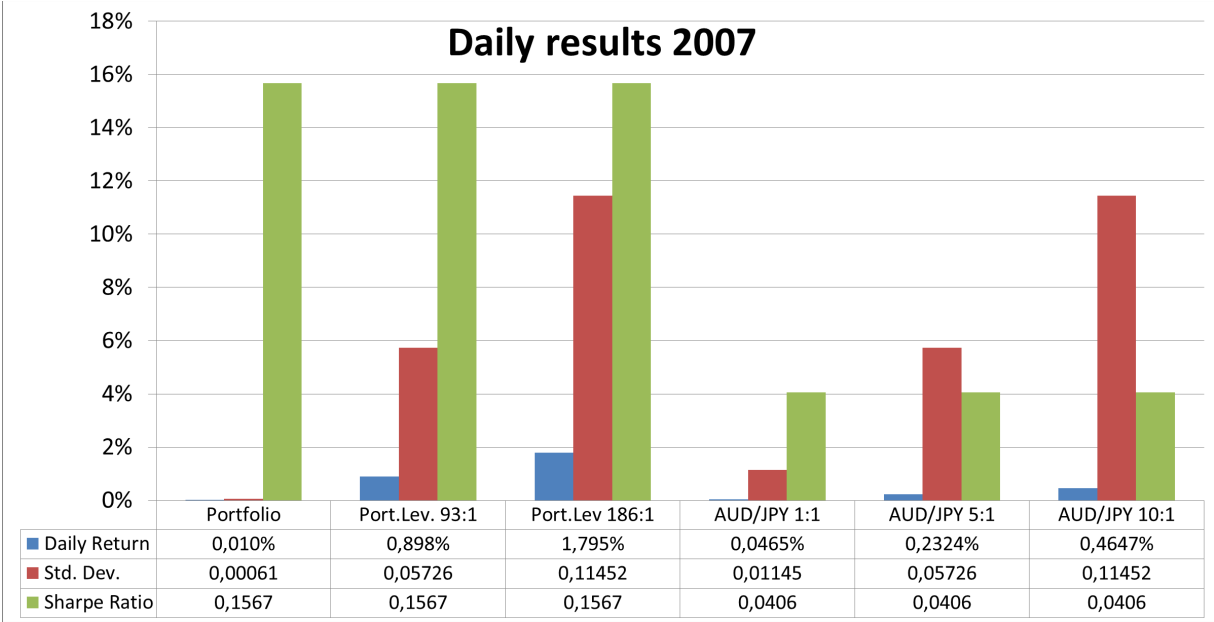
To cover the full period of the 2008 Yen carry trade unwind three different portfolios have been calculated. One for each of the years 2007, 2008 and 2009 to cover the full scenario, before, during and after the unwind. Every yearly portfolio has been calculated and reweighted based on the historical data from the previous year, i.e. portfolio weights calculated on 2006 return data have been applied to the historical return data of 2007, and so on, to measure how well they would have actually performed.

The return and standard deviation numbers of the yearly portfolios have then been calculated into two leveraged portfolios with the same standard deviation as the two AUD/JPY proxies to make them comparable.

4. Results and Analysis

The column charts for the different years show data from the calculated portfolio without leverage as well as two portfolios that have been leveraged to reach the same standard deviation as the two leveraged AUD/JPY of five to one and ten to one respectively, which the hypotheses are based upon. Furthermore, we have the unleveraged AUD/JPY and the two AUD/JPY leveraged to five to one and ten to one respectively.

4.1 Year 2007



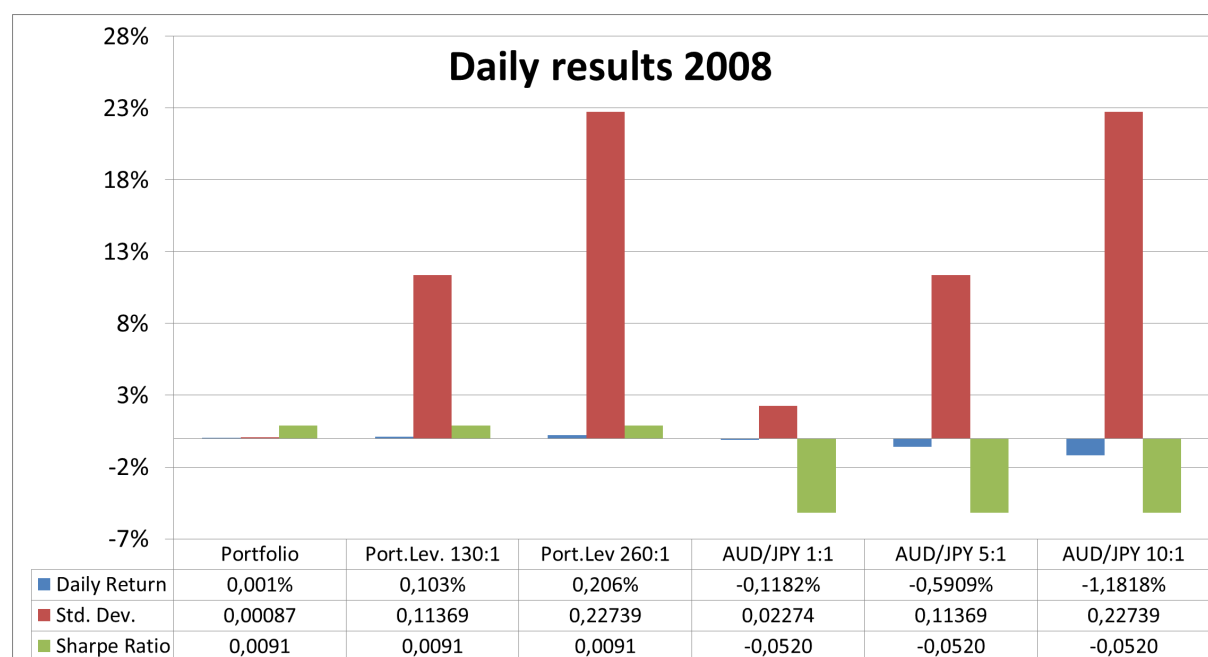
4.1.1 Interpreting the Variables

For the data concerning year 2007 there is a stark discrepancy between the portfolio and the AUD/JPY regarding returns and levels of standard deviation. The AUD/JPY will clearly outperform the portfolio in terms of returns but the level of risk associated with the portfolio is remarkably low providing for a prodigious Sharpe Ratio. When the portfolio is leveraged 93 to one and 186 to one, returns are observed that are close to fourfold the returns of the leveraged AUD/JPY investments at the same levels of standard deviation.

4.1.2 Summary and Interpretation of Hypotheses

Throughout the 2007 time period, during most of which the AUD/JPY saw great returns due to the continued depreciation of the JPY during the upward trending period before the crash, none of the two hypotheses can be rejected. Furthermore, we clearly note that the leveraged portfolios yield far greater returns at equal levels of risk due to the fourfold Sharpe Ratio.

4.2 Year 2008



4.2.1 Interpreting the Variables

During 2008 the diversified portfolio continues to produce positive returns, although miniscule compared to the amount of risk, yielding an extremely low Sharpe Ratio.

Meanwhile, the AUD/JPY carry trade fairs drastically worse with negative returns and therefore negative and thereby insignificant Sharpe Ratios. During this period the AUD/JPY carry trade saw most of its total unwind from mid-year starting with the Lehman Brothers bankruptcy and lasting until year end. The results of this was an average daily return of negative 0.1182 percent on an unleveraged investment which equates to a total loss of more than 35 percent on a yearly basis. Naturally, these terrible numbers become exponentially

worse when leverage is added to the equation. The five to one leveraged AUD/JPY investment saw a negative return of 88.5 percent on a yearly basis and the ten to one yielded in an astonishingly horrific negative 98.7 percent yearly return on investment.

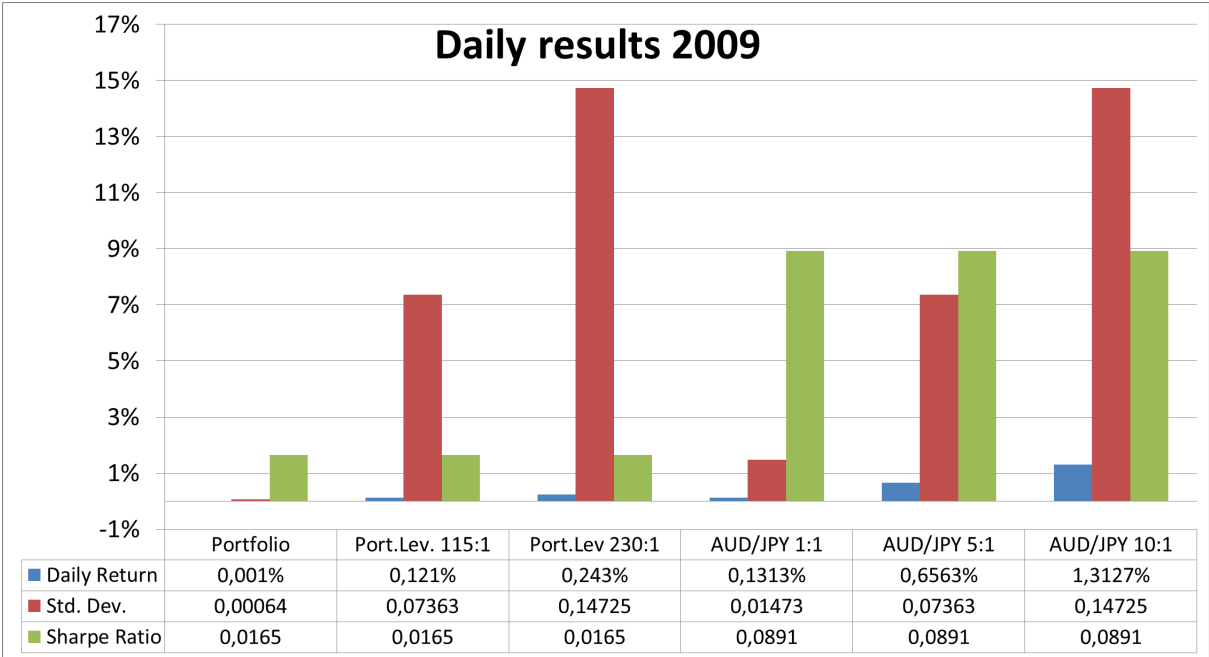
4.2.2 Summary and Interpretation of Hypotheses

The key observation in this data is that the diversified portfolio delivers positive returns on average and thusly stays afloat during the worst part of the carry trade unwind. Noteworthy is that enormous levels of leverage are required to gain small amounts of returns at the same time as huge standard deviations, providing the investment with a meager 0.0091 Sharpe Ratio. Numbers like these would not be preferable in a real investment opportunity and should rather be interpreted as showing the possibilities of mean variance portfolio construction when turning negative returns into positive.

Concerning the AUD/JPY carry trade we see a steep yearly decline of 35.05 percent out of total asset value. When leverage is applied we observe that the five to one leverage investment loses 88,5 percent of its value which is far more than the applicable 20 percent margin call limit and would force the investor to exit the position with all assets lost. Since the ten to one leveraged carry trade has an even lower 10 percent margin call the investor would have lost all his assets in half the time compared to the five to one leveraged investment.

Finally, it would not be wise, if at all possible, to engage in investments with levels of leverage reaching 260 to one. If any trading platform were to offer these leverage levels the investor would get a margin call after a depreciation of just one 260th of the total position. Therefore, a wise investor would perhaps invest assets at lower leverage to be able to withstand the volatility of the market without losing the entire position.

4.3 Year 2009



4.3.1 Interpreting the Variables

In late January of 2009 we observed the bottom of the unwind resulting in an overall positive investment environment for the AUD/JPY carry trade investor during the rest of the year. Since the diversified portfolio is optimally calculated for the returns of an overall negative 2008 it produces fairly modest returns in an otherwise positive environment, which could be significantly larger if the portfolio were to be recalculated more often to better adjust to the current market conditions. The portfolio Sharpe Ratio is very low making it a less than optimal investment considering the low returns compared to high levels of risk. Nevertheless, the diversified portfolio continues to provide positive returns which would probably improve considerably when the portfolio weights are recalculated for the next year time period.

4.3.2 Summary and Interpretation of Hypotheses

In this time period there is nothing that rejects the hypotheses, due to overall positive returns, but we clearly observe the power of the leveraged carry trade investment in a favorable environment. The diversified portfolio critically stays afloat in an environment where it is

predicted to perform poorly due to only being recalculated yearly and therefore not reflecting the oncoming period consisting of upward momentum.

4.4 Total Time Period Overview

Indexed Yearly Returns						
Year	Portfolio 1:1	Port. Comp. 5:1	Port. Comp. 10:1	AUD/JPY 1:1	AUD/JPY 5:1	AUD/JPY 10:1
2006	100	100	100	100	100	100
2007	104	2609	66110	118	233	543
2008	104	3798	140114	77	27	7
2009	104	5913	339345	124	292	827

Yearly Returns						
Year	Portfolio 1:1	Port. Comp. 5:1	Port. Comp. 10:1	AUD/JPY 1:1	AUD/JPY 5:1	AUD/JPY 10:1
2007	3,58%	2508,59%	66010,19%	18,48%	133,29%	443,16%
2008	0,29%	45,61%	111,94%	-35,05%	-88,50%	-98,70%
2009	0,39%	55,67%	142,19%	61,42%	989,00%	11576,50%

Over the extended time period the diversified portfolio that is comparable to the AUD/JPY carry trade with a ten to one leverage ends up with the highest total return. This is due to the marvelous early performance during 2007 followed by stable positive returns of over 100 percent for the two following years.

Throughout the diversification process one certain currency pair has been shown to constantly provide great returns-to-variance over the entire time period. On average, 75 percent of the portfolios have been weighted towards the USD/HKD pair. The reason for this performance is the guaranteed limits on the currency pair that the Hong Kong Monetary Authority has instituted between 7.75 and 7.85 Hong Kong dollars per U.S. dollar (HKMA 2013). This greatly reduces foreign exchange volatility in the carry trade investment, while at the same time providing the interest rate carry offering a solid low risk long term investment.

The AUD/JPY carry trade shows that it can be a very rewarding strategy over long time periods and in stable environments. Nevertheless, in negatively trending time periods the strategy is extremely weak and heavily exposed to carry trade unwinds.

5. Conclusions

This paper has studied how Markowitz's mean-variance carry trade portfolios fair in times of great volatility in the foreign exchange market using the 2008 Japanese yen carry trade unwind as examination time period and the Australian dollar/Japanese yen as a reference for the undiversified carry trade strategy proxy.

Both hypotheses have been rejected since both of the conservatively leveraged carry trade proxies fell far below their respective margin-call levels even when taking the gains of the previous year into account. Therefore the conclusion is that foreign exchange rate volatility can be diversified away in a carry trade strategy. It should however be noticed that in practice the comparable diversified portfolios leveraged to the same levels of risk as the carry trade proxies were leveraged to unsustainable levels for an investor without substantial means and is therefore not suitable as a realistic investment strategy.

Finally, a substantial part of the diversified portfolio weights have been focused on the United States dollar/Hong Kong dollar currency pair which are both low interest rate currencies. This produces low yields but at a remarkably low level of volatility and does not pose an investment problem since the position can be leveraged. The key to this is the guaranteed limits imposed by the Honk Kong Monetary Authority on the USD/HKD between 7.75 and 7.85 Hong Kong dollars per U.S dollar which in practice eliminates foreign exchange volatility in the uncovered interest parity arbitrage and therefor provides a solid long term carry trade investment strategy (HKMA 2013).

6. Suggestions for Further Research

In order to take this research further there are a number of interesting areas to look into.

Firstly, it would be preferable to shorten down the recalculation period to preferably produce new weights for the portfolio every day to faster adjust to swings in the foreign exchange market. It would also then be preferable to shorten down the period over which the covariance matrix is calculated to around one month which would be trailing after the investment decision day. This would favorable be done in an automated fashion utilizing a connection to a trading console.

Another interesting aspect would be to investigate the possibility to incorporate volatility indexes, e.g. the VIX and/or the TED spread to better adjust the weights of the portfolio to the prevailing market conditions in the case of sudden unpredictable movements of magnitude.

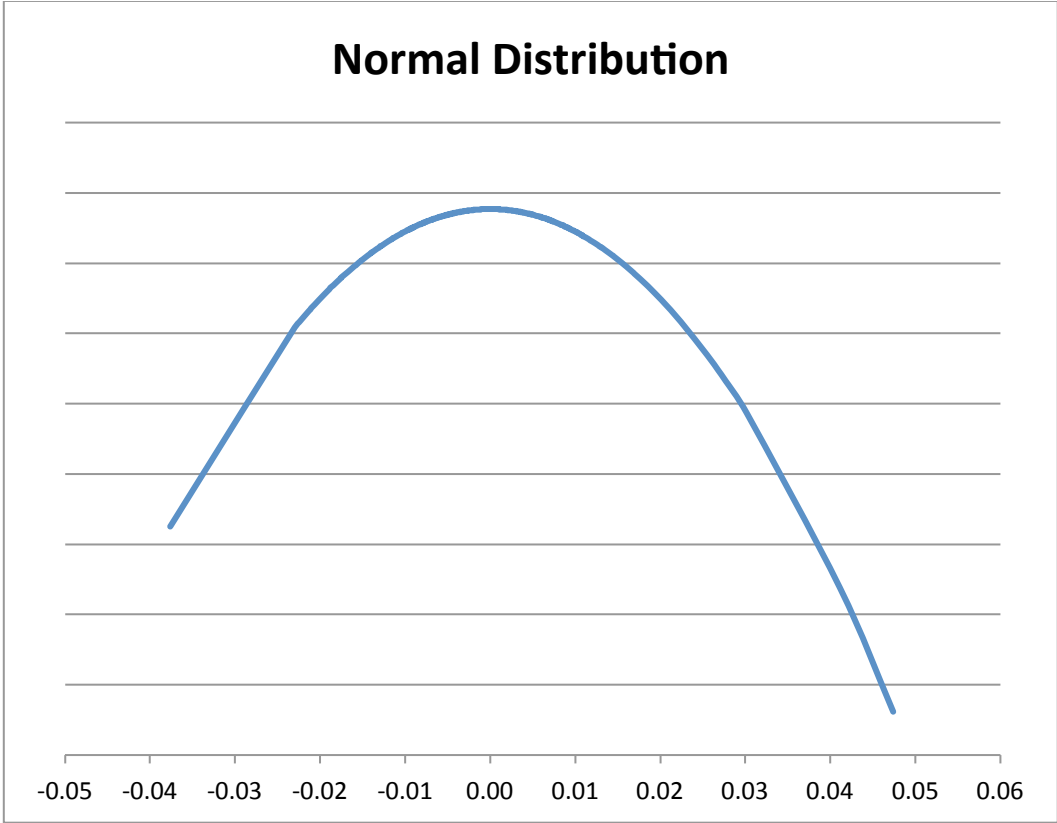
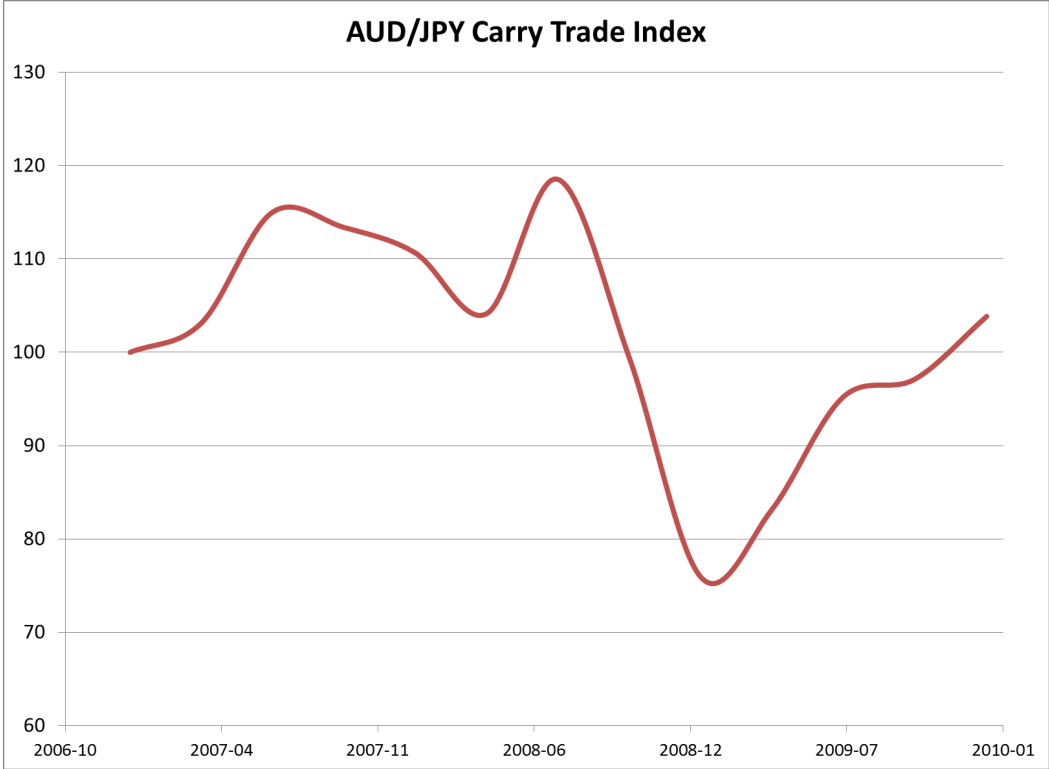
Finally, considering the fact that in the majority of time periods the carry trade is a well performing strategy it would be very appealing to be able to avoid the grand dips in the market. This could possibly be done as simply as constructing a trading strategy that utilizes stop-losses that execute in case of a certain value drop compared to the time period. Another version of this would be to hedge the active carry trade positions using options to cover unexpected volatility in foreign exchange market.

7. References

- BIS, Bank for International Settlements. *Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity in 2010 - Final results*. 12 2010.
<http://www.bis.org/publ/rpxf10t.htm> (accessed 07 11, 2013).
- Bodie, Zvi, Alex Kane, and Alan J Marcus. *Investments and Portfolio Management*. Ninth Edition. New York: Mc Graw Hill, 2011.
- Briefs, Bloomberg. *Central Banks Carry Traders to Best Start Since 2007: Currencies*. 01 24, 2013. <http://news.zurichna.com/article/66af99b5e27d1e2bc1434aab9dfad520/central-banks-carry-traders-to-best-start-since-2007-currencies> (accessed 04 22, 2013).
- Brunnermeier, Markus K., Stefan Nagel, and Lasse H. Pedersen. "Carry Trades and Currency Crashes." In *NBER Macroeconomics Annual 2008, Volume 23*, by Daron Acemoglu, Kenneth Rogoff and Michael Woodford, 313-347. Chicago: University of Chicago Press, 2009.
- Burnside, Craig A., Martin S. Eichenbaum, Isaac Kleshchelski, and Sergio Rebelo. *Do Peso Problems Explain the Returns to the Carry Trade?* NBER Working Papers with number 14054., Cambridge: National Bureau of Economic Research, Inc, 2008.
- Clarida, Richard, Josh Davis, and Niels Pedersen. *Currency Carry Trade Regimes: Beyond the Fama Regression*. NBER Working Paper No. 15523, Cambridge: National Bureau of Economic Research Inc., 2009.
- FTL. *Financial Times Lexicon - Carry Trade*. n.d. <http://lexicon.ft.com/Term?term=carry-trade> (accessed 06 18, 2013).

- HKMA, Hong Kong Monetary Authority. "Monetary Stability." *Hong Kong Monetary Stability*. 01 01, 2013. http://www.hkma.gov.hk/media/eng/publication-and-research/annual-report/2012/11_Monetary_Stability.pdf (accessed 06 16, 2013).
- Korajczyk, Robert A. "The Pricing of Forward Contracts for Foreign Exchange." *Journal of Political Economy*, vol. 93, issue 2, 1985: 346-368.
- Krugman, Paul R., and Maurice Obstfeld. *International Economics, Theory and Policy, Eighth Edition*. Pearson, 2008.
- Lothian, James R., and Liuren Wu. *Uncovered Interest Rate Parity over the Past Two Centuries*. New York City: Center for Research in International Finance at Fordham University, 2003.
- Markowitz, Harry Max. "Portfolio Selection." *The Journal of Finance*, 1952: 77-91.
- Meese, Richard A., and Kenneth Rogoff. "Empirical Exchange Rate Models of the Seventies." *Journal of International Economics* 14, 1983: 3-24.
- Shandy, John. "File:Uncovered-interest-rate-parity.svg." *Wikimedia Commons, the free media repository*. 07 19, 2011. <http://commons.wikimedia.org/wiki/File:Uncovered-interest-rate-parity.svg> (accessed 06 10, 2013).
- Sharpe, William F. "The Sharpe Ratio." *The Journal of Portfolio Management*, Vol. 21 Fall 1994: 49-58.
- Verdelhan, Adrien. "A Habit-Based Explanation of the Exchange Rate Risk Premium." *The Journal of Finance*, vol. 65, issue 1, 2010: 123-146.

8. Appendix



Portfolio Optimization 2007					Max Sharpe Ratio 2006	AUD/JPY 2007 Returns Leverage 5 to 1	AUD/JPY 2007 Returns Leverage 10 to 1
Const. Var.	Equal Weight	Min St Dev	Max Returns	Max SR			
Val. of Const.	None	Std. Dev. <=	Ang. Ret. >=	None			
	N/A	0,000403	0,0872%	N/A			
Portfolio Weights							
EUR/USD	1,52%	0,99%	0,00%	0,00%	0,00%		
USD/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
USD/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
GBP/USD	1,52%	0,07%	0,00%	0,00%	0,15%		
AUD/USD	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/USD	1,52%	0,01%	0,00%	0,00%	0,05%		
USD/HKD	1,52%	54,49%	0,00%	78,38%	75,60%		
USD/SGD	1,52%	2,22%	0,00%	0,00%	0,00%		
USD/CAD	1,52%	1,08%	0,00%	0,63%	0,57%		
USD/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
USD/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
EUR/CHF	1,52%	0,01%	0,00%	5,64%	4,75%		
EUR/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
EUR/GBP	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/EUR	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/EUR	1,52%	0,00%	0,00%	0,00%	0,00%		
EUR/HKD	1,52%	0,00%	0,00%	0,00%	0,00%		
EUR/SGD	1,52%	2,57%	0,00%	0,00%	0,00%		
EUR/CAD	1,52%	4,23%	0,00%	0,00%	0,00%		
EUR/SEK	1,52%	7,48%	0,00%	0,00%	0,00%		
EUR/NOK	1,52%	2,19%	0,00%	0,00%	0,00%		
JPY/CHF	1,52%	0,36%	0,00%	0,00%	0,00%		
GBP/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
HKD/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
SGD/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
CAD/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
SEK/CHF	1,52%	6,22%	0,00%	0,00%	1,49%		
NOK/CHF	1,52%	0,01%	0,00%	0,00%	0,00%		
GBP/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
HKD/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
JPY/SGD	1,52%	0,00%	0,00%	0,00%	0,00%		
CAD/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
JPY/SEK	1,52%	0,00%	0,00%	0,00%	2,74%		
JPY/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
GBP/AUD	1,52%	0,01%	0,00%	0,00%	0,00%		
GBP/NZD	1,52%	1,06%	0,00%	0,63%	0,50%		
GBP/HKD	1,52%	0,04%	0,00%	0,00%	2,68%		
GBP/SGD	1,52%	0,00%	0,00%	0,00%	0,00%		
GBP/CAD	1,52%	5,73%	0,00%	0,86%	0,96%		
GBP/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
GBP/NOK	1,52%	0,00%	0,00%	0,00%	2,14%		
AUD/NZD	1,52%	2,10%	0,00%	3,71%	2,23%		
AUD/HKD	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/SGD	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/CAD	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/HKD	1,52%	0,01%	0,00%	0,00%	1,71%		
NZD/SGD	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/CAD	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
HKD/SGD	1,52%	5,86%	0,00%	0,00%	0,00%		
HKD/CAD	1,52%	0,72%	0,00%	0,00%	0,00%		
HKD/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
HKD/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
SGD/CAD	1,52%	0,03%	100,00%	4,52%	1,16%		
SGD/SEK	1,52%	0,01%	0,00%	1,82%	1,47%		
SGD/NOK	1,52%	0,05%	0,00%	0,00%	0,60%		
CAD/SEK	1,52%	0,02%	0,00%	0,00%	0,00%		
CAD/NOK	1,52%	2,37%	0,00%	0,00%	0,00%		
SEK/NOK	1,52%	0,05%	0,00%	3,82%	1,18%		
Sum Wt	100,00%	100,00%	100,00%	100,00%	100,00%	AUD/JPY	AUD/JPY
Expected Ret.	0,013%	0,003%	0,087%	0,014%	0,010%	0,2324%	0,4647%
Portfolio Std.	0,003157	0,000403	0,005848	0,000491	0,000615	0,05726	0,11452
Sharpe Ratio	0,0418	0,0626	0,1491	0,2811	0,1567	0,0406	0,0406

Portfolio Optimization 2008					Max Sharpe Ratio 2007	AUD/JPY 2008 Returns Leverage 5 to 1	AUD/JPY 2008 Returns Leverage 10 to 1
Const. Var.	Equal Weight	Min St Dev	Max Returns	Max SR			
Val. of Const.	None	Std. Dev. <=	Ang. Ret. >=	None			
	N/A	0,000368	0,0660%	N/A			
Portfolio Weights							
EUR/USD	1,52%	0,00%	0,00%	0,00%	0,00%		
USD/CHF	1,52%	0,00%	0,00%	1,64%	0,00%		
USD/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
GBP/USD	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/USD	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/USD	1,52%	0,01%	0,00%	0,00%	0,00%		
USD/HKD	1,52%	96,89%	0,00%	72,82%	78,38%		
USD/SGD	1,52%	0,00%	0,00%	0,00%	0,00%		
USD/CAD	1,52%	0,00%	0,00%	0,00%	0,63%		
USD/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
USD/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
EUR/CHF	1,52%	0,01%	0,00%	0,00%	5,64%		
EUR/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
EUR/GBP	1,52%	0,17%	0,00%	3,18%	0,00%		
AUD/EUR	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/EUR	1,52%	0,00%	0,00%	0,00%	0,00%		
EUR/HKD	1,52%	0,01%	0,00%	0,00%	0,00%		
EUR/SGD	1,52%	0,34%	0,00%	4,25%	0,00%		
EUR/CAD	1,52%	0,35%	0,00%	3,13%	0,00%		
EUR/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
EUR/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
JPY/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
GBP/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
HKD/CHF	1,52%	0,20%	0,00%	0,00%	0,00%		
SGD/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
CAD/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
SEK/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
NOK/CHF	1,52%	0,01%	0,00%	0,00%	0,00%		
GBP/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
HKD/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
JPY/SGD	1,52%	0,00%	0,00%	0,00%	0,00%		
CAD/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
JPY/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
JPY/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
GBP/AUD	1,52%	0,01%	0,00%	0,00%	0,00%		
GBP/NZD	1,52%	0,00%	0,00%	0,55%	0,63%		
GBP/HKD	1,52%	0,00%	0,00%	0,00%	0,00%		
GBP/SGD	1,52%	0,00%	0,00%	0,00%	0,00%		
GBP/CAD	1,52%	0,00%	0,00%	0,00%	0,86%		
GBP/SEK	1,52%	0,17%	0,00%	0,00%	0,00%		
GBP/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/NZD	1,52%	0,34%	0,00%	5,42%	3,71%		
AUD/HKD	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/SGD	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/CAD	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/HKD	1,52%	0,01%	0,00%	0,00%	0,00%		
NZD/SGD	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/CAD	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
HKD/SGD	1,52%	1,17%	0,00%	8,53%	0,00%		
HKD/CAD	1,52%	0,00%	0,00%	0,00%	0,00%		
HKD/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
HKD/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
SGD/CAD	1,52%	0,02%	0,00%	0,00%	4,52%		
SGD/SEK	1,52%	0,01%	100,00%	0,47%	1,82%		
SGD/NOK	1,52%	0,02%	0,00%	0,00%	0,00%		
CAD/SEK	1,52%	0,02%	0,00%	0,00%	0,00%		
CAD/NOK	1,52%	0,20%	0,00%	0,00%	0,00%		
SEK/NOK	1,52%	0,06%	0,00%	0,00%	3,82%		
Sum Wi	100,00%	100,00%	100,00%	100,00%	100,00%	AUD/JPY	AUD/JPY
Expected Ret.	-0,036%	0,003%	0,066%	0,013%	0,001%	-0,5909%	-1,1818%
Portfolio Std.	0,006438	0,000368	0,010519	0,000902	0,000875	0,11369	0,22739
Sharpe Ratio	-0,0561	0,0798	0,0627	0,1470	0,0091	-0,0520	-0,0520

Portfolio Optimization 2009					Max Sharpe Ratio 2008	AUD/JPY 2009 Returns Leverage 5 to 1	AUD/JPY 2009 Returns Leverage 10 to 1
	Equal Weight	Min St Dev	Max Returns	Max SR			
Const. Var.	None	Std. Dev. <=	Ang. Ret. >=	None			
Val. of Const.	N/A	0,000100	0,1313%	N/A			
Portfolio Weights							
EUR/USD	1,52%	0,13%	0,00%	0,00%	0,00%		
USD/CHF	1,52%	0,04%	0,00%	0,00%	1,64%		
USD/JPY	1,52%	0,05%	0,00%	3,48%	0,00%		
GBP/USD	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/USD	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/USD	1,52%	0,00%	0,00%	0,00%	0,00%		
USD/HKD	1,52%	97,02%	0,00%	40,90%	72,82%		
USD/SGD	1,52%	0,11%	0,00%	0,00%	0,00%		
USD/CAD	1,52%	0,00%	0,00%	0,00%	0,00%		
USD/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
USD/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
EUR/CHF	1,52%	0,23%	0,00%	0,00%	0,00%		
EUR/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
EUR/GBP	1,52%	0,02%	0,00%	2,50%	3,18%		
AUD/EUR	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/EUR	1,52%	0,00%	0,00%	3,75%	0,00%		
EUR/HKD	1,52%	0,21%	0,00%	0,00%	0,00%		
EUR/SGD	1,52%	0,00%	0,00%	0,00%	4,25%		
EUR/CAD	1,52%	0,00%	0,00%	0,00%	3,13%		
EUR/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
EUR/NOK	1,52%	0,05%	0,00%	0,01%	0,00%		
JPY/CHF	1,52%	0,07%	0,00%	0,00%	0,00%		
GBP/CHF	1,52%	0,01%	0,00%	0,00%	0,00%		
AUD/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
HKD/CHF	1,52%	0,17%	0,00%	4,22%	0,00%		
SGD/CHF	1,52%	0,35%	0,00%	1,34%	0,00%		
CAD/CHF	1,52%	0,17%	0,00%	3,33%	0,00%		
SEK/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
NOK/CHF	1,52%	0,00%	0,00%	0,00%	0,00%		
GBP/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/JPY	1,52%	0,00%	100,00%	0,00%	0,00%		
NZD/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
HKD/JPY	1,52%	0,29%	0,00%	6,90%	0,00%		
JPY/SGD	1,52%	0,00%	0,00%	0,00%	0,00%		
CAD/JPY	1,52%	0,00%	0,00%	0,00%	0,00%		
JPY/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
JPY/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
GBP/AUD	1,52%	0,05%	0,00%	0,00%	0,00%		
GBP/NZD	1,52%	0,00%	0,00%	0,54%	0,55%		
GBP/HKD	1,52%	0,02%	0,00%	0,00%	0,00%		
GBP/SGD	1,52%	0,08%	0,00%	0,00%	0,00%		
GBP/CAD	1,52%	0,15%	0,00%	5,21%	0,00%		
GBP/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
GBP/NOK	1,52%	0,08%	0,00%	5,74%	0,00%		
AUD/NZD	1,52%	0,10%	0,00%	9,57%	5,42%		
AUD/HKD	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/SGD	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/CAD	1,52%	0,00%	0,00%	0,00%	0,00%		
AUD/SEK	1,52%	0,10%	0,00%	0,00%	0,00%		
AUD/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/HKD	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/SGD	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/CAD	1,52%	0,00%	0,00%	0,00%	0,00%		
NZD/SEK	1,52%	0,01%	0,00%	0,00%	0,00%		
NZD/NOK	1,52%	0,02%	0,00%	2,94%	0,00%		
HKD/SGD	1,52%	0,08%	0,00%	3,83%	8,53%		
HKD/CAD	1,52%	0,11%	0,00%	0,00%	0,00%		
HKD/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
HKD/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
SGD/CAD	1,52%	0,21%	0,00%	0,00%	0,00%		
SGD/SEK	1,52%	0,00%	0,00%	0,00%	0,47%		
SGD/NOK	1,52%	0,00%	0,00%	2,08%	0,00%		
CAD/SEK	1,52%	0,00%	0,00%	0,00%	0,00%		
CAD/NOK	1,52%	0,00%	0,00%	0,00%	0,00%		
SEK/NOK	1,52%	0,07%	0,00%	3,65%	0,00%		
Sum Wi	100,00%	100,00%	100,00%	100,00%	100,00%	AUD/JPY	AUD/JPY
Expected Ret.	0,034%	0,001%	0,131%	0,025%	0,001%	0,6563%	1,3127%
Portfolio Std.	0,004277	0,000100	0,014725	0,000982	0,000641	0,07363	0,14725
Sharpe Ratio	0,0784	0,1190	0,0891	0,2540	0,0165	0,0891	0,0891