BTRM

A case study in carry trade and cross pair allegiance switching, pre and post 2008

BTRM Working Paper Series # 3

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December 2015

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EUR/USD, USD/JPY and the position of EUR/JPY was investigated in this paper using regression analysis with the overarching question where EUR/JPY sits in relation to both pairs and its position in terms of a carry trade. What was determined was EUR/JPY switches allegiance period to period. The carry trade premise is to borrow a low interest rate currency and lend in a high interest rate currency. The low interest rate currency becomes the fund currency while the high interest rate currency becomes the investment. The historical assumption promulgates as long as the condition of Uncovered Interest Parity fails, actual carry trades may last for years as an interest rate arbitrage until a possible shock hits the markets or until the disparity in interest rates compresses to Covered Interest Parity whereby positions are covered.

Introduction

The core of carry trades is found in Uncovered Interest Parity and interest differentials. The UIP condition states high interest rate currencies tend to appreciate relative to low interest rate currencies and violates previous UIP findings. Dated since Fama (1984) in scores of studies, the interest differential between two nations should equal the expected exchange rate. Exchange rate regression on interest differentials should offer intercept 0 and coefficient 1. Instead, the coefficient is negative to inform higher interest rate currencies tends to appreciate. The counter argument to UIP is Fama's Forward Premium Puzzle. Currencies traded at forward premiums tend to depreciate.

As an exchange rate derived from EUR/USD and USD/JPY, EUR/JPY shares exclusive connections to either EUR/USD or USD/JPY. As an alliance with EUR/USD, markets favor risk exposure and risk averse as an allegiance to USD/JPY. Alignments validate proclivities of markets, informs a market message and EUR/JPY substantiates strength or weakness to risk exposure or risk aversion. EUR/JPY price movements are not only responsive to either EUR/USD or USD/JPY but its price disposition is dependent on the complexion of traded markets, periodic nature of markets, attachment EUR/JPY shares with either EUR/USD or USD/JPY and length of time of the relationship.

EUR/JPY assumed a wholesale positional adjustment in 2008, a market change in a categorical realignment as loyalty was shifted from risk pair EUR/USD to risk averse USD/JPY. A question remains if the 2008 crash was the cause or if the prior and assumed 10 year EUR/USD, EUR/JPY association achieved statistical exhaustion. Correlations, r squared, r squared adjusted, rho and t scores attained vital peaks by 2008.

As periods, the official United States 1982 Gold Report documents approximately 50 year intervals between Gold and free float currency durations and dates to the 1500's. If the December 1971 Smithsonian Agreement measured as the free float commencement date, the current term enters not only year 45 but possibly market shifts and currency pair realignments may conceivably be viewed as 12.5 years when separated in four quadrants. As such, possible turning points since 1971 would occur in 1983, 1995, 2007, 2019 and 2021 as the 50 year end point. From January 1972, possible turning points would transpire in 1984, 1996, 2008, 2020 and 2022 as the 50 year end point. Predominant market arrangements endured from the 1971 Smithsonian Agreement to the 1985 Plaza Accords then from the 1987 Louvre Accords to the December 1994 Mexican Peso crisis. Market crashes since 1971 materialized in 1987, 1994, 1997 Thai Baht, 2001 and 2008. Year 2008 qualified as a turning point and its possible the crash was the catalyst to switch EUR/JPY from EUR/USD to USD/JPY.

This paper investigates further structural and positional relationships between and among EUR/USD, USD/JPY and EUR/JPY pre and post 2008. The paper is organized as follows. Section 2 presents data and methodologies, Section 3 demonstrates results and Section 4 concludes.

I Literature Review

Historic rise of carry trades from the "currency wars" of the 1930's and settlement by the 1936 Tripartite Agreement to the Gold standard and then overnight sensation of Euro Bonds and Eurodollars in the 1960's is found in minute detail in "Gold Wars, The Story of the World's Monetary Crisis", (Weil and Davidson 1971). Eurodollars began the slow development in not only interest rate markets and connection to carry trades with origination and sales in London money markets but floating exchange rates in the 1970's. The slow rise in interest rate markets and carry trades is seen in Frenkel and Levich (1975) who found arbitrage opportunities were fleeting due to transaction cost and this led to wide bands between and among interest rates. Further, Frenkel and Levich also found neutral bands around Interest Rate Parity to limit profit opportunities.

Fama's contribution to the study of Efficient Markets (1970) and the Forward Premium Puzzle (1984) led to 30 years of research in carry trades and interest differentials, profit opportunities, returns and many other respects. The combination of Efficient Markets, carry trades and interest rate differentials is seen for example in Brunnermeier, Nagel and Pedersen (2008) as carry trades were viewed in terms of the VIX. Quoted papers are few as works range in a 40 year time span.

II Data and Methodology

To understand the relative relationship and position of EUR/JPY in terms of USD/JPY and EUR/USD, 5,532 exchange rates between weekly and monthly closing Spot prices were documented for the pre-crisis period from 1/5/2000 - 7/4/2008 and post crisis period from 7/4/2008 – 4/15/2014. A total of 12 samples were observed separated by weekly and monthly time frames for each paired relationships. The year 2000 was chosen to yield consistency as it allowed one full year of Euro market trading from its January 1999 introduction and because world central banks adopted interval meetings every six weeks. To further capture the true market price and accurate Simple Regression analysis, July 2008 was chosen as the start date post 2008 because market prices failed to reflect the housing crisis dilemma that occurred one month later in mid-August 2008.

For pre and post 2008, EUR/USD and USD/JPY were employed as the dependent variable and EUR/JPY as the independent variable. To understand a true cause and effect, EUR/USD as the dependent variable was positioned against USD/JPY as the independent variable for both pre and post 2008 periods, weekly and monthly. The research design assumption was EUR/USD or USD/JPY influences EUR/JPY but to guard against a false presupposition, EUR/USD was measured against USD/JPY to add validity, an insight and determine a possible positional balance against the sample statistics.

The US Dollar was chosen because it remains "on either side of every trade 87% post 2008 and 90% pre 2008" based on the Bank of International Settlements Triennial Surveys 2001 - 2013. (BIS.org).

The Euro maintains its status as the second most widely traded pair with a daily average turnover of 33% market share in 2013, 39% in 2010, 27% in 2007, 28% in 2004 and 30% in 2001, (Bis.org).

As the third most widely traded currency pair, the Japanese Yen experienced a 63% increase in daily turnover activity from 2010 - 2013 and a 19% - 23.0% surge in USD/JPY. Historic Yen daily average turnover varied 14% - 23% during the time period of 2001 - 2013. Currently, Yen daily average turnover remains at historic peaks.

EUR/JPY still maintains its historic 3% daily average turnover between 2001 and 2013 but increases in actual trading values in billions increased from 36 billion in 2001 to 147 billion in 2013. EUR/JPY still remains from 2001 - 2013 the most widely traded currency pair among all cross pairs in both daily average market share and turnover amounts, (Bis.org).

III Results

A. EUR/USD vs EUR/JPY Correlations

For the time frame of 2000 – 2008, on a weekly basis EUR/USD and EUR/JPY not only shared a 0.93% correlation but a healthier and positive r squared covariance of 0.87%. Based on rho population parameters, the correlation and r squared values are significant throughout all samples.

By 2008 - 2014, the weekly relationship completely reversed to a correlation of 0.60% and r squared of 0.36%. The EUR/USD between 2000 - 2008 and monthly EUR/JPY experienced a correlation of 0.93% and r squared of 0.87% while the monthly relationship between 2008 - 2014 represented a reduced correlation of 0.57% and r squared of 0.32%.

B. USD/JPY Vs EUR/JPY Correlations

USD/JPY correlation for the weekly time frame between 2000 - 2008 was negative 0.11% and an R squared of 0.01% while the weekly period between 2008 - 2014 turned positive with a 0.91% correlation and R squared of 0.83%. The monthly period between 2000 - 2008 provided confirmation as the correlation was negative 0.15% and R squared of 0.02% while 2008 - 2014 again attained a positive correlation of 0.91% and R squared of 0.82%.

C. EUR/USD Vs USD/JPY Correlations

An interesting relationship developed between 2000 - 2008 as the weekly correlation revealed negative 0.45% and an R squared of 0.20% and confirmed significantly among all pairs pre-2008 the allegiance EUR/JPY shared exclusively with the EUR/USD. Between the 2008 – 2014 weekly periods, correlations turned positive at 0.22% and R squared of 0.05%. The monthly time frames confirms further the weekly scenario as the 2000 - 2008 correlation revealed a connection of negative 0.48% and R squared of 0.23% while the 2008 - 2014 period calculated a correlation of positive 0.18% and R squared of 0.03%.

D. Variation

As a consequence of R squared values, 13% unexplained variation between EUR/USD and EUR/JPY pre 2008 existed while post 2008 experienced 18% and 17% unexplained variation between USD/JPY and EUR/JPY. For EUR/USD and USD/JPY pre 2008, 80% of the weekly variation is unexplained while 77% variation is unexplained in the monthly time frame.

Post 2008, 95% unexplained variation existed in the weekly time period and 97% for the monthlies.

E. EUR/JPY Allegiance and RHO

A possible explanation why EUR/JPY transferred its allegiance from EUR/USD to USD/JPY is seen in rho as a measure of the correlation significance in the pre-2008 period. Correlations seen in rho for EUR/USD and EUR/JPY were approaching the upper limits of the 95% and 99% percentiles for the weekly and monthly periods.

As a corollary, USD/JPY and EUR/JPY approached critical 95% and 99% rho limits for both the weekly and monthly time frames. EUR/USD possibly saw its meridian against EUR/JPY and USD/JPY a possible base evidenced by rho therefore EUR/JPY was in a crucial position particularly when EUR/USD and USD/JPY shared essentially no relationship by unexplained variations in both pre and post 2008.

Fascinating is EUR/JPY not only chose its future relationship to USD/JPY post 2008 but the alliance came full circle as the dependence pre 2008 was negative and now the correlation approaches upper Rho's 95% confidence interval.

F. Covariance and EUR/JPY

Covariance as a measure of further strength of association directly related to the X, Y variables and expected values reveals a strong positive relationship between EUR/USD and EUR/JPY pre 2008 on the weekly and monthly time periods. Conversely, USD/JPY and EUR/JPY pre 2008 factors a strong negative association. EUR/USD and USD/JPY also reveal a negative homogeneity but barely negative yet adverse enough to expose the substantial association EUR/USD shared with EUR/JPY.

By the post 2008 period, covariance values had completely reversed on the weekly and monthly time frames to reveal USD/JPY and EUR/JPY shared a vigorously positive alliance and EUR/USD and EUR/JPY revealed a barely positive relationship. As the relationship between EUR/USD and USD/JPY was barely negative pre 2008, the post 2008 period now reveals a slight positive relationship.

As a strength of relationship variable to further define EUR/JPY positions within the EUR/USD and USD/JPY framework, covariance addresses first the question of joint distributions because the question is acknowledged by actual values and means symmetrically by the covariance formula: Sigma X,Y = Covariance (X, Y) = E (X minus Ux) (Y minus Uy). The magnitude of covariance is defined as how far X and Y vary symmetrically from their means as dependence rather than independence is sought in EUR/JPY terms. If X and Y were independent, both variables would assume zero correlation.

Covariance values are linear associations and intended to measure strength of covariation or strength of associations. Correlation is an inequality and unitless due to its +1, -1 measure but represents a measure of a sample to address questions of cause and effect, coincidences and sample co-variation.

If Correlation is defined as co-variation X, Y/ sigma X, sigma Y then covariance defines correlational strength. By measuring X and Y minus means and obtaining positive deviate values, X and Y means are positive and co vary as was the case for EUR/USD and EUR/JPY pre 2008. Covariance is found between the bounds of correlational +1 and -1. Essentially, covariation removes part of the variability of Y that co varies with X and focuses on the remainder sections: the Residual Variance.

What allowed EUR/JPY to assume a strong positive relationship with EUR/USD pre-2008 was USD/JPY had a negative covariance with EUR/USD, USD/JPY means were negative while both EUR/USD and EUR/JPY means were positive. When the August 2008 Housing crisis was announced, means for EUR/USD, USD/JPY and EUR/JPY all dropped considerably but USD/JPY and EUR/JPY prices fell below respective means therefore a new covariance relationship formed as USD/JPY and EUR/JPY.

EUR/USD maintained a weak association with EUR/JPY because EUR/USD prices remained slightly above its mean and the aftermath was seen in lower correlation and R squared values. Had EUR/USD prices fell below its respective mean, EUR/USD and EUR/JPY as a covariance and correlation relationship would have completely severed and melded into a complete paradigm shift among the three pairs because USD/JPY was below its complementary mean. EUR/JPY choices at this juncture was either break above its mean and reattach to EUR/USD or assume a new relationship with USD/JPY. Instead, EUR/JPY shifted allegiance from EUR/USD to USD/JPY.

G. Carry Trade Crash Risks

Many studied the concept of Carry Trade crash risk. Brunnermeier, Nagel and Petersen (2008) reveal investment currencies are subject to crash risk due to funding constraints as it relates to the VIX, the implied volatility of the S & P 500. Burnside (2011) failed to classify the housing polemic as a crisis because his portfolio consisted of carry and momentum. If carry lost then momentum profited. Hutchison and Sushko (2013) look at carry trades and macroeconomic surprises as it relates to global risk.

H. Residuals

Residual plots, defined as predicted y minus y are provided for both weekly and monthly time frames pre and post 2008. All plots display homoscedasticity, constant variances, non-linearity to response variables, and lack autocorrelation therefore all pairs contain the same variances. Residual means are zero, therefore slope and intercept lines are accurate.

I. EUR/JPY and Standard Errors

Standard Error Estimates inform EUR/JPY positional change pre 2008 against USD/JPY as the weekly errors were 19.8 for the weekly and 20.8 for the monthly. Post 2008, errors reduced to a robust 6.3 for both the weekly and monthly periods. EUR/USD and EUR/JPY pre-2008 displayed a 7.2 Standard Error and rose to 12.2 and 12.5 for the weekly and monthly time periods respectively for post-2008 data. EUR/USD and USD/JPY shared a 6.5 error pre-2008 for the weekly and monthly period but saw a slight rise post-2008 to 8.9 and 9.1 for the weekly and monthly data respectively. Standard error further informs a fairly constant relationship between EUR/USD and USD/JPY to allow EUR/JPY movements within the confines of EUR/USD and USD/JPY.

J. EUR/JPY and Interest Rates

If the carry trade in interest rate terms and EUR/JPY's positional change is an assessment, Europe, Japan and the United States experienced reduced interest rates since year 2000. The United States Fed Funds rate March 2000 was 6.50% and 5.75% for the Euro Refinance Rate October 2000. The carry trade as USD/EUR was the opportune position until September 2007 when the Fed Funds rate fell to 4.75% and the Refinance Rate was 5.0% by July 2007. EUR/USD became the new Carry trade post 2008 until both saw an equalized interest rate of 0.25% post 2008.

Both USD/JPY and EUR/JPY worked as a carry trade pre and post 2008 because Japan's Base Rate, the Overnight Call Rate was 0.25% August 2000, 0.00 March 2001 and 0.50% February 2007. The Overnight Call Rate today is 0.1% for post 2008. Gyntelberg and Remolona (2007) and many others identified the failure of the Uncovered Interest Parity condition in five year time horizons. August 2014 will be the sixth year approximately for the USD/JPY and EUR/JPY relationship. A speculative assumption and topic specific to carry trade crash risk is EUR/USD and EUR/JPY began their association at the time of the 1997/ 1998 Asian financial crisis. The relationship was found in 2000 as research began. When and how long the relationship began is unknown. What is known post-2008, EUR/JPY and USD/JPY relationship mirrors the exact position of EUR/JPY and EUR/USD before the crisis. The question of will a market crash occur to force a breakdown of the allegiance to see EUR/JPY switch loyalties again to EUR/USD is unknown, nor is it known if a market implosion is the essential element to experience a change.

K. Regression Slopes and Intercepts

EUR/USD and EUR/JPY revealed a positive slope and Y intercept pre 2008 on both weekly and monthly time frames but post 2008, slopes steepened and intercepts turned negative for both the weekly and monthly periods. The weekly rather than monthly period saw the most dramatic increase, 131.23 vs 122.15 for the monthly and a 908 Pip difference.

Again the opposite effects occurred between USD/JPY and EUR/JPY pre-2008 as slopes were negative, yet barely, and intercepts positive. The monthly intercept revealed 179.27 and the weekly period 168.67, a 1060 pip difference. As EUR/JPY left its EUR/USD loyalty post 2008, USD/JPY and EUR/JPY assumed a positive slope post 2008 during the weekly and monthly period and a negative intercept. EUR/USD and USD/JPY shared a negative slope and positive intercept pre-2008 and positive slope and intercept post 2008.

In price movement terms, USD/JPY and EUR/JPY experienced a wholesale change in their renewed relationship pre to post 2008 as the slope line reversed from negative to positive.

To accommodate the change, EUR/USD and USD/JPY also experienced a wholesale change of slopes from negative pre-2008 to positive post-2008. The EUR/USD and EUR/JPY slope extended rather than dropped.

Despite steepness and changes of slopes, the slope definition is average amount of Y increases or decreases as a function of X. If error terms are random, normally distributed with positive and negative values then the assumption in any Regression model is $E(e) = 0$. Therefore, the standard deviation of e represented as sigma xy remains constant over all values of X.

With presence of Homoscedasticity, the supposition remains that $E(y) = Y + BX$. The coefficients B and Y are average values however Y remains a constant and B the coefficient so to explain the variation of EUR/JPY as Y.

L. Slope, T test and EUR/JPY

To determine how different the slope of the Regression line is from 0, a t test on the B coefficients was determined by the equation B divided by SE and is distributed as a t-distribution to test the hypothesis that B = 0. In all values of t measured in each paired instances, significance was observed and therefore rejected Ho.

Since t-values measure slopes and errors regard distance, EUR/JPY Vs EUR/USD pre-2008 calculated to a t value of 54.4 for the weekly and 26.6 for the monthly and an error of 7.2 for both time frames. Post 2008, t-values decreased, errors increased and slopes remained positive for pre and post 2008. USD/JPY and EUR/JPY experienced negative t values, large errors and negative slopes pre 2008 but positive t values, small errors and positive slopes post-2008.

EUR/USD and USD/JPY experienced negative t values, small errors and negative slopes for both the weekly and monthly periods pre 2008. Post 2008, t values were positive, errors increased slightly and slopes were positive.

M. Weekly Versus Monthly Values

The vast majority of past carry trade research employed monthly values and dates its history to 1984 and Eugene Fama's identification of the Forward Premium Puzzle. Weekly findings were consistent with monthly values in all technical analysis until large differences were recognized between monthly and weekly slopes and intercepts.

N. Carry Trade Definition

Carry trades are based on FX points per day, per month, per year and answers the question how many pips are earned to carry positions. The indispensable aspect is earn more points than is paid to derive compensation to offset price depreciation in a long currency pair position.

The complexity of carry trades changed in 1994 when closing spot prices were marked to market therefore gains and losses were marked daily. Previously, FX points ran throughout the life of the contract term as traders earned the difference cumulatively without showing daily mark to market loses so carry trade positions were carried to maturity. Losses, risk/reward, crash risk is determined by the question is earnings in points enough to offset a currency price depreciation or an implosion that might strike the market.

FX points calculate as closing spot price X interest differential divided by Day Count X spot lots or futures contracts. Findings suggest carry trades contain two distinct definitions. One is interest differential income and the other price appreciation. Both are based on the theory of expectation. The sine qua non is to define interest differential in terms of nominal versus real interest rates over time or in longer 20 - 50 year terms as a natural interest rate first identified as an equilibrium rate by Knut Wiksell (1898).

Price appreciation / depreciation is then defined in terms of carry trade holding periods and length of time in trades. Essentially, an FX point is the interest differential and employed as predictor of future spot prices but it is defined as the cost to carry positions, formally as the Forward Discount. Currency risk is not found necessarily in the investment side of the long position to earn yield but the cost or borrow side may not continue to assist financing the long position. Uncovered Interest Parity equals Forward Discount equals Interest differential, same terms.

EUR/JPY experienced temporary price and permanent interest rate depreciation pre to post 2008. The genesis of 2000 saw EUR/JPY paid 5.75% vs 0.50% pre 2008 vs 0.25% and 0.1% post 2008. Carry trade losses / gains in FX points are found by length of time in the position and income earnings pre vs post 2008. Possible losses were experienced from reduced disbursements post 2008 but were losses enough to offset pre-2008 gains. Current price trades in excess of returns pre and post 2008, 131.39 pre 2008 and 121.30 post-2008.

Excess returns calculates as r t + 1 = Spot price t + 1 divided by Spot t X (1 + Domestic interest rate) minus (1 + foreign interest). Gains / cost versus borrowing cost represented in equation 1 as gains and cost represented in equation 2 are known. Calculated to the future spot price is represented as F t + 1 = S t 1 + foreign Currency divided by 1 + Domestic currency. If interest parity holds as assumed then the future price equalizes to the spot price to earn excess returns.

O. Carry Trade and EUR/JPY

EUR/JPY is a currency pair whose position is found within the bounds between EUR/USD and USD/JPY. Since EUR/JPY is derived from EUR/USD and USD/JPY by USD subtraction, boundaries must hold residual constants or EUR/JPY transforms as a free floating financial instrument without a connection to EUR/USD or USD/JPY. While residual constants hold firm, EUR/JPY may change allegiance year to year, period to period or possibly crash to crash. An allegiance switch implies EUR/JPY boundaries range wide or small within EUR/USD or USD/JPY residual variances.

The assumption EUR/JPY maintains a perfect 0.5 balance between EUR/USD and USD/JPY was not found however it does not imply a 0.5 balance is not possible. Perfect balance further implies EUR/JPY lacks allegiance and is solely independent of EUR/USD or USD/JPY. An explanation to perfect balance is EUR/USD and USD/JPY ranges varied widely enough against each other and reached polar opposite extremes. Since EUR/USD and USD/JPY are completely opposite pairs whose relationship barely holds a statistical relationship, EUR/JPY is allowed to roam freely between both pairs. Findings suggest however EUR/JPY is influenced by either EUR/USD or USD/JPY but not both so a 0.5 balance may be fleeting instances along time horizons. Therefore, EUR/JPY is either EUR/USD or USD/JPY in co varying movements.

The EUR/JPY carry trade is then defined further to include either EUR/USD or USD/JPY. To view EUR/JPY exclusively in carry trade terms fails the full comprehensiveness contained within carry trades.

P. Money Supply and Economic Change

A fundamental economic theory that caused EUR/JPY to change its status pre to post 2008 can be viewed in money supply terms rather than directly relate a wholesale EUR/JPY positional change to the announcement of the housing crisis polemic. Housing was the cause, the effect was central banks worldwide adopted Quantitative Easing stimulus spending through bond issuance. Known since John Maynard Keynes, interest rates share an adverse relationship to money supplies therefore interest rates since 2008 continuously dropped for all nations as money was issued. Nations then experienced a Keynesian liquidity trap dilemma by nations spending enough monies to drop the interest rate to either zero or near zero. Low and interest rate uncertainty brings small price movement to EUR/JPY due to shrinkage of the interest differential.

Quantitative Easing defined a wholesale economic change adopted by many nations as "Keynesian Economics" and "stimulus spending" from the previous 1980's supply side practices. Keynesian economics is a focus on the demand side of an economy while its corollary is practice based on supply. Both define EUR/JPY as an economic insight, a price, a carry trade and currency pair alignment.

IV Conclusion

EUR/JPY and its position revealed an attachment to EUR/USD or USD/JPY occurred throughout a 15 year period post and pre 2008. The carry trade in EUR/JPY terms was revealed by entering 5,532 exchange rates weekly and monthly pre and post 2008. EUR/JPY as a carry trade is defined based on its attachment to either EUR/USD or USD/JPY but not both. The perfect EUR/JPY 0.5 balance between EUR/USD and USD/JPY was not seen although the possibility exists in fleeting instances along time horizons. Carry trades were further defined by FX points and revelations to carry trade interest rates, time and holding periods. A possible fundamental explanation why EUR/JPY changed loyalty from EUR/USD to USD/JPY was a result of governmental adoption of QE. If EUR/JPY had a chance to reinstitute its EUR/USD attachment, the drop in interest rates and Keynes liquidity trap for all nations appeared to fail under that occurrence. Results were assessed through 12 separate samples and a host of statistics for technical analysis. EUR/JPY loyalties and allegiance switches were seen in statistics in a step by step approach.

Covariance was the preeminent statistic to see and understand how and why EUR/JPY transferred its loyalty from EUR/USD to USD/JPY. Slopes and regression lines was the pictorial result to understand how price traveled. The most pronounced regression lines was seen in USD/JPY and EUR/JPY pre and post 2008 due to a complete line reversal. The study encompassed three pairs yet its implications may lay the groundwork to other pairs and carry trade studies.

References

[1] Brunnermeier, Markus K., Nagel, Stefan, Pedersen, Lasse H., 2008, *"Carry Trades and Currency Crashes"*, National Bureau of Economic Research, Working Paper 14473

[2] Burnside, Craig, Eichenbaum, Martin, Rebelo, Sergio, 2011, *"Carry Trade and Momentum in Currency Markets"*. National Bureau of Economic Research, Working Paper 16942

[3] Fama, Eugene F., 1984, *"Forward and Spot Exchange Rates"*, Journal of Financial Economics.

[4] Fama, Eugene F., 1970, *"Efficient Capital Markets: A Review of Theory and Empirical Work"*, Journal of Finance

[5] Frenkel, Jacob A., Levich, Richard M., 1975, *"Covered Interest Arbitrage: Unexplained Profits"*, Journal of Political Economy

[6] Hutchison, Michael M., Sushko, Vladyslav, 2012, *"Impact of Macroeconomic Surprises on Carry Trade Activity"*, Journal of Banking and Finance.

[7] Triennal Central Bank Survey, 2013, *"Foreign Exchange Turnover in April 2013: Preliminary Global Results, Monetary and Economic Department Bank of International Settlements"*.

[8] Weil, Gordon L, Davidson, Ian, 1971, *"The Gold War: The Story of the World's Monetary Crisis"*, Holt, Rinehart and Winston

[9] Wiksell, Knut, *"Interest and Prices"*, 1st Edition, London, Royal Economic Society, 1936.

Appendix I: Data Tables

I — EUR/USD, EUR/JPY Weekly 2000-2008

Data Summary					Regression Statistics								P-Value		Confidence Intervals of Rho				Residuals			
ΣX	ΣY	ΣX²	ΣY²	ΣXY	N	df	r	r²	Adj. r²	Slope	Y-Int.	t	One-Tailed	Two-Tailed	.95 Lower Limit	.95 Upper Limit	.99 Lower Limit	.99 Upper Limit	df	S.S.	M.S.	St. Err. Of Estimate
511.9642	58423.76	607.5709	7865161	68998.57	444	442	0.933	0.87	0.87	94.653	22.443	54.458	<.0001	<.0001	0.92	0.944	0.916	0.947	442	23018.7	52.079	7.21654424

II — EUR/USD, EUR/JPY Monthly 2000-2008

Data Summary					Regression Statistics								P-Value		Confidence Intervals of Rho				Residuals			
ΣX	ΣY	ΣX²	ΣY²	ΣXY	N	df	r	r²	Adj. r²	Slope	Y-Int.	t	One-Tailed	Two-Tailed	.95 Lower Limit	.95 Upper Limit	.99 Lower Limit	.99 Upper Limit	df	S.S.	M.S.	St. Err. Of Estimate
119.289	13604.3	142.381	1839489	16152.9	103	101	0.94	0.88	0.874	93.96	23.26	26.65	<.0001	<.0001	0.907	0.956	0.896	0.961	101	5306.87	52.54	7.249

III — USD/JPY, EUR/JPY Weekly 2000 - 2008

Data Summary					Regression Statistics								P-Value		Confidence Intervals of Rho				Residuals			
ΣX	ΣY	ΣX²	ΣY²	ΣXY	N	df	r	r²	Adj. r²	Slope	Y-Int.	t	One-Tailed	Two-Tailed	.95 Lower Limit	.95 Upper Limit	.99 Lower Limit	.99 Upper Limit	df	S.S.	M.S.	St. Err. Of Estimate
50921.39	58422.76	5863713	7864835	6692729	444	442	-0.12	0.014	0.0117	-0.323	168.68	-2.5	0.0064	0.0128	-0.208	-0.026	-0.236	0.004	442	174930.7	395.77	19.8939878

IV — USD/JPY, EUR/JPY Monthly 2000 - 2008

Data Summary					Regression Statistics								P-Value		Confidence Intervals of Rho				Residuals			
ΣX	ΣY	ΣX²	ΣY²	ΣXY	N	df	r	r²	Adj. r²	Slope	Y-Int.	t	One-Tailed	Two-Tailed	.95 Lower Limit	.95 Upper Limit	.99 Lower Limit	.99 Upper Limit	df	S.S.	M.S.	St. Err. Of Estimate
11811.82	13604.39	1360198	1839505	1557800	103	101	-0.15	0.022	0.0128	-0.412	179.28	-1.522	0.0656	0.1311	-0.333	0.044	-0.387	0.106	101	41661.87	412.49	20.3099436

V — EUR/USD, USD/JPY Weekly 2000-2008

Data Summary					Regression Statistics								P-Value		Confidence Intervals of Rho				Residuals			
ΣX	ΣY	ΣX²	ΣY²	ΣXY	N	df	r	r²	Adj. r²	Slope	Y-Int.	t	One-Tailed	Two-Tailed	.95 Lower Limit	.95 Upper Limit	.99 Lower Limit	.99 Upper Limit	df	S.S.	M.S.	St. Err. Of Estimate
511.9549	50891.28	607.5533	5856727	58393.48	444	442	-0.45	0.202	0.2006	-16.63	133.8	-10.59	<.0001	<.0001	-0.521	-0.373	-0.542	-0.348	442	18798.57	42.531	6.52155656

VI — EUR/USD, USD/JPY Monthly 2000-2008

Data Summary					Regression Statistics								P-Value		Confidence Intervals of Rho				Residuals			
ΣX	ΣY	ΣX²	ΣY²	ΣXY	N	df	r	r²	Adj. r²	Slope	Y-Int.	t	One-Tailed	Two-Tailed	.95 Lower Limit	.95 Upper Limit	.99 Lower Limit	.99 Upper Limit	df	S.S.	M.S.	St. Err. Of Estimate
119.2894	11811.82	142.3811	1360198	13605.48	103	101	-0.48	0.232	0.224	-17.6	135.06	-5.522	<.0001	<.0001	-0.617	-0.319	-0.654	-0.262	101	4335.262	42.923	6.55159409

VII — EUR/USD, EUR/JPY Weekly 2008-2014

Data Summary					Regression Statistics								P-Value		Confidence Intervals of Rho				Residuals			
ΣX	ΣY	ΣX²	ΣY²	ΣXY	N	df	r	r²	Adj. r²	Slope	Y-Int.	t	One-Tailed	Two-Tailed	.95 Lower Limit	.95 Upper Limit	.99 Lower Limit	.99 Upper Limit	df	S.S.	M.S.	St. Err. Of Estimate
412.7677	37137	560.1301	4593222	50457.87	305	303	0.605	0.366	0.364	131.23	-55.84	13.22	<.0001	<.0001	0.529	0.671	0.503	0.69	303	45280.39	149.44	12.2245746

VIII — EUR/USD, EUR/JPY Monthly 2008-2014

Data Summary					Regression Statistics								P-Value		Confidence Intervals of Rho				Residuals			
ΣX	ΣY	ΣX²	ΣY²	ΣXY	N	df	r	r²	Adj. r²	Slope	Y-Int.	t	One-Tailed	Two-Tailed	.95 Lower Limit	.95 Upper Limit	.99 Lower Limit	.99 Upper Limit	df	S.S.	M.S.	St. Err. Of Estimate
94.6841	8499.7	128.4175	1047913	11539.08	70	68	0.57	0.325	0.315	122.15	-43.8	5.72	<.0001	<.0001	0.387	0.709	0.322	0.745	68	10696.37	157.3	12.5419147

IX — USD/JPY, EUR/JPY Weekly 2008 - 2014

Data Summary					Regression Statistics								P-Value		Confidence Intervals of Rho				Residuals			
ΣX	ΣY	ΣX²	ΣY²	ΣXY	N	df	r	r²	Adj. r²	Slope	Y-Int.	t	One-Tailed	Two-Tailed	.95 Lower Limit	.95 Upper Limit	.99 Lower Limit	.99 Upper Limit	df	S.S.	M.S.	St. Err. Of Estimate
27407.02	37136.9	2488235	4593202	3375946	305	303	0.911	0.83	0.8299	1.526	-15.36	38.524	<.0001	<.0001	0.89	0.928	0.883	0.933	303	12105.72	39.953	6.32082722

X — USD/JPY, EUR/JPY Monthly 2008 - 2014

Data Summary					Regression Statistics								P-Value		Confidence Intervals of Rho				Residuals			
ΣX	ΣY	ΣX²	ΣY²	ΣXY	N	df	r	r²	Adj. r²	Slope	Y-Int.	t	One-Tailed	Two-Tailed	.95 Lower Limit	.95 Upper Limit	.99 Lower Limit	.99 Upper Limit	df	S.S.	M.S.	St. Err. Of Estimate
6275.22	8499.7	568429.4	1047913	770775	70	68	0.911	0.829	0.8269	1.495	-12.58	18.14	<.0001	<.0001	0.861	0.943	0.84	0.951	68	2702.465	39.742	6.30413633

XI — EUR/USD, USD/JPY Weekly 2008-2014

Data Summary					Regression Statistics								P-Value		Confidence Intervals of Rho				Residuals			
ΣX	ΣY	ΣX²	ΣY²	ΣXY	N	df	r	r²	Adj. r²	Slope	Y-Int.	t	One-Tailed	Two-Tailed	.95 Lower Limit	.95 Upper Limit	.99 Lower Limit	.99 Upper Limit	df	S.S.	M.S.	St. Err. Of Estimate
412.7707	27407.02	560.1381	2488235	37135.7	305	303	0.227	0.051	0.048	29.353	50.135	4.048	0.0001	0.0001	0.118	0.33	0.083	0.362	303	24158.95	79.733	8.92930631

XII — EUR/USD, USD/JPY Monthly 2008 - 2014

Data Summary					Regression Statistics								P-Value		Confidence Intervals of Rho				Residuals			
ΣX	ΣY	ΣX²	ΣY²	ΣXY	N	df	r	r²	Adj. r²	Slope	Y-Int.	t	One-Tailed	Two-Tailed	.95 Lower Limit	.95 Upper Limit	.99 Lower Limit	.99 Upper Limit	df	S.S.	M.S.	St. Err. Of Estimate
94.6841	6275.22	128.4175	568429.4	8496.307	70	68	0.183	0.034	0.019	23.935	57.271	1.538	0.0644	0.1288	-0.054	0.4	-0.128	0.461	68	5683.392	83.579	9.14217145

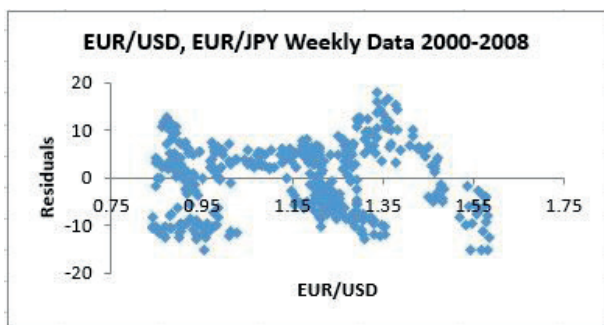## Appendix II: Residual Plots

Figure 1: Residual Plot EUR/USD, EUR/JPY Weekly 2000-2008
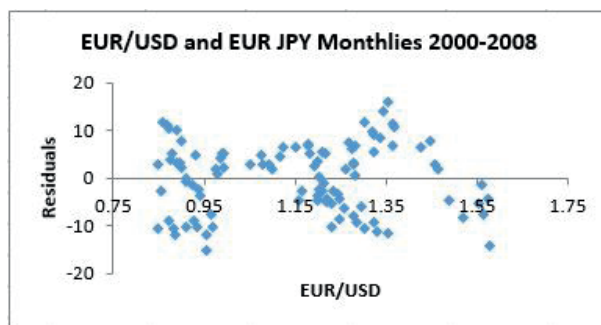

Figure 2: Residual Plot EUR/USD, EUR/JPY Monthly 2000-2008
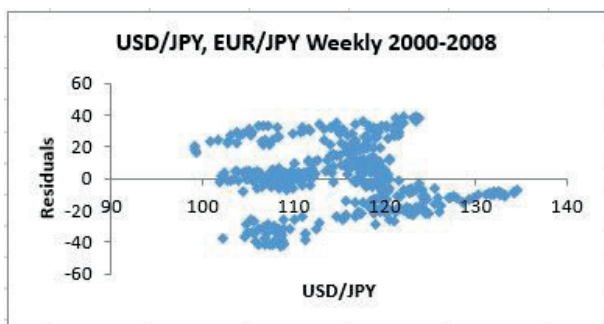

Figure 3: Residual Plot USD/JPY, EUR/JPY Weekly 2000-2008
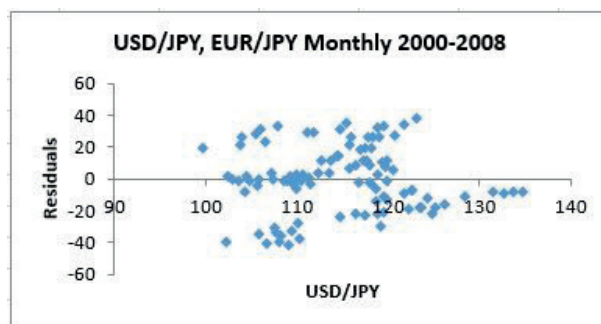

Figure 4: Residual Plot USD/JPY, EUR/JPY Monthly 2000-2008
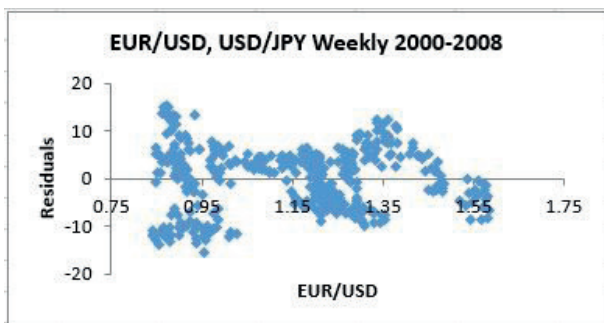

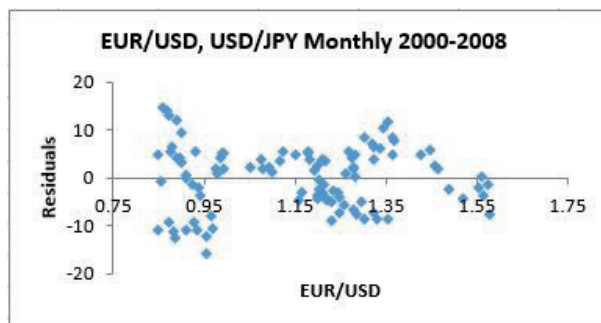
Figure 5: Residual Plot EUR/USD, USD/JPY Weekly 2000-2008

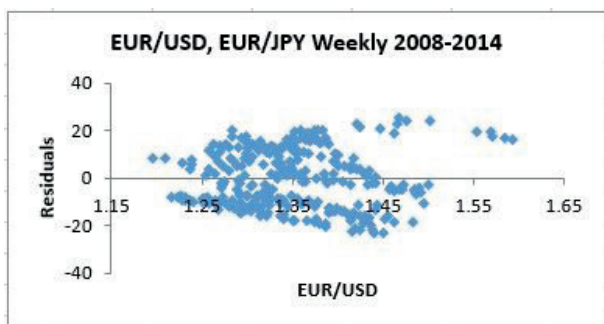Figure 6: Residual Plot EUR/USD, USD/JPY Monthly 2000-2008

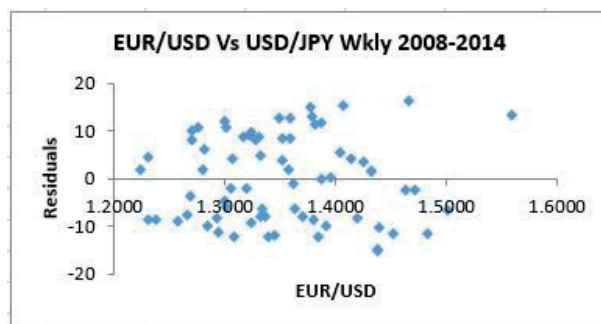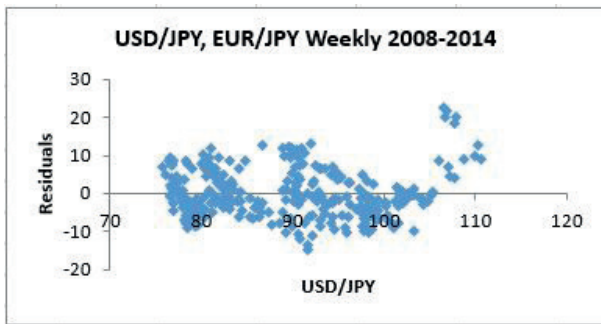

Figure 7: Residual Plot EUR/USD, EUR/JPY Weekly 2008-2014

Figure 8: Residual Plot EUR/USD, EUR/JPY Monthly 2008-2014

Appendix II: Residual Plots

Figure 9: Residual Plot USD/JPY, EUR/JPY Weekly 2008-2014
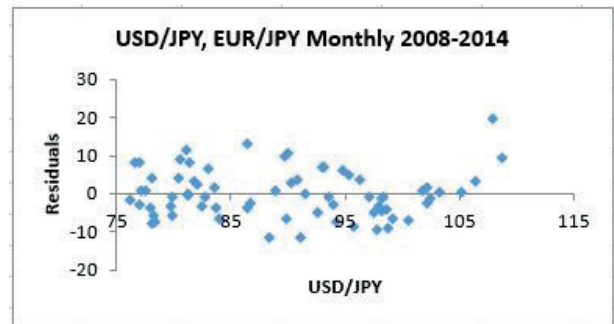

Figure 10: Residual Plot USD/JPY, EUR/JPY Monthly 2008-2014
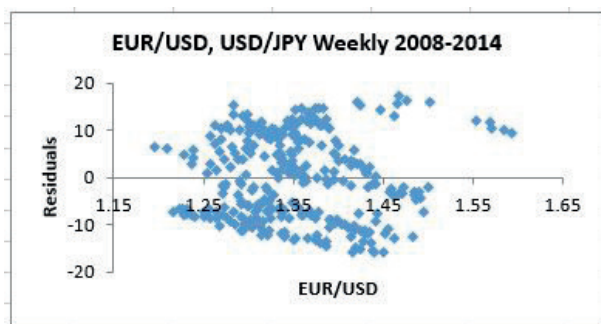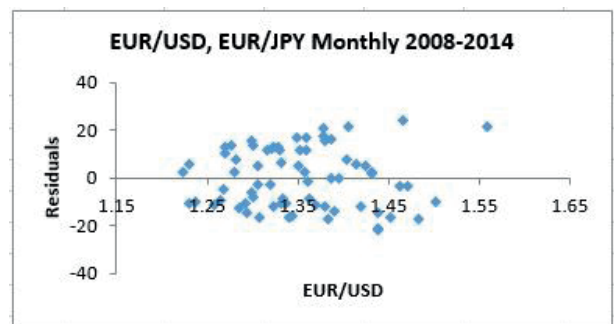

Figure 11: Residual Plot EUR/USD, USD/JPY Weekly 2008-2014

Figure 12: Residual Plot EUR/USD, USD/JPY 2008-2014