MASTERS OF SCIENCE IN FINANCE

AN INVESTIGATION INTO THE VIABILITY OF THE CARRY TRADE AS AN INVESTMENT STRATEGY, 2001 - 2015

By

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Abstract

The carry trade is an investment strategy which an investor borrows money at a low interest rate, then proceeds to invest that money into a country with a higher rate. One of the underlying theories that states carry trading should not be profitable is Uncovered Interest Parity. This assumption states that an investor looking to profit from the interest rate differential between two countries should not benefit because of the movements in the foreign exchange market. This theory has been historically disproved academically which has led to investors making excess returns. Furthermore, an inability to explain excess returns largely based on Fama's (1984) hypothesis of risk premium has left the finance industry scratching their head.

Recent literature suggests that for a number of currencies that a reversal in UIP has made carry trades unprofitable. This has been documented for a brief period after the financial crisis (until Sept 11'). This thesis investigates 9 carry trades over the period of period of 2001-2015. Through analysis on the characteristics of returns and their distributions it is evident there is large risk involved in the strategy. By splitting the data into relevant rime periods to fully assess its performance during the business cycles over the timeframe it gives conclusive evidence of performance. Using Sharpe ratios to measure risk adjusted compensation and a carry trade model for profitability it enables detailed analysis of when the trade is profitable. Alongside this assessment, the S&P500, FTSE 250 and Nikkei 225 are used to comparably evaluate the carry trades position in the investment landscape. It is discovered that the carry trades attraction post financial crisis has largely diminished as an investment strategy, but is concluded to be still profitable on the whole.

Keywords: Carry Trade, Investment, Foreign Exchange, Interest Rate, Risk Premium.

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Abbreviations

AUD – Australian Dollar

BRL – Brazilian Real

CAD – Canadian Dollar

CAPM – Capital Asset Pricing Model

C-CAPM – Consumption Capital Asset Pricing Model

CHF – Swiss France

CT – Carry Trade

DKK – Danish Krone

EMH – Efficient Market Hypothesis

ETF – Exchange Traded Funds

EUR – Euro

FPP – Forward Premium Puzzle

FX – Foreign Exchange

FT – Financial Times

GDP – Great British Pound

IBM – International Business Machines

JPY – Japanese Yen

LIBOR – London Interbank Offered Rate

NYSE – New York Stock Exchange

NBER – National Bureau of Economic Research

NOK – Norwegian Krone

NZD – New Zealand Dollar

PLN – Polish Zloty

RBA – Royal Bank of Australia

RIRO – Relative Interest Rate Opportunity

S&P – Standard and Poor

SPSS – Statistics Package for the Social Sciences (original name)

UIP – Uncovered Interest Parity

USD – United States Dollar

VIX – Volatility Index

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Chapter 1: Introduction

1.1: Background

“Change is the only constant in life” – Heraclitus

Over a couple of millennia ago, Greek philosopher Heraclitus was quoted to have said “change is the only constant in life”. This is no different for the world of finance, with people looking to save, manage and raise money. Many individuals look to raise steady income for their pension, businesses look to increase their bottom line and governments invest in sovereign wealth funds for the welfare of their state. The landscape of investment has changed over the past few decades, with many academics showing the futility of active investing. This means active investment vehicles such as hedge funds are losing out with the Financial Times reporting that in 2014 $141bn came out of active funds, while $293bn went in to passive investment funds. Investors are getting a better return from these types of investments which has been shown to give a higher return than active investing in all markets (French, 2008; Malkiel, 2003).

This is down to the unpredictability of the market backing up seminal theories such as Fama’s Efficient Market Hypothesis, with no yet viable alternative to the age old theoretical viewpoint (Fama, 1965). The work of Fama in the 1960’s argued that it was impossible to consistently beat the market as securities would always trade at their fair price. Thus making them as likely to go up in value as down in value, following a random walk (ibid., 1965). Nevertheless, some cracks have been shown such as the ‘small firm effect’ (Lustig et al., 1983). This demonstrated in six out of nine five year periods from 1936-1975 a portfolio consisting of the bottom fifth of stocks (by value) on the NYSE outperformed a portfolio of the biggest stocks (ibid., 1983). The next crack was seasonal patterns shown in the work of Rozeff and Kinney (1986). This showed over the period of 1904 to 1975 that the average monthly return in January was higher than all other months’ average (3.5% January vs 0.5% other months). The final opponent to EMH is the psychological irrationality of investors dating famously back to Keynes observation of 'animal spirit' behavior within the market (1936). More recent research on behavioural economics can be seen in Kahneman and Tversky's numerous papers (1979; 1986), which detail the cognitive biases and shortcomings humans face in interpreting information.

These bouts of irrationality go against the rationale agent model which EMH is based on. Yet despite mounting evidence, empirical data has shown that over the long term any patterns in markets movement such as mention above have dissipated (Fama, 1998). The correction in the markets of profitable situations (patterns) is effectively arbitraged out by investors paradoxically believing they can beat the market. The fascination of whether investors can beat the market leads on to this paper and its investigation of a potentially profitable trading strategy. While stocks markets patterns have been shown to been arbitraged out, the investment strategy this paper will focus on has been shown to have a history of profitability. What makes this strategy different? Is it consistently profitable and if so how is it profitable? What risks does it face? These are some of the questions this paper will attempt to answer. This investment strategy is called the Carry Trade (CT).

1.2: The Carry Trade

The CT, a global trading strategy, looks to take advantage of interest rate differentials across nations. This strategy entails an investor taking out a loan in a country that has a low interest rate (funding currency) and investing it in a country with a high interest rate (target currency). The investment strategy is something of a phenomenon as the very nature of how carry trades have been shown to be profitable is due to the failure of Uncovered Interest Parity (UIP). UIP states the difference between the interest rates in two countries will be equal to the expected change in the exchange rate. Thus any apparent profitable interest rate differential between countries should be made null by the exchange rate (Froot and Thaler, 1990). This has not always shown to be true and led to the term 'forward premium puzzle' (FPP) being coined by Eugene Fama in 1984 and extensively documented then onwards (Fama, 1984; Froot and Thaler, 1990; Engel, 1996; Burnside et al., 2007). This has led to many claims of inefficiency within the foreign exchange market, due to the unexplainable appreciation of high yielding currencies (Engel, 1996).

However, the strategy does not come without risks, in the form of foreign exchange (FX) and interest rate risk. Adverse movements to the mechanisms mentioned can come about through economic downturn. This can cause the CT to unwind and become unprofitable quickly, particularly with unexpected shifts in the FX market. Market volatility for this reason is a scourge on CT activity, due to minimal changes in these components having a strong impact on profitability (Menkhoff et al. 2012). A further area of concern for the trade is crash risk, defined as "rapid devaluations of currency with relatively higher interest rate" (Jurek, 2014, p. 1). This is one of the most proposed reasons for excess returns, that investors are being compensated for bearing risk (Jurek, 2014; Burnside, 2011).

While these risks persist modelling the viability of the trade to ascertain whether it can be a potentially profitable investment strategy is paramount. The work of Baillie and Cho (2014) indicate that through the reversal of UIP in the immediate aftermath of the 2008 recession, that carry trade trades are no longer profitable. This thesis aims to fill the gap in the literature and research whether the carry trade is still a viable strategy up until 2015. Whether these rapid crashes, in particular the 2008 crash and ensuing volatility, diminish the success of the CT thereafter will be fundamental to this reports investigation. Through this avenue the aim is to model and measure returns over the period of 2001-2015. The report will conduct analysis with 9 currency pairs and three indexes, for comparison with market averages.

1.3: Research Question

The investment landscape has changed over the past few decades. In a market saturated with information, patterns and trends are quickly arbitraged out (Fama, 1998). By Investigating the viability of an investment strategy, the work here will bring to light the profitability (or lack of) of the CT. In doing so this thesis will explore the themes and risks that persist in this trade while also looking at ways of judging performance such as skewness, kurtosis, volatility, Sharpe ratios and profitability. The thesis purpose is to bridge the gap in the literature post crisis in particular and thus, the question is:

'An investigation into the viability of the carry trade as an investment strategy over the period of 2001-2015?'

By finding out the potential profitability of CT activity this thesis can enable further research to be taken into the matter based on explaining excess returns, if indeed that is the case. It will provide a critical review of underpinning models and literature up to this point giving clarity and contributing to the development of further research by academic staff. By doing this empirical work, it will support further researchers in their endeavor to demystify the failure of Uncovered Interest Parity. It will ultimately and most crucially contribute to the empirical documentation of CT performance post-2008 global financial crisis. This is the focal point of the thesis.

Chapter 2: Literature Review

In the literature review, an exploration and cross examination of literature pertaining to the CT will be examined. This area will in particular focus on extrapolating information from the vast multitude of underpinning literature sources to detail the relevant themes that make up the CT. Through this avenue the goal is to fully exhaust all significant characteristics of the strategy which will enable a thorough empirical study to be carried out.

With this in mind the areas to be explored are: The history of the carry trade including empirical evidence of when it was profitable. Why the carry trade is profitable which includes the enigma of the forward premium puzzle and the failure of uncovered interest parity. FX efficiency as a potential explanation for excess returns. Implied volatility as a potential explanation for excess returns. Crash risk as a potential explanation for excess returns. The macroeconomic determinants of the carry trade conducive conditions. The profitability of the carry trade as a means of establishing comparable results and finally the research focus and rationale behind the work to be undertaken.

2.1: History of the Carry Trade

The "the popularity of the carry trade is reputedly a relative recent phenomenon" (Baillie and Cho, 2014, p.5). The scope of the trade though, in terms of profitability, has spanned decades (Burnside, Eichenbaum, Kleshchelski and Rebelo, 2006). Not only that, but has been shown to have similar returns to the S&P500, yet with lower volatility. This has led to a higher recorded Sharpe ratio than given by equity returns such as the S&P (ibid., 2006). The increase in CT activity has been argued to coincide with growing interest rate differentials in the early 2000s (Galati and Melvin, 2004). This period of growth around the globe succeeded the 'dotcom bubble' and saw the buildup to the global meltdown in 2008. This meant a lot of countries were raising rates to curb inflation. An example of the interest differentials that developed evidenced in Figure 2.0:

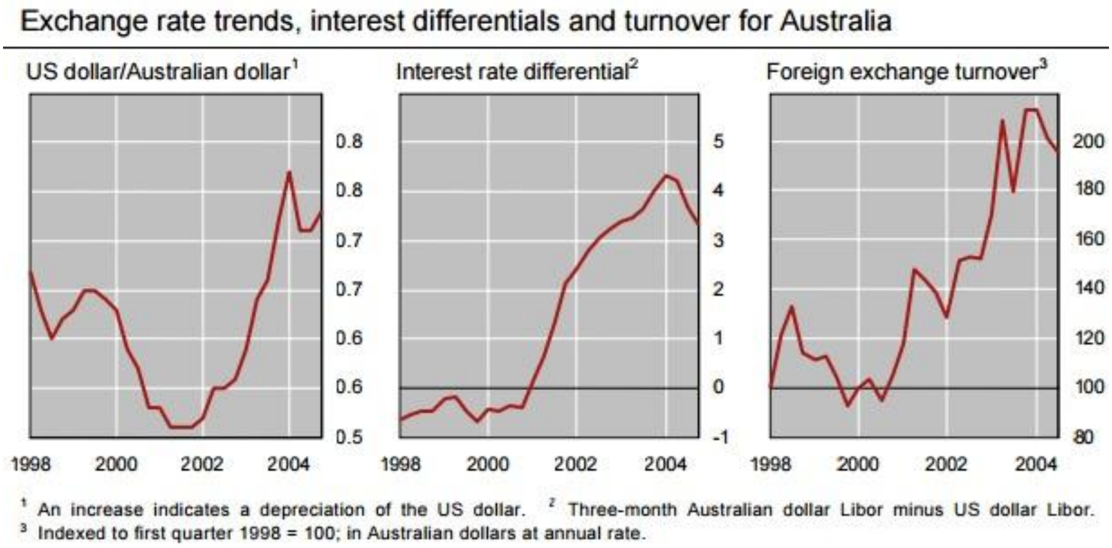


Figure 2.0: USD/AUD CT activity? **Source:** Galati and Melvin, 2004, p.70

As illustrated by the graph, the US and Australian interest rate differential began to widen in approaching 2001. The AUD then increased in value greatly while the turnover of foreign exchange rapidly grew. These indications detail the potential effect of speculative strategies on exchanges and FX turnover.

First indications of the effect of currency speculation rose from the Long Term Capital Management hedge fund crisis in 1998. During the proceeding volatility the JPY appreciated by approximately 12.8% and bid ask spreads rose to about 30 times the average within the interbank market (Evans and Lyons, 2002). This led to many arguing it was a mass unwinding of carry trade positions. Thereby, investors desperation to unload their target currency for JPY led to the spread to widen and appreciation to follow (Béranger, Galati, Tsatsaronis and Kleist, 1999). The carry trade is not easily tracked, which makes it difficult to pin down. There is no easy way to distinguish the carry trade from other positions investors may hold in the market such as “corporate, household or interbank lending and borrowing” (Galati, Maguire and Heath, 2007, p. 32). Alongside this, corporations only report their on-balance sheet positions and therefore, can’t be linked to the few bi-lateral sources for capital flow data (ibid., 2007). This makes it hard to explicitly identify

CT activity. It leaves only the suggestion of increased activities among JPY and CHF being because of the trade (McGuire and Tarashev, 2006; Galati, Maguire and Heath, 2007).

2.2: Why is the carry trade profitable?

Uncovered Interest Parity failure is the very reason why carry trades can be profitable[1]. While UIP would dictate that investors would be indifferent to investing in similar foreign or domestic assets returning interest, this hasn't always held true. In fact, Engel's (1996) vast studies on the topic have rejected UIP and shown the opposite to be true. Which is, rather than the higher interest rate country's currency depreciating (tending towards parity), the higher interest rate currency has actually appreciated relative to the lower interest rate country's currency. This phenomenon is known as the forward premium puzzle and strengthens an already profitable CT position. Baillie et al. (2000) has stated "the forward premium puzzle has become a well-established regularity and is generally regarded as being one of the most important unresolved paradoxes in international finance". Sarno et al. (2006) echoed this, stating it as not convincingly explained and that it continued to elude the international finance industry.

Forward premium is described as the difference between the forward and spot price of the exchange. UIP implies that the "interest differential is an estimate of the future exchange rate. If expectations are rational then this estimate of future exchange rate changes provided by the interest differential should be unbiased" (Froot and Thaler, 1990, p.181). Thus any deviations from UIP is known as the 'failure of UIP' and the 'forward premium puzzle'. Bilson and Fama (1981; 1984) were amongst the first to look at the forward premium puzzle and the relationship between the spot and forward exchange. Bilson found future spot rates had been closer to current spot rates than to forward prices. Furthermore, that if the market

[1] Covered interest rate parity is another form of interest parity. This based off entering forward contracts to remove the FX risk, but results in nulling the returns to zero for the most part (See Frenkel and Levich, 1975; Serra, 2012; Ranaldo & Griffoli, 2012).

were truly efficient forward rates would be equal to spot rates, but that the premium may be due to transaction costs, risk premia or information costs. Burnside et al. (2007) added credence to the information costs suggestion by Bilson (1981) based on adverse selection problems for market makers, particularly when currencies are expected to appreciate. Fama suggested, that on the basis of rational markets, the difference between the forward price and future spot price was the varying risk premium (Fama, 1984). Equated, the forward exchange rate F_t was the result of the expected future spot price $E(S_{t+1})$ plus the premium P_t as seen here:

$$F_t = E(S_{t+1}) + P_t$$

Figure A: Forward Rate Inclusive of Risk Premium

While Fama pointed to the potential of the risk premium in explaining the forward premium puzzle. The main issue found was that there were no models to efficiently quantify the risk involved. Recent work by Burnside was unable to explain the excess returns through traditional risk measures such as CAPM, C-CAPM and Fama-French (Burnside et al., 2011). Furthermore, that it could only be risk premium if rational expectations held true and hence this risk "were found to be determined by the economic variables to which theory says it should be related" (Engel, 1996, p.130). He suggested that the answer may be found in either expanding the risk analysis models, peso problems, a survey of exchange expectations (entailing rationality of investors) or within the inefficiency of the international capital markets. Some of these potential reasons why CTs have been shown to exhibit excess returns will now be explored.

2.21: Foreign Exchange Efficiency

The potential failure of UIP and indeed birth of FPP has led to many to question the efficiency of the foreign exchange market on the whole. Early studies by Huang (1981) into the foreign exchange efficiency show suggestion from a monetary model perspective that the FX market behaves inconsistently, notably from a volatility and forecasting point of view. These methodologies included implied variance bounds, regression and is a within country model. Since the late 1980's methodologies have changed and led to tests of co-integration by modelling currencies across countries for tests of market efficiency. This methodology was used by Aroskar et al. (2004) over the 1990s and found strong market inefficiency in the European FX markets, particularly during the European Monetary System Crisis (EMSC) of 1992.

Contrasting with this is the work of Wong and Ahmad (2012) with the same methodology, who found over the period of 1997 to 2012 that the European markets are largely efficient. Despite this, Wong and Ahmad (2012) found discrepancies in market efficiencies that were consistent with the work of Aroskar et al. (2004), around the time of the tragedy in September 2001. Oh, Kim and Eom approached this test of efficiency from a different line of thinking which provide another perspective of market efficiency (2007). Their work used Approximate Entropy or 'ApEn' to "quantify the randomness inherent in time series data" (2007, p. 210). It compared the relative magnitude of regularity in patterns, small ApEn figures were indicative of less randomness within the time series data and high figures relatively more randomness. As seen in Figure 2.1 below:

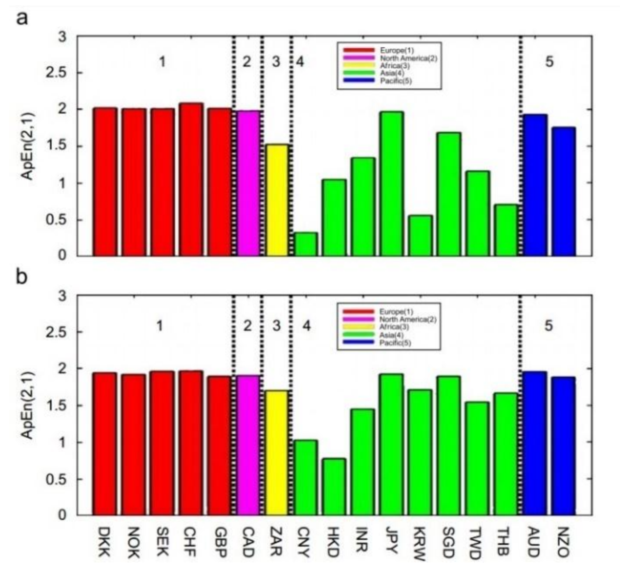


Figure 2.1: FX 'ApEn' Test of Efficiency **Source:** Oh, Kim and Eom, 2007, p.211

They found markets with higher liquidity such as European and North America markets to be a more efficient than Asia and Africa (excluding Japan). This was over two periods across 1984 to 2004[2].

Many have argued against the failure of UIP and foreign exchange market inefficiency. Baillie and Bollarslev (2001) show some evidence that suggest the failure of UIP is a statistical abnormality because of the autocorrelation in the forward premium's small sample size, which affects accuracy of prediction. This line of thinking is also suggested by Yan et al. (2000), Phillips et al. (2001) and Maynard (2006). This was the assumption Pilbeam and Olmo (2011) held when they persisted with the idea of a statistical anomaly but based off the significant differences of volatility within the regression models variables, notably the future spot price S_{t+1} and forward price F_t. The higher volatility of the spot exchange (leading to conditional hetroskedacity) can make inferences about UIP and in turn foreign exchange market efficiency unreliable. This goes against much of the preceding literature that has questioned UIP and FX efficiency (Bilson, 1981; 1984; Huang, 1981; Aroskar, Sarker and Swanson, 2004; Sarno, Valente and Leon, 2006). Pilbeam et al. (2011) also approached this from a profitability perspective, aimed to exploit the assumption of inefficient markets and make excess returns. Outside of Burnside et al. (2006) past literature had failed to consider this approach. Pilbeam and Olmo's (2011) work found that for two out of four tests of profitability that the efficient market hypothesis held and that the foreign exchange is more efficient than past literature on UIP would suggest.

[2] 'A' represents the ApEn analysis of FX of 17 countries over 1984-1998 while 'B' represents the ApEn analysis of FX for the countries over 1999-2004. "The red, pink, yellow, green and blue colour bars correspond to European, North American, African, Asian and Pacific countries, respectively."

2.22: Rational Agent Model

Most conventional economic theory is based on the premise that the rational agent model is true. This includes the Efficient Market Hypothesis (Fama, 1965). The rational agent model entails that investors make rational decisions based on all available information and know the "objective probability distribution of all exogenous shocks" (De Grauwe and Kaltwasser, 2012, p. 1177). This has been shown to be false, with a number of cognitive biases effecting humans' ability to make decisions. In the influential work of Tversky and Kahneman (1979) on prospect theory they record human's choices based on risk and uncertainty. One study in particular included two experiments. The first experiment gave subjects a choice between: 1) 100% chance of winning $3000 and; 2) an 80% chance of winning $4000 with a 20% chance of winning nothing. It was shown even though the fair gamble offered an expected value of $3200 that 80% of people choose the guaranteed $3000.

In the second experiment it gave subjects a choice between: 1) 100% chance of a guaranteed $3000 loss and; 2) an 80% chance of losing $4000 with a 20% chance of breaking even. With this experiment, 92% of people chose the gamble despite it offering an expected value of -$3200 compared to the guaranteed -$3000 loss. This study demonstrated how people are risk adverse when it comes to making gains but risk seekers when they face a loss (ibid., 1979). This is an example of one of many heuristic flaws inherently part of the human psyche. When this subject is taken to FX market psychological drivers can also be witnessed. De Grauwe and Kaltwasser (2012) looked at these flaws in the foreign exchange market. There work simplified traders into 2 categories, optimists and pessimists, based on the overvaluation and undervaluation of the fundamental FX rate. While many economists base fundamental value on the criteria that the asset follows a random walk (Manzan and Westerhoff, 2005; De Grauwe, Grimaldi, 2006b), De Grauwe and Kaltwasser (2012, p.1178) based fundamental value on the premise that if a market exchange is "below (above) its fundamental value it will increase (decline) in the next period". Therefore, when the exchange at time t equals t+1 or overall observations of pessimism and optimism cancel each other out, rational expectations are met. In this simplistic model it is suggested that FX markets do indeed follow cycles based on optimism and pessimism even if the fundamental value remains the same. Thus, this work suggests there are deviations from markets fundamental value. Furthermore, non-normal returns are observed combined with fat tails characteristic of extreme events far outside that indicative of a normal distribution (De Grauwe and Kaltwasser, 2012).

This work is reminiscent of Keynes observation of animal spirits within the fluctuations of prices within the financial market (1936). Kahneman and Tversky's vast multitude of work on psychological behaviour in decision making led them to argue "deviations of actual behavior from the normative model are too widespread to be ignored… and too fundamental to be accommodated by relaxing the normative system" (Kahneman and Tversky, 1986, p.3). These deviations are contrary to that of the rational agent model and that of EMH, paving the way for skepticism of efficiency within capital markets.

2.23: Volatility

The research of Lustig et al. (2011) and Menkhoff et al. (2012) find that the CT performs poorly during times of economic turmoil and suggest that excess returns are the culmination of volatility risk premia. Lustig, Roussanov and Verdelhan (2011) approach this from no arbitrage angle. They find they can explain by alternative means, a slope factor based off the exchange rate movements of high yielding and low yielding currency. The covariation of the slope factors accounts for the majority of spread in average returns to the CT. As such, their no arbitrage model consists of the interest rates and exchange rates combined with two variables, country specific risk and global risk. This accounts for over two-thirds of the cross sectional variation and demonstrates that the estimated risk prices are similar to those obtained from the CT portfolios themselves.

The work of Menkhoff et al. (2012) is partially based off the two factor risk framework of Lustig et al. (2011), with dollar risk as one factor (country specific risk eg. US investor), and CT factor the other (global risk factor, the return to the CT portfolio's high and low yielding currencies). By Replacing the CT factor with global foreign exchange volatility the model became more effective (Menkhoff et al., 2012). Through this standard asset pricing test, with global FX volatility as a systemic risk factor, Menkhoff et al. (2012) found that the covariance of excess returns with volatility accounts for more than 90% of the spread in the 5 CT portfolios. This may add credence to Brunnermeier and Pedersen's (2009) work, who have looked at market premiums from a liquidity perspective. They argue that liquidity is the driver of the market risk premium. When funding is in short supply, investors are reluctant to take positions in the market. Thus, it lowers market liquidity and builds volatility. Furthermore, when investors take long positions that experience negative capital shocks, funding constraints can exponentially trigger a sharper drop. Thus, can potentially explain the negative skewness of returns demonstrated in previous empirical research (Brunnermeier et al., 2009). This implied volatility explanation for returns leads on to an another area of explanation, the crash risk.

2.24: Crash Risk

The most obvious reason for the excess return is the crash risk premia or peso events. Burnside et al. (2011), define peso events as low probability events. These low probability events can result in negative average payoffs to the investor and thus, can result in a premium return for holding such an investment. As carry trades are susceptible to these events such as crashes, Burnside et al. (2011) looked at hedging away the crash risk through at-the-money currency options. Furthermore, hedged with options with one leg USD (X/USD). Through this methods, the authors gained exposure to the USD, even if USD didn't make a part of the CT model (ibid.). In an example, if the CT model consisted of JPY and AUD, Burnside et al. (2011) hedged both legs with USD derivatives (ie. USD/JPY and USD/AUD). This means there was a persisting dollar risk factor in the empirical data. Another key part of the methods was the use of at-the-money options. The reason given for choosing at the money options is because they are more heavily traded and efficiently priced relative to out-of-the-money options (contrasting with later work by Jurek, 2014). Burnside et al. (2011) show by means of CT portfolios, that the hedged carry trades are less volatile due to the minimization of negative payoffs, which the unhedged CT was subjected too over the period of 1986-2009. In linking excess returns to crash risk, Burnside et al. argued peso problems were indeed an underlying factor that resulted in modest negative payoff to the unhedged CT. This wasn't the only study with this methodology. Farhi et al. (2013) was also consistent with this model although estimated crash risk after the financial crisis as well. Furthermore, found the risk premium accounts for at least one-third of the excess returns in the CT in G10 countries (ibid., 2013).

Using contrasting methodologies Jurek (2014) also looked to explain excess returns by means of hedging crash risk. In doing so, used out-of-the-money options, which resulted in greater estimates of returns from crash hedged CT portfolios. By the very nature of out-of-the-money options, they are less expensive than at-the-money options used by Burnside et al. (2011). Another alternate factor in this methodology was hedging currencies through their domestic denominated exchange rates rather than hedging through puts and calls in the long and short position against the USD. This avoided the premium paid on using the international reserve currency, dollar. Furthermore, Jurek showed a hedge that used USD options produces downward biased projections of crash-hedged currencies' returns, also illustrated by the dollar risk factor demonstrated in previous literature (Lustig et al., 2011; 2013). This downward bias resulted in 0.6-0.7% loss in mean returns annually (Jurek, 2014). Taking into account these factors yielded different results. By using these methods Jurek found that crash risk premia amounted to no more than one-third of excess returns to its spread weighted CT portfolio, going against earlier work by Burnside et al. (2010; 2011) and Farhi et al. (2013).

2.3: Macroeconomic factors

While the evidence to explain the excess returns to the CT is anything but conclusive, Brunnermeier et al. (2009) looked at the determinants of CT activity. Brunnermeier et al. (2009) showed that positive shocks to interest rates (unexpected movements) lead to CT induced conditions and thus voice their concern that carry trades can create currency bubbles. In their empirical data, UIP’s failure is construed as the inability of the foreign (investing) currency to depreciate due to CT activity. The exchange rates sluggish reaction to interest rate shocks then results in a mass unwind of CT investments as investors resort back to fundamentals. This is evident in the amount of net speculative positions closed in the futures market after Lehman’s collapse (Anzuini & Fornari, 2012, p.26). This is also evident in the work of Hutchison and Sushko (2010) who investigate periods of potential activity (measured by the currency futures market), notably between: i) January 2005 and March 2006 and ii) between April and May 2006. Within these time periods the former was linked to surprise changes in US Gross Domestic Product (GDP), US Consumer Credit and Trade Balances while the latter was linked to Japanese changes. In this work news of improvements in Japans trade balance led to heighten perception of risk of JPY appreciation against the USD (Hutchison and Sushko, 2010). This perception was noted through a reduction in speculative positions in the region of 10% on the Chicago Mercantile Exchange (CME). This angle was explored further by Anzuini and Fornari (2012).

Anzuini and Fornari (2012) take a larger sample for their analysis over the period of 1986-2010 and look at macroeconomic determinants in the form of monetary policy, demand, supply and to a lesser degree confidence. This enabled an examination of these four structural shocks in order to determine the role played in foreign exchange rates, interest rate differentials and CT investment. Such analysis by Anzuini and Fornari demonstrated an average unexpected interest shock in the region of 0.4% produced an average appreciation of the 6 currencies analysed (Australian Dollar AUD, Canadian Dollar CAD, Swiss Franc CHF, Euro or German Marc EUR, Pound Sterling GBP and Japanese Yen) of between 5% in the first year and 15% after four years (vis-a-vis the dollar). Furthermore, crash risk, equated as skewness of returns remained high in the year that followed the shock, but subsided shortly after and was measured as statistically insignificant. This suggests there may be inherent risk once investors initiate carry trade activity or indeed currency speculation.

In the macroeconomic empirical data, demand[3] was found to be the most seismic shock with increases in foreign exchange returns recorded in excess of 10% within four years. Alongside this significant increases in net positions to foreign exchange futures and persistent decreases in skewness indicative of favorable conditions conducive to CT activity. There was less of a significant change in conditions for monetary policy shocks with foreign exchange appreciations in the region of 5%, while negligible changes for supply shocks. Confidence, as measured by a shock that increases consumer confidence index and reduces implied stock market volatility (VIX) gave rise to mass depreciation of the Japanese Yen through short selling (Anzuini and Fornari, 2012). While this movement is not significantly measured in other currencies, it is indicative of the reported role of JPY as a funding currency in CT activity. Alongside this, constant positive increases in skewness of returns from the JPY/USD exchange is recorded which show the greater risk of a rapid appreciation in the Yen which would lead to mass unwinds in CT activity (ibid., 2012).

[3] As demonstrated by Barsky and Sims (2010) as a measure of forward confidence contributing increases in consumption, output and TFT (total factor productivity).

2.4: Performance

Gyntelberg and Remolona (2007) found over the period of January 2001 to September 2007 that AUD/JPY was one of the most profitable trades, alongside NZD/JPY. Both CT pairs recorded annualised returns of 12.5% and 14.93% respectively. The two funding currencies used in the work of Gyntelberg and Remolona are the CHF and the JPY, consistent with funding currencies in this report. Another method of performance is the Sharpe ratio. Burnside et al. (2006) documented over the period of 1976-2005 that the in terms of Sharpe ratio, the performance of their carry trade portfolio exceeded the S&P500. This was demonstrated with a non annualised monthly average. It was true both without transaction costs (.18) and without (.15), compared to the S&P (.14). This was also backed up by Gyntelberg and Remolona with Sharpe ratios for CTs exceeding the S&P500, Nikkei 225 and FTSE100 over the period of 2001-2007.

Fundamental to the purpose of this research is the work of Baillie and Cho (2011; 2014), conducting analysis on CT profitability using the currencies of AUD, CAD, CHF, DKK, JPY, GBP, NOK and the NZD. Evident in their work from the immediate aftermath of the crisis is the potential reversal of the forward premium puzzle as noted in the currencies AUD, CHF, NOK and NZD (ibid., 2011; 2014). The model of Relative Interest Rate Opportunity (RIRO) used by Baillie and Cho entails the regime switching of funding currency in a regression model is contrasting with the singular methodology used here but coincides nonetheless, with the measuring of CT profitability. Reports of conditional negative skewness in carry trades is consistent with Brunnermeier et al. (2009) and Anzuini and Fornari (2012). Furthermore, as evident through Baillie and Cho's (2011) rolling regression that UIP has reversed for the mentioned currencies post 2008 crisis. Therefore, it will be of particular interest to see how these currencies and other currencies chosen perform within the CT.

2.5: Research focus

The areas to be looked at that are detailed in the literature review will now be considered:

1) The first area will be to analyse the returns of the CT and evaluate whether negative skewness and large kurtosis is still an inherent characteristic (Anzuini and Fornari, 2012; Brunnermeier et al., 2009; Baillie and Cho, 2011; Burnside, 2006).

2) The second area is to analyse is the Sharpe ratios of the carry trade vs other indexes, to see if CT still results in a larger figure (Burnside, 2006; Remolona and Gyntelberg, 2007).

3) Whether carry trades are still profitable in this economic environment central to this research project. Building on Baillie and Cho's (2014) post-recession analysis of the reversal of UIP, which may signal the end of profitability is paramount.

By going way of profitability it gives clarity to the pairs that are and are not profitable. This will allow an insight, from an economic perspective, as to which countries have conditions conducive to the investment strategy. As the research is only conducted up to 2011 this gap in literature needs to be filled. The next section pertains the methodology to be used in the research.

Chapter 3: Methodology

The aim of the chapter is to provide the approach to the empirical research and methodology that enables a thorough analysis to be conducted. There are four sections, the Research Strategy as seen in section 3.1, the Data Collection seen in section 3.2, the Framework for Data Analysis in section 3.3 and the Considerations in section 3.4.

3.1: Research Strategy

This section will entail the strategy and elaborate on the design of the research. The goal of this methodology chapter can be summarised as an attempt to give unambiguous rationale, methods and considerations, so that the reader could with ease replicate the project undertaken. Therefore, with that in mind, being able to provide necessary and pertinent information to replicate the investigation into the viability of the CT as an investment strategy was paramount.

As with undertaking any form of research project, it was important to have an understanding of both forms of research, qualitative and quantitative. Creswell described qualitative research as an “inquiry process of understanding a social or human problem, based on a complex holistic picture, formed with words, reporting detailed views of informants and conducted in a natural setting” (1994, p. 1-2). The research to be carried out is objective in nature and therefore is deemed more fitting with quantitative research as Gay and Airasian’s described as “the collection of numerical data in order to explain, predict and/or control phenomena of interest” (2000, p.627).

This was chosen as the research variables are objective in nature such as interest rates and foreign exchange information. Therefore, do not need an interpretation or “phenomena in terms of the meanings people bring to them” (Denzin, Morse and Lincoln, 1994, p.2). The results will be also of the same quantitative nature and will enable the reader to form their own interpretation based on the validity of the work carried out.

3.2: Data Collection

The data for the CT activity is sourced from Bloomberg Professional. This is a company founded by Michael Bloomberg in 1981. It is a powerful trading platform that enables individuals to get real-time data, analysis and make financial trading based decisions. It provides a wide range of financial data and news. It was originally offered to investment professionals but has been expanded to academics and currently has over 325,000 subscribers worldwide (Bloomberg, 2016).

The data sourced consists of the daily exchange rates and the 1-month interbank rates over the period of 2001-2015. The funding currencies to be used are Swiss Franc (CHF), Japanese Yen (JPY) and Euro (EUR) while the target currencies to be used are Australian Dollar (AUD), Great British Pound (GBP), Polish Zloty (PLN) and Brazilian Real (BRL).

For modelling the CT, the exchange rates and interest rate were lined up to their corresponding dates. Where any dates corresponded to no data, the previous days' exchange rate and/or interest rate was used, as daily standard market practice would suggest. This means that for the data missing on weekends for example, Fridays exchange and interest rate was used on both the Saturday and the Sunday. This was also the case for public and bank holidays. The total cases of data for each CT was 5477, representing 15 years of data. In order to calculate the yearly return, the average daily return for the period was multiplied by 360.

Three indexes are also used to compare returns to equities over this period. The data for the index benchmarks is source from Yahoo Finance. The three indexes to be used are the S&P500, Nikkei 225 and the FTSE250. This data runs from 2001-2015 and has 3772 days of data for the S&P500, 3693 days of data for the Nikkei

225 and 3785 days of data for the FTSE 250. The S&P500 is to be used in line with Burnside et al. (2006) empirical work and the three indexes are also consistent with Gyntelberg and Remolona (2008). This can measure potential instances where Sharpe ratios of CTs exceed the ratio of equity returns (Burnside, 2006). Having comparative indexes is also in the interests of giving a more thorough picture of how the CT are performing in profitability next to equities, not being limited solely to the S&P. The type of index price used was the adjusted close as it takes into consideration corporate actions such as dividends, stock splits and rights offerings. In order to calculate the annual index return, the average daily return for the period was multiplied by 260 as there is no compounding on weekends or public holidays.

3.3: Quantitative Methods

As described by Sukamolson (2010, p.19) “quantitative research is about explaining phenomena by collecting quantitative data which are analyzed using mathematically based methods”. This section will pertain the mathematical formulae and rationalization of such formulae to conduct analysis. The descriptive statistics are shown in the first section (Figure B), the Sharpe ratio is shown in the second section (Figure C) and the Carry Trade model is shown in the final section (Figure D) compared with UIP (Figure E).

Descriptive Statistics

The descriptive statistics as seen in Figure B give an insight into the innate aspects of the returns. These include measures of central tendency and dispersion such: mean, variance and standard deviation.

Figure B: **Sample**

Descriptive Statistics

Mean	$\overline{x} = \frac{\sum x}{n}$
Variance	$s^2 = \frac{\sum (x - \overline{x})}{n - 1}$
Standard Deviation	$s = \sqrt{\frac{\sum (x - \overline{x})^2}{n - 1}}$
Skewness	$S_K = [\frac{n}{\{n-1)(n-2)}] \frac{\sum (x - \overline{x})^3}{s^3}$
Kurtosis	$K = \left[\frac{n(n+1)}{(n-1)(n-2)(n-3)}\right] \frac{\sum (x - \overline{x})^4}{s^4} - \frac{3(n-1)^2}{(n-2)(n-3)}$

For the distributions of returns for the data skewness and kurtosis are important. While a distribution is symmetric is "if the right and left sides of the histogram are approximately mirror images of each other", this is not often found in real data (Moore, 1997, p13). Data is often skewed to the right (positive skew) or the left (negative skew). When looking at returns, an investment with negative skew has long left tail which would indicate small gains but a greater chance of extreme losses and vice versa. There is particularly important compared to standard deviation which measures symmetrical dispersion only. By gaining a directional movement it enables a better understanding of downside risks potentially involved. Black describes kurtosis as "the amount of peakedness of a distribution" (Black, 2009, p.78). Contrastingly, Ali (1974) states kurtosis is only a measurement of the "tailedness". While some look to explain kurtosis by the peaks of its distribution, the work of Westfall objects this description, demonstrating that kurtosis is deemed by the tails of the distribution (Westfall, 2014; Johnson, Tietjen and Beckman, 1980). Congruent with this, Kaplansky (1945) had documented leptokurtic distribution with both a lower and higher peak than a normal distribution. The next formula to be explained is the Sharpe ratio.

Sharpe ratio

William Sharpe first introduced his namesake ratio in 1966. This was to compare portfolio returns relative to their level of risk, giving "thus the reward provided the investor for bearing risk" (ibid., p.123). In calculating the Sharpe ratio, it is equated as follows:

$$= \frac{R_p - R_f}{\sigma_p}$$

Figure C: Sharpe Ratio

This gives an insight into the return in excess of the risk free rate compared to the amount of risk taken on in terms of volatility. Where R_p is the return of the asset or the portfolio, R_f is the risk free rate and σ_p is the volatility of the asset or the portfolio. One area the Sharpe area suffers is in non-normally distributed data which tends to inflate the figure by aggrandizing the variance (Bailey and Lopez, 2012). This is a potential error investors can fall victim too when used to compare investments with different confidence bands. The ratio was used to for both the indexes and CTs.

When calculating the Sharpe ratio return was the average return of the relevant CT or index over that period. The risk free rate for the CTs was the average target currencies interest rate, as this was deemed as the maximum risk free rate. For the indexes the risk free rate used was the average daily 3-month US Treasury Bill in that timeframe. This data was sourced from the Federal Reserve Bank of St.

Louis's website. While the denominator is the standard deviation for the defined period. A negative Sharpe ratio is negative when the return is found to be less than the risk free rate. The next formula to be illustrated is the CT model.

Carry Trade

The final analysis tool and the most pertinent to this research is the CT model. This is what will be used to establish the viability in terms of profitability, of the CT. The model itself is not complex and is easy to understand. In order to calculate the daily return of the CT it is equated as so:

$$Z_{t+1} = \left(\frac{S_{t+1}}{S_t}\right) - 1 + \frac{(i_t^* - i_t)}{360}$$

Figure D: Carry Trade Daily Return

Where the return tomorrow (Z_{t+1}) equals the spot exchange tomorrow over the spot exchange today ($\frac{S_{t+1}}{S_t}$) less one, plus, the target country interest rate minus the funding currency interest rate divided by 360 for the daily rate ($\frac{(i_t^* - i_t)}{360}$). Therefore, if the exchange rate tomorrow falls the first component will be negative and if the target country's interest rate falls below the funding country's rate it will also be negative (and vice versa). This formula is consistent with Baillie et al. (2011), Brunnermeier et al. (2008) among others. In order to contextualize the framework for which the CT makes excess returns, the formula for Uncovered Interest Parity will be equated. When UIP holds true, the following applies:

$$E_t \, \Delta S_{t+1} \ = \ i_t^* - i_t$$

Figure E: Uncovered Interest Rate Parity

So that while E_t is the "conditional expectations operator on a sigma field up to and including time t" (Baillie and Cho, 2011, p. 4), the expected return on the currency component (ΔS_{t+1}) is equal to the interest rate differential ($i_t^* - i_t$) (Baillie and Cho, 2011, 2014). Thus when you consider UIP, the CT model above should not on average be profitable. Microsoft Excel was used to model the CT, calculate Sharpe ratios and build graphs. IBM's SPSS Statistics package was used for descriptive statistics and the histograms of return distributions.

3.4: Considerations

This section entails the potential problems and limitations in the research conducted. In defining a recession, the National Bureau of Economic Research's (NBER, 2010) timescale will be used. NBER does not define a recession as two successive quarters of falling real GDP. Rather, it is the culmination of economic downturn across many indicators such as real income, unemployment, industrial production, wholesale retail sales and real GDP. As such, the recession began at the peak in December 2007 and ended at the trough in June 2009. Following this period will mark the time of most interest in assessing the viability of the CT, particularly after Baillie et al. research ends in 2011 suggesting potential unprofitability post-recession.

One barrier to this research that had to be overcome is LIBOR scandal that has led to many currencies interbank benchmark rate being discontinued. This has included AUD and even some maturities for the JPY and CHF. The former rates have been cut completely while the latter only in some cases. This means historical data up until May 2013 for AUD is the limit in terms of LIBOR. There has even been a committee set up by the US FED to find alternative benchmarks for interbank trading now that many have been discontinued (FT, 2016). To overcome the discontinuation of one-month AUD LIBOR on the 31^{st} of May 2013, the overnight Royal Bank of Australia (RBA) Refinancing Rate was used. The BRL 1m was unavailable on Bloomberg. Therefore, the overnight rate is used instead of the one-month swap rate as the risk burden is less on a swap, so it would have a lower return. This is because there is inherently less risk in only swapping the fixed or floating leg of a swap compared to borrowing. The next chapter reveals the results of putting the methodology detailed above to work.

Chapter 4: Analysis & Findings

Descriptives, Distributions, Sharpe Ratios & Carry Trade Returns & Volatility

This section reveals the analysis and findings of the CT investigation across the pairings and indexes. The first section will detail the descriptive statistics of all CT pairs and the indexes (4.0). The second section will detail the distributions of the CT pairs and indexes, building on the technical analysis of the first section graphically (4.1). The third section will entail the Sharpe ratios of the CT pairs and the indexes (4.2) and the fourth section will detail the CT pairs and indexes performance based on their returns and volatility (4.3). This analysis is supplemented with daily returns graphs and cumulative return graphs located in section A -D within the appendix. The descriptive statistics and the distributions will be displayed for the entire period of time, while the two final sections (Sharpe ratios and Returns and Volatility) will be separated by their relevant time periods as prescribed in the methodology.

4.1: Descriptive Statistics

The descriptive statistics are portrayed in Figure 4.0 and entail the summary statistics of the data daily. This gives empirical insight into the areas of the mean, standard deviation, skewness and kurtosis. The areas of particular note to the research will be detailed here.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
AUDJPY	5477	-.09873	.12701	.0002188	.00882172	-.316	.033	25.613	.066
GBPJPY	5477	-.05542	.08046	.0000995	.00646382	-.318	.033	13.380	.066
PLNJPY	5477	-.07502	.12599	.0002060	.00908260	.016	.033	14.749	.066
BRLJPY	5477	-.09260	.10223	.0003175	.01102938	-.083	.033	10.188	.066
AUDCHF	5477	-.16928	.08814	.0000974	.00754072	-1.914	.033	61.792	.066
GBPCHF	5477	-.17912	.08341	-.0000164	.00570650	-5.158	.033	191.118	.066
PLNCHF	5477	-.19671	.08355	.0000825	.00750631	-3.041	.033	97.240	.066
BRLCHF	5477	-.18369	.10008	.0002015	.01053889	-.790	.033	24.145	.066
PLNEUR	5477	-.05347	.04776	.0000968	.00541752	-.484	.033	9.646	.066
SandP500	3772	-.09035	.11580	.0002023	.01255856	.002	.040	8.881	.080
Nikkei225	3693	-.11406	.14150	.0002090	.01545712	-.206	.040	6.330	.081
FTSE250	3785	-.06513	.07747	.0003186	.01087867	-.225	.040	3.915	.080
Valid N (listwise)	3693								

Figure 4.0: Descriptive Statistics of CTs and Indexes

The various CT pairings are shown in the first column of Figure 4.0, alongside the three indexes. It is evident from the graphic that for all 9 carry trade pairings the number of variables, in column 'N', is 5477. This differs from the three indexes as shown. The S&P500 has 3772 days of data, Nikkei 225 has 3693 days of data and the FTSE250 has 3785. The change in the number of days is due to the varying bank holidays in the countries, America (S&P500), Japan (Nikkei 225) and UK (FTSE 250) when markets are closed.

The mean is the next column and shows that the CT pair which demonstrated the highest mean daily return over the period is BRL-JPY with .000318 followed by AUD-JPY with .000219. These figures were both trumped by the FTSE250 index which had a mean daily return of .0003186 over the period. The lowest CT return was demonstrated by the pair of GBP-CHF with a loss (-.0000164). The standard deviation is the next column and shows that the CT pair with the highest daily standard deviation is BRL-JPY with .011029 followed by BRL-CHF with .010539. Again, both figures were trumped by an index, this time the Nikkei 225 with .015457. The lowest CT standard deviation was the PLN-EUR with a figure of .005418.

The skewness follows in the next column. The most negative skewed CT pair is GBP-CHF with a figure of -5.158 followed by PLN-CHF with -3.041. These were extremely large in comparison to the indexes with next to no skew across the three. It is also of particular note that all CHF CTs were a great deal more skewed (-.79 to -5) in comparison to JPY funded trades which hovered between 0 to -.3. This is indicative of the potential of extreme negative losses experienced over the period across CHF CTs. The standard error of skew across the CTs representing the deviation that exists between the values of skew is consistent at .033 for the CTs and .040 for the indexes.

The kurtosis of returns is illustrated in the following column illustrating the extremes in the tails of the distribution. The CT with the highest kurtosis is the GBP-CHF with an extreme figure of 191.1 followed by PLN-CHF with 97.2. Both of these pairings are highly leptokurtic and have sharper peaks with fat tails well above and beyond the peak of a mesokurtic normal distribution with a kurtosis of approximately 3 (Balanda and MacGillivray, 1988). This is also evident in all of the CTs and indexes, with the FTSE 250 coming closest to that representative of a normally peaked distribution with skinnier tails (3.9). The standard error of kurtosis in this case for the CT is consistent at .066 with approximately .080 for the indexes.

Consistent with returns profile of Gyntelberg and Remolona (2008) carry trades funded with the JPY exhibit far higher returns than that of their CHF funded counterparts. Furthermore, while AUD-JPY was the highest returning CT over the period of 2001-2007 (ibid., 2008), the addition of the BRL to the portfolio has demonstrated even higher returns. This is at least true for the entire period in this report (2001-2015). The performance of the trades will be explored further in section three and four. Alongside BRL-JPY being the highest mean return for the period, it also displayed the highest volatility too. Furthermore, the BRL-CHF standard deviation was the second highest, illustrating the volatile nature of the BRL. This will make the Sharpe ratio analysis of BRL pairs later all the more interesting. In terms of skewness, the BRL-CHF which displays moderate negative skew, sits alongside the other three CHF funding CTs with high negative skew above -1 (Bulmer, 1979). All four JPY CTs are approximately symmetrical within the range of -0.5 to 0.5. Particularly relative to others. The extreme CHF skew noted above is potentially indicative of the Swiss National Bank's unpegging of the CHF to EUR, which seen a huge appreciation of the currency, in the region of 30% (Telegraph, 2015). This particularly evident in Appendix A, where it can be observed in the daily return illustrations of these extreme losses suffered around the period of the CHF appreciation. This decimates any CT returns as the currency that is short in the trade gains in relative value to the target currency'. Furthermore, as CHF CTs are highly leptokurtic, much of the risk is coming from corresponding events in the far ends of the tails. The constant error terms across both skewness and kurtosis is representative of the constant population sizes across the CTs and index data.

4.2: Distributions

The distributions on a histogram of the CTs and indexes are illustrated below. There are 12 distributions in total, with the 9 CTs in Figure 4.1-4.18, followed by the indexes in Figure 4.1-4.192. Throughout this section the findings will be stated and analysed, followed by a synthesis at the end. This will bring to light the findings in section 1, comparative to a normal distribution (as show by the dotted line) and relevant to the literature. The X axis pertains the daily return in percentage while the Y axis details the frequency of the returns.

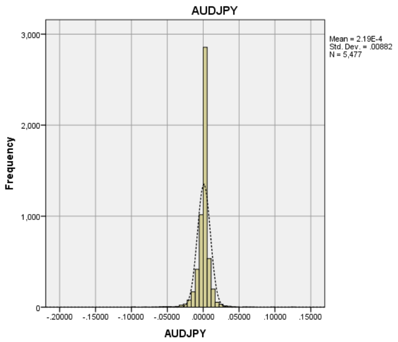


Figure 4.1: AUD-JPY Distribution

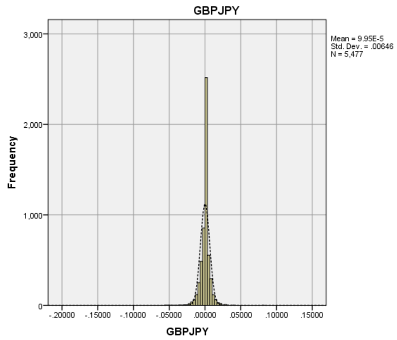


Figure 4.11: GBP-JPY Distribution

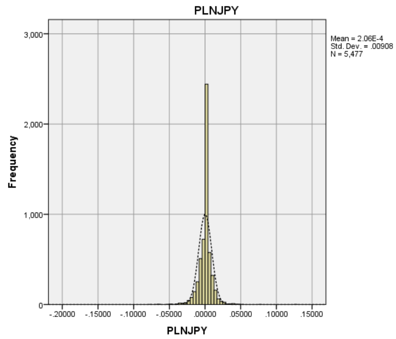


Figure 4.12: PLN-JPY Distribution

In Figure 4.1 we can observe the distribution of the AUD-JPY CT. The peak of the distribution, has a frequency of approximately 2800. It is evident that the tail on the left side of the diagram is slightly but it is negligible as supported by Section 1 of the findings (-.316). Furthermore, it is observed to have a comparatively longer tails than that of a normally distributed dataset. When looked at relative to the indexes in Figure 4.1-4.192, it is notable that very little of the returns fall in the shoulders of the distribution. Where shoulders are defined as μ ± σ (Darlington, 1970; Moors, 1986). Similar characteristics are also noted in Figure 4.11-4.13, among the JPY funded CTs. The GBP-JPY peak has a frequency of approximately 2500 (Figure 4.11), PLN-JPY peak has a frequency of approximately 2400 (Figure 4.12) and the BRL-JPY peak has a frequency of approximately 2300 (Figure 4.13).

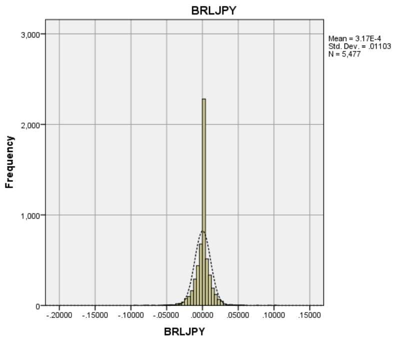


Figure 4.13: BRL-JPY Distribution

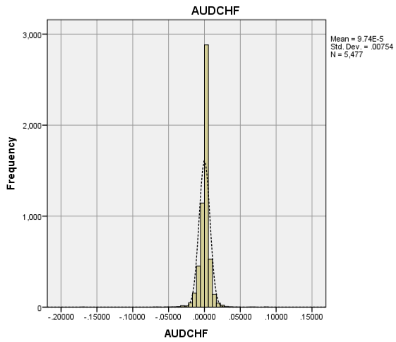


Figure 4.14: AUD-CHF Distribution

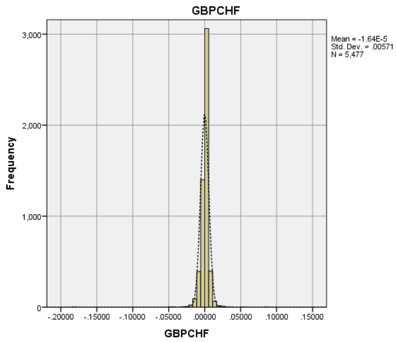
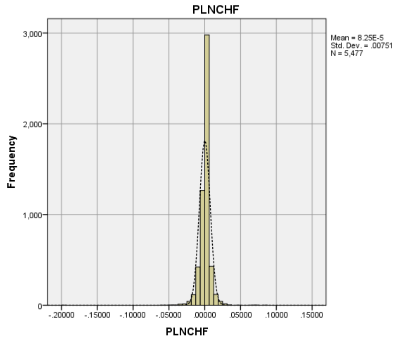
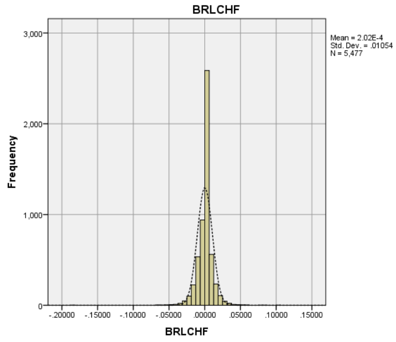


Figure 4.15: GBP-CHF Distribution

In Figure 4.14 we can observe the distribution of the AUD-CHF CT which alongside the previous graphics shows small daily returns making up the highest frequency'. This extreme peak is fundamental in the highlighting the non-normality of returns of the CTs, as the normally distributed dotted line clearly fails to fit. The highest frequency observed in the AUD-CHF was approximately 2800; GBP-CHF ≈ 3100 (Figure 4.15); PLN-CHF ≈ 3000 (Figure 4.16); BRL-CHF ≈ 2600 (Figure 4.17); PLN-EUR ≈ 2300 (Figure 4.18). The loss in the daily returns mean is evident in Figure 4.15 with a large frequency of daily losses noticeable in comparison to other CTs. While the highest frequency remained small gains even in this case, large pockets of losses located in the left tail ultimately nulled these gains.





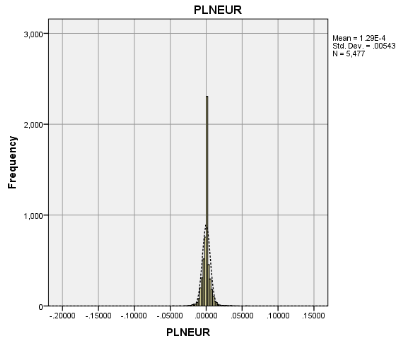
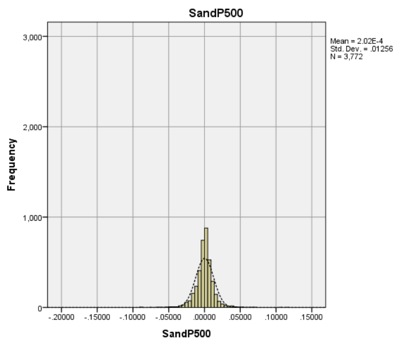
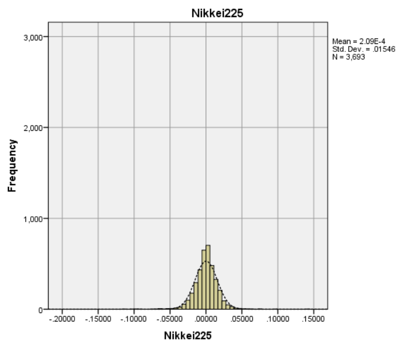


Figure 4.16: PLN-CHF Distribution **Figure 4.17:** BRL-CHF Distribution **Figure 4.18:** PLN-EUR Distribution

The PLN-EUR (Figure 4.18) CT distribution is notably less dispersed than all other carry trades, backed up by having a standard deviation of .0054. The three indexes in Figure 4.19-4.192 are strikingly different from any of the CT return distributions. They are all relatively symmetrical and are somewhat similar to the normally distributed bell shape illustrated by the dotted line. The one area they all fall short on in an attempt to fit the characteristics of a normal distribution is their kurtosis. While in a symmetric distribution the skewness outliers in both tails can offset each other, outliers located in both tails will enlarge the kurtosis. This is perhaps most evident here despite it having a close fit within the normal distribution. The outliers, although not in the same numbers as many of the CTs, still culminate into leptokurtic distributions. There is also disparity in the frequencies of the peaks with the highest for the S&P500 in Figure 4.19 at approximately 900, Nikkei225 in Figure 4.191 at 700 and FTSE250 in Figure 4.192 at 650. This shows the difference in the profile of returns between CTs and indexes.





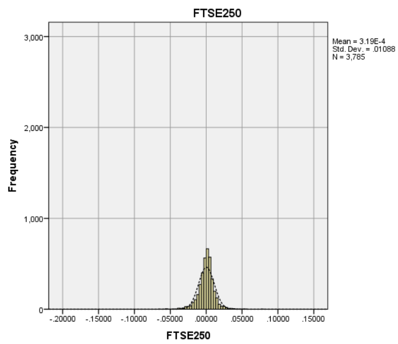


Figure 4.19: S&P500 Distribution **Figure 4.191:** Nikkei225 Distribution **Figure 4.192:** FTSE250 Distribution

It is also telling that over this period 2001-2015 there is nearly as many days of losses as there is gains. This in the direct opposite of the CT daily returns where there are a lot of small gains across all trades relative to the frequency of extreme losses. This evidently a feature of all CTs laying claim to the risk that is posed by this investment. This is also highlighting differing profiles of performance within investing in an index or in a CT. The non-normality witnessed among the CT distributions in particular was also evident in the literature (Gyntelberg and Remolona, 2007; Burnside, 2006; Grauwe and Kaltwasser, 2012). This is due to excess kurtosis and skewness (Burnside, 2006; Gyntelberg and Remolona, 2007; Anzuini and Fornari, 2012).

4.3: Sharpe Ratio Analysis

This sections portrays the findings of the Sharpe ratio analysis for the pertaining CTs, alongside equites indexes for comparison. There are four graphs in total, detailing the relevant time periods as defined in the methodology: entire period, pre-recession, recession and post-recession. The entire period portrays 2001-2015 as seen in Figure 4.2, while the pre-recession period details from 2001 until 11/2007 as found in Figure 4.21. The recessionary period portrays 12/2007 until 06/2009 as seen in Figure 4.22, whereas post-recession details from 07/2009 until the end of 2015 as illustrated in Figure 4.23. The X axis illustrates the varying CTs and indexes while the Y axis demonstrates the Sharpe ratio figures. The blue bars indicate a CT while the green show the comparable indexes.

The Sharpe ratio for the entire period is illustrated in Figure 4.2. The CT with the highest Sharpe ratio was the AUD-JPY with a figure of .20, whereas the worst performing CT in terms of the Sharpe ratio is BRL-CHF with a figure of -.33 followed closely by GBP-CHF with -.31. The indexes S&P500, Nikkei 225 and FTSE 250 trumped all the CTs in this period. The index with the highest Sharpe ratio was the FTSE 250 with .49. Notably all CHF CTs have negative ratios. Furthermore, all CT performed poorly relative to equity index returns for this timeframe.

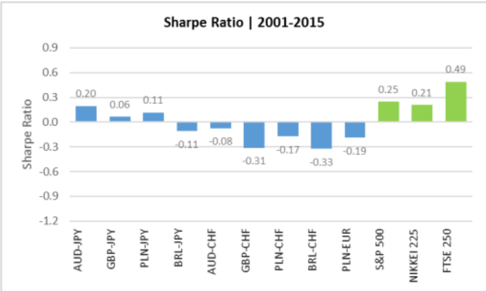


Figure 4.2: Sharpe ratio 2001-2015

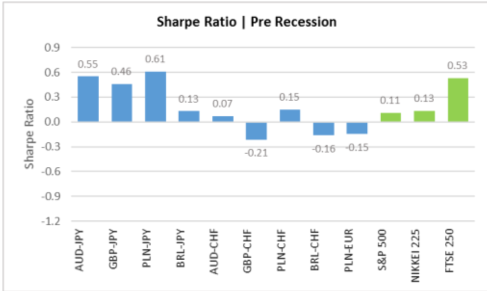


Figure 4.21: Sharpe ratio Pre-Recession

The Sharpe ratio results for the time period preceding the recession are detailed in Figure 4.21, above. In this period many CTs performed a lot better than for the entire period. The CT with the highest Sharpe ratio in this instance was the PLN-JPY with a figure of .61 followed by AUD-JPY with .55. Tellingly, all JPY funded CTs bar the BRL-JPY outperformed the CHF funded trades. In fact, three out of four CHF trades resulted in negative Sharpe ratios, despite this period preceding the turmoil during and after the recession. The CT with the lowest resulting Sharpe ratio was the GBP-CHF with -.21. The best performing index in terms of Sharpe ratio was the FTSE 250 with a figure of .53, with both the Nikkei 225 and S&P500 far lower on .19 and .11 respectively. In this timeframe both AUD-JPY and PLN-JPY outperformed the indexes.

The results for the period during the recession are illustrated in Figure 4.22, below. In this period, it is observed that all CTs and indexes are negative. The CT of BRL-CHF, has the highest Sharpe ratio of -.19 whereas the trades with the lowest ratios are GBP-CHF with a figure of -1.07 and GBP-JPY with -.95. A negative Sharpe ratio demonstrates that a risk free asset would perform better than this particular investment. This highlights how during market downturn CTs and equites are extremely poor places to put your investment. The worst performing index was the FTSE250 with -.75 followed closely by the S&P500 on -.74.

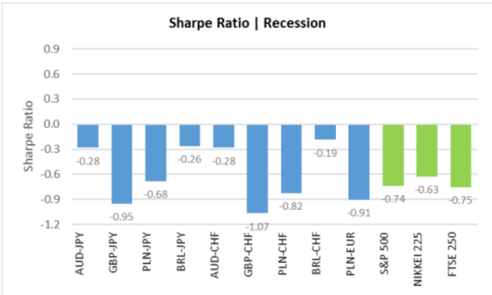


Figure 4.22: Sharpe ratio Recession

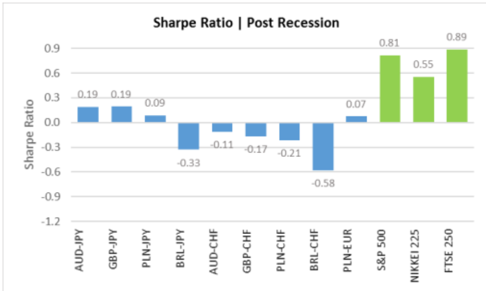


Figure 4.23: Sharpe ratio Post-Recession

The Sharpe ratio results for the period that followed the recession is detailed in Figure 4.23, above. In this period the majority of CTs suffered negative ratio results. The CTs with the highest ratios were AUD-JPY and GBP-JPY, both on .19. The trade with the lowest ratio was the BRL-CHF with a figure of -.58. In contrast, all equity indexes performed remarkably well. The index with the highest Sharpe ratio was the FTSE 250 with .89, with both the S&P500 (.81) and Nikkei 225 (.55) not far behind. This is a startling contrast of performance with the CTs over this period. This is perhaps indicative of the bull market that equities found themselves in over the period 2009-2014 with quantitative easing being carried out particularly within the US and EU (FT, 2015). Furthermore, it is observed how CHF funded trades underperform again, relative to JPY funded trades.

Across all periods, the highest resulting Sharpe ratio was during the pre-recession with PLN-JPY giving a figure of .61. While this gave the highest result, it was poor in all other timeframes. This was exceeded by both the S&P500 and the FTSE 250 post-recession with .89 and .81. Aside from the recession all indexes gave a positive Sharpe ratio, the same cannot be said for the CTs.

In the work of Burnside et al. (2006) they found over the period of 1976 to 2005 they found that the carry trade's Sharpe ratio exceeded that of the S&P500. Furthermore, Gyntelberg and Remolona found over 2001-2007 that the CTs exceeded not just the S&P500, but the Nikkei 225 and FTSE100. It is observed here for the entire period in Figure 4.2 that all carry trades have a lower Sharpe ratio than all three equity indexes. It is observed in Figure 4.21 that pre-recession over half the CTs outperformed the S&P500 while only two out of nine outperformed all indexes. For the recessionary period in Figure 4.22, five out of eight CTs outperformed the S&P500 while four out of nine outperformed all indexes. Although, no investment during this period gave a positive ratio. In Figure 4.23, the post-recession period, all CTs underperformed compared to the indexes. This was by a large margin. This could potentially be linked to the work of Baillie and Cho (2011) who have shown for a brief period post-recession that the failure of UIP and in tandem profitability has reversed. As profitability is such a major component in the Sharpe ratio, this is distinct possibility. Furthermore, non-normal returns have been shown to inflate Sharpe ratios as demonstrated by the work of Bailey and Lopez (2012). Yet, post-crisis CT Sharpe ratios remain low comparably to the indexes, despite exhibiting higher characteristics of non-normality in the form of kurtosis and some skewness (CHF CTs). This will be further explored in the final findings that follow.

4.4: Carry Trade Profitability and Volatility

This section details the ultimate findings of the investigation into the viability of the carry trade as an investment strategy. It reveals the profitability and volatility of the CTs and indexes. There are four graphs, each for their relevant time frame as defined in the methodology: entire period, pre-recession, recession and post-recession. The entire period portrays 2001-2015 as seen in Figure 4.3, while the pre-recession period details from 2001 until 11/2007 as found in Figure 4.31. The recessionary period portrays 12/2007 until 06/2009 as seen in Figure 4.32, whereas post-recession details from 07/2009 until the end of 2015 as illustrated in Figure 4.33. The X axis illustrates the relevant investments (CTs and indexes) while the Y axis pertains the percentage of profitability and volatility. All CT returns/losses are noted in the blue bars, indexes in the green and each is accompanied by the volatility over that period (orange). This section will reveal which CTs are profitable and when, in direct comparison to equities. This will build on the previous analysis from the report and attempt to ascertain whether CT strategies are still a viable investment strategy. This will be followed by a summary statistics table as seen in Figure 4.4.

The profitability and volatility results for the entire period are illustrated in Figure 4.3, below. The first thing that is noticeable is all CT and index investments were profitable except the GBP-CHF trade which made a slight loss. The CT with the highest return was the BRL-JPY with an annualised average return figure of 11.42%, followed by AUD-JPY with 7.87%. The GBP-CHF made a loss for the period with an annualised average loss of -.58%. The index with the highest return over the period was the FTSE250 with a figure of 11.47%, exceeding the highest CT return. In terms of volatility, the most profitable CT was also the most volatile with BRL-JPY having an annualised average standard deviation of 20.93%, illustrating the riskiness of the investment. The FTSE 250 had a similar but slightly lower volatility with a figure of 20.64%. While over the entire period the most volatile investment was the Nikkei 225 with 29.33%.

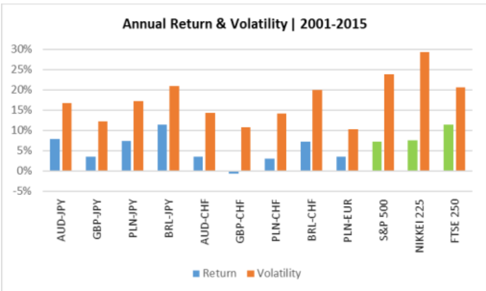


Figure 4.3: Profitability & Volatility 2001-2015

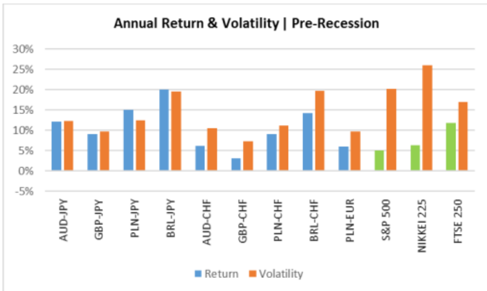


Figure 4.31: Profitability & Volatility Pre-Recession

The profitability and volatility results for the pre-recession period are shown in Figure 4.31, above. All investments are less volatile comparably with the overall timeframe, as would be expected. The returns for the CT are also vastly different, with all trades in profit. The highest annualised return across all investments was the BRL-JPY with a profit of 20.03% followed by PLN-JPY with 15.02%. The lowest CT return was the GBP-JPY (3.09%). The highest return of the indexes was the FTSE 250 with 11.76%. All JPY funded trades exceeded their equivalent CHF funded trades and the just under half of CTs (4 out of 9) outperformed the indexes in terms of profitability. The highest volatility was witnessed with the Nikkei 225 with standard deviation at 26.03% while the highest CT was noted at 19.67% (BRL-CHF). Most of the CTs annual profitability was approximately par with volatility while all three indexes were inherently more volatile relative to their return, illustrating the attractiveness of CTs pre-recession.

The results of the profitability and volatility analysis for during the recession are illustrated in Figure 4.32, below. It must be noted that the scale has been changed for this period (as noted in red) as the results were extreme, as might be expected for this economic climate. An extra 15% was added to the top of the bar graph and an extra 30% added to the negative side of the graph. As standard deviation cannot be negative, these elements are still shown above the 0% line.

Despite the market turmoil around this period, two out of nine CTs remained profitable. The highest profitable investment recorded was the BRL-CHF CT with an average annualised return of 6.57%, well above any other CT during this period. Alongside this, BRL-JPY made a profit with a result of 2.99%. There was a stark contrast in results for the equity indexes during this period with all three recording losses exceeding 25%. The largest annualised loss was the S&P500 with -32.78%. Beside these extreme losses was huge bouts of volatility with all indexes exceeding 35% standard deviation, with the Nikkei 225 the highest on 49.76%. All CTs exceeded the 15% volatility with the BRL-JPY having the highest on 33.82%. The lowest standard deviation was the GBP-CHF on 15.71%. This was followed by PLN-EUR with 16.52%.

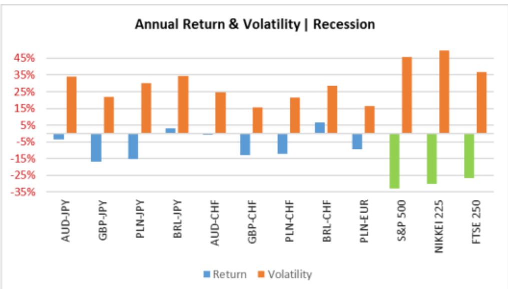


Figure 4.32: Profitability & Volatility Recession with change in scale

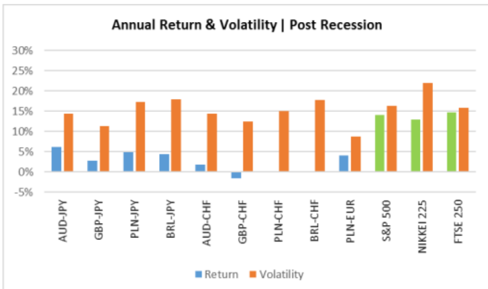


Figure 4.33: Profitability & Volatility Post-Recession

The annualised profitability and volatility for the period post-crash are shown in Figure 4.33. The first distinct change that is prominent is the huge upswing in fortunes of the S&P500, Nikkei 225 and FTSE 250. Furthermore, the CTs did not rebound in the same manner. The highest recorded return for the CTs over this period was AUD-JPY with a figure of 6.20%. This was dwarfed by at least 2 to 1 across all indexes, with the FTSE 250 being observed as the highest with 14.75%. Furthermore, both PLN-CHF and BRL-CHF returns were negligible while GBP-CHF made an annualised loss of 1.52%. In terms of volatility, the CTs with the largest standard deviation were the BRL-JPY and BRL-CHF with 17.87% and 17.73%. While the indexes were more profitable over the period, they were also generally more volatile too. All three exceeded the 15% annualised mark, while the Nikkei 225 reached 21.96%.

While over the whole of 2001 to 2015 all CTs bar GBP-CHF were profitable, the results become more insightful once broken up into their timeframes. In the period preceding the recession consistent with Gyntelberg and Remolona (2007), the CTs perform generally well compared to indexes with some things to note. The GBP-CHF trade appears to perform poorly across all periods with losses, but this period it makes a low profit of 3.09%. The findings here have different target currencies (except AUD) than Gyntelberg & Remolona (2007). Yet, it is still evident pre-recession that the CT outperforms indexes with an average annualised mean return of 10.53% and annualised standard deviation of 12.49% compared with the indexes 7.68% and 21.09%. During the crisis 7 out of 9 CTs make losses but with an annualised average loss of -6.85% for the period it still performs a lot better than an investment in an index with -29.88%.

The real change comes post-recession, where the gap in the literature meets this empirical research. Baillie and Cho (2014) document the existence of the forward premium anomaly or failing of UIP from the 1980s onwards with a reversal in the initial aftermath of the financial crisis. Baillie and Cho's work up until September 2011 led them to speculate that the carry trade may not be profitable over the period documented in this report. For the pairs demonstrated here, it is evident post financial crisis that CTs are still profitable on average. Yet, equities have vastly outperformed CTs post-crisis. The annualised average return of CTs for the period of 2.50% was a far cry from it pre-recession highs evident in the of Burnside et al. (2006) and Gyntelberg Remolona (2007). The two BRL trades represent the best CT investments being profitable in all 3 periods, owing in part to Brazils extremely high interest rates. This changes the context of the CT investment. No longer is it outperforming equity indexes' in terms of Sharpe ratio or profitability as it has historically (Burnside, 2006; Gyntelberg and Remolona, 2007). Indexes are now superior to CTs approximately 3 to 1 in Sharpe ratio and 2 to 1 in profitability. What this means in terms of investment will be discussed in the following chapter. The summary statistics for the return, volatility and Sharpe ratios of all investments is shown in Figure 4.4 below.

	2001-2015			Pre-Recession			Recession			Post Recession		
Long-Short	Return	Volatility	Sharpe	Return	Volatility	Sharpe	Return	Volatility	Sharpe	Return	Volatility	Sharpe
AUD-JPY	7.87%	16.74%	0.20	12.09%	12.24%	0.55	-3.64%	33.83%	-0.28	6.20%	14.45%	0.19
GBP-JPY	3.59%	12.26%	0.06	9.09%	9.65%	0.46	-17.04%	22.02%	-0.95	2.76%	11.40%	0.19
PLN-JPY	7.42%	17.23%	0.11	15.02%	12.46%	0.61	-15.18%	30.27%	-0.68	4.84%	17.23%	0.09
BRL-JPY	11.42%	20.93%	-0.11	20.03%	19.54%	0.13	2.99%	34.22%	-0.26	4.32%	17.87%	-0.33
AUD-CHF	3.51%	14.31%	-0.08	6.11%	10.58%	0.07	-0.96%	24.54%	-0.28	1.83%	14.38%	-0.11
GBP-CHF	-0.58%	10.83%	-0.31	3.09%	7.27%	-0.21	-12.81%	15.71%	-1.07	-1.52%	12.41%	-0.17
PLN-CHF	2.97%	14.24%	-0.17	9.08%	11.21%	0.15	-12.09%	21.31%	-0.82	0.14%	14.96%	-0.21
BRL-CHF	7.25%	20.00%	-0.33	14.28%	19.67%	-0.16	6.57%	28.43%	-0.19	-0.05%	17.73%	-0.58
PLN-EUR	3%	10.28%	-0.19	5.97%	9.76%	-0.15	-9.49%	16.52%	-0.91	4.00%	8.72%	0.07
S&P 500	7.28%	23.83%	0.25	5.02%	20.24%	0.11	-32.78%	45.75%	-0.74	14.01%	16.25%	0.81
NIKKEI 225	7.52%	29.33%	0.21	6.26%	26.03%	0.13	-30.15%	49.76%	-0.63	12.89%	21.96%	0.55
FTSE 250	11.47%	20.64%	0.49	11.76%	16.99%	0.53	-26.71%	36.85%	-0.75	14.75%	15.78%	0.89
JPY Funded	7.57%	16.79%	0.07	14.06%	13.47%	0.44	-8.22%	30.08%	-0.55	4.53%	15.24%	0.04
CHF Funded	3.29%	14.84%	-0.22	8.14%	12.18%	-0.04	-4.82%	22.50%	-0.59	0.10%	14.87%	-0.27
CT Mean	5.21%	15.20%	-0.09	10.53%	12.49%	0.16	-6.85%	25.20%	-0.61	2.50%	14.35%	-0.10
Index Mean	8.76%	24.60%	0.31	7.68%	21.09%	0.26	-29.88%	44.12%	-0.71	13.88%	18.00%	0.75

Figure 4.4: Summary Statistics including return, volatility and Sharpe ratio, for all assets.

Chapter 5: Discussion & Conclusion

This chapter will discuss the findings of the research in relation to the underpinning literature. It will look to bring together all relevant aspects of the empirical study in order to sufficiently critically analyse and evaluate findings. It will state the limitations of the research and any problems encountered. Furthermore, will reflect on the implications of the research going forward.

5.1: Discussion on findings

The research design of this thesis was based on conducting analysis on the carry trade. This was based on profitability and the characteristics that pertained. The model used was singular in application consistent with Baillie et al. (2011) and Brunnermeier et al. (2008) in terms of returns but differed in its reporting. This singular approach brought to light individual carry trades which gave insight into the countries involved. The ex post models built, such as in the instance of Baillie & Cho (2011), analyse with a 'Relative Interest Rate Opportunity' model. This entailed the switching of funding currency in to optimize the model which takes into account interest differentials. Additionally, the work of Burnside et al. (2006) built a CT portfolio model against the GBP as a numeraire. The research here aimed to take a more direct route in reporting individual pairs based on their percentage return for that individual trade.

Through this avenue, by taking into account multiple carry trades and running them over the relevant time periods it will more sufficiently answer the research question posed in this thesis. The reporting of individual trades is consistent with Gyntelberg and Remolona (2007), which offered insight into the country's most conducive to carry trade activity. The findings here suggest that CTs are not as an attractive investment post- crisis, particularly relative to their performance both pre-crisis and vs indexes after the crash. In a follow up to the work of the Baillie and Cho (2011), it is evident that CTs profitability has fallen, but it is not unprofitable on average within the sample researched here. An average annualised post crisis profit of 2.50% dispels expectations of potential negative returns. Nevertheless, the carry trades attraction lay within its excess returns generally exceeding equities pre crisis as shown in Figure 5.0. This shows specifically with JPY funded trades a profitability of 14.06% and volatility of 13.47% exceed indexes average of 8.14% and 12.18%. Furthermore, Burnside et al. (2006) and Gyntelberg and Remolona (2007) reported, carry trades can also exhibit high Sharpe ratios above and beyond that by an index. This is witnessed here for JPY funded trades with a pre-crisis average Sharpe ratio of .44 compared to .26.

Why are Japan funded trades more profitable pre and post-recession? In the period preceding the financial crisis Japan had lower interest rates relative to Switzerland, as seen in Figure 5.0 below. This was big factor in having a 14.06% profitability over CHF funded trades 8.14%. In the years after the recession the same dominance is seen. Whereas before the crash JPY trades had an interest rate advantage, Swiss interest rates post crisis fell below that of Japan. The big factor in this latter period is the general depreciation in JPY post crisis relative to its target currencies (Appendix C). This is strengthening an already profitable position suggestive of the prevalence of the forward premium puzzle and failed UIP. This is contrasting with the exchange rates of CHF funded trades as seen in Appendix C where the funding currency has been appreciating relative to its target currencies. These contrasting fortunes are noticeable within the profitability of trades as seen in Figure 4.4, with JPY funded trades having an average profitability of 4.53% compared to CHF's 0.10%.

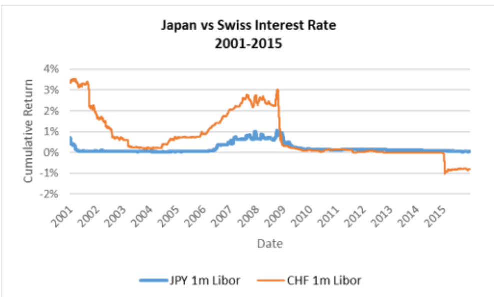


Figure 5.0: Japan vs Swiss Interest Rate 2001-2015

The descriptive statistics highlighted the vulnerabilities that persist in CT investment, in terms of skewness and kurtosis. The CHF funded trades were especially negatively skewed showing the dangers that lie if the far left tails pertaining extreme losses. While “volatility is a symmetric measure of risk… skewness keeps track of the direction” (Anzuini & Fornari, 2012, p.7). This illustrates the likelihood according to the measure skewness of adverse negative movements to CHF CT returns. This was particularly evident during 2011 and 2015 with in Appendix A to C illustrating daily returns, cumulative returns and the exchange rate. The JPY funded trades didn’t suffer from the same negative skew perhaps illustrating its symmetry. Yet, this does not discount the idea of extreme movements. All CTs did have highly leptokurtic distributions which demonstrates the susceptibility of trades to large fluctuations in either tail.

This was contrasting with the profile of investment in indexes which had no skew and less excess kurtosis. This was highlighted in the distributions (4.2) section of the findings showing the vast differences in the returns graphically. While these favorable underlying characteristics of indexes pre-recession was met with inadequate returns relative to CTs, this is no longer the case. CTs have approximately a quarter of the gains over time span of 2009-2015 compared to 2001-2007. Meanwhile equities have approximately doubled their returns from 2001-2007 to 2009-2015. This makes CTs place within the investment landscape less appealing and loses some of the lure that was once there.

Yet, there remain/There are still standout CTs that have withstood the test of economic turmoil. The AUD-JPY was the most highly profit CT after the crisis and had the highest Sharpe ratio over the entire timeframe (2001-2015). These currencies are some of the most widely researched currencies within the literature, pertaining for their high interest rate differential and favorable FX history (Burnside et al., 2006; Burnside, 2011; Gyntelberg and Remolona, 2007; Anzuini and Fornari, 2012; Jurek, 2014; Galati et al., 2007). While BRL was the most profitable overall its Sharpe ratio suffered. This is because of the high risk free rate (average BRL rate) and higher volatility. This makes the AUD-JPY the most viable especially considering the performance in the latter period.

Japan shocks conducive to CT activity include more quantitative easing induce inflation and to boost its corporates exports. Japan's vested interest in downward pressure may be the precursor to future CT conditions. Yet, the Bank of Japan being able keep persistent downward pressure the JPY is far from guaranteed. While in 3 of 4 CTs the JPY has weakened post crisis, 2016 has seen a JPY appreciation. While there is pressure on the BoJ to expand monetary policy, they have yet to do so (FT, 2016). This makes its role as the most prominent CT funding currency less than certain going forward.

5.2: Limitations

This project undertaken on the CT was not without its limitations. It is important to consider these limitations in interpreting the results of such research. The limitations include the comparison of CTs vs indexes post crisis, the limited sample size, the lack of transaction costs and simplicity of the model.

The economic environment surrounding 2009-2015 is unique in that during this time the US (S&P500), UK (FTSE250) and Japan (Nikkei225) were all carrying out quantitative easing on a large scale (Guardian, 2015). This buying of debt securities in particular bonds can cause equities to 'artificially' rise as the cost of capital becomes cheaper for businesses (Tobin, 1969; Mishkin, 1996). This makes the comparison of equites vs CTs potentially less credible than before 2009, when the first rounds quantitative easing started in the US.

The sample size could have been composed of different countries which may have enabled a better representation of the CT as a whole. Nevertheless, JPY and CHF funded trades are evident in countless past empirical studies due to their low interest rates (Gyntelberg & Remolona, 2008; Burnside, 2010; Menkhoff et al., 2012). On the investing side geographic representations from South America

(BRL), Europe (GBP, PLN, CHF, EUR) and South Pacific (AUD) were included. Other currencies could have been added, perhaps from Scandinavia and Asia.

This research was conducted on the premise of no transaction costs. While costs can be minimal when partaking in a large scale carry trade, this is a limitation of the work presented here. There is a lack of information about real carry trade activity. Due to the very nature of such transactions being private, having insight into activity of investors is limited. While researchers (Galati, Heath and Maguire, 2008; Anzuini and Fornari, 2012) have looked at conditions conducive to its undertaking, there is no factual information to ascertain if other speculative or non-speculative strategies from banks or hedge funds are at play.

The CT model as the framework for research is chosen for relatability and is thus not complex in nature. While a more complex model that is able to process larger quantities of CT data would appeal to the concept of generalizability, it would not allow the focus and in depth discussion that this model has provided through its simplicity and smaller data set. Yet, this is means the research has focused on depth of study rather than scope.

5.3: Conclusion

The research question:

'An investigation into the viability of the carry trade as an investment strategy over the period of 2001-2015?'

The overall research aim was to investigate the viability of the carry trade as an investment strategy. The research was conducted over the period of 2001-2015. The strategy has a history of excess returns (Burnside, 2006; Jurek, 2014; Gyntelberg and Remolona, 2007) due to the failure of UIP (Engel, 1996; Froot and Thaler, 1990). This phenomenon has eluded the finance industry (Baillie and Bollerslev, 2000; Sarno, Valente and Leon, 2006) thus far and efforts to comprehensively explain excess returns to the trade have fallen short of conclusive.

The search for an explanation of such returns to the CT has cast its net wide. The research on foreign exchange market show that while inefficiencies have been shown to exist at times (Aroskar, Sarkar and Swanson, 2004; Wong and Ahmad, 2013), markets are largely efficient and particularly for the currencies in this report (Oh, Kim and Eom, 2007; Pilbeam and Olmo, 2012). Yet, even though research into behavioural finance would indicate that markets participants are susceptible to biases and 'animal spirits', there remains no way of effectively quantify such psychological movements (Kahneman and Tversky, 1979; 1976; Grauwe and Kaltwasser, 2012). The work on volatility showed encouraging results in measuring the co-movement of excess returns with global FX volatility. Negative co-movement between high interest rate currencies and volatility innovations illustrated the investors dislike of rapid changes (Menkhoff et al., 2012). The crash risk of the trade, perhaps the most intuitive form of explanation for excess returns was not enlightening. This work showed promise by crash-hedging through option derivatives, but was ultimately shown to count for no more than one-third of returns (Burnside et al., 2010; 2011; Farhi et al., 2013; Jurek, 2014). While palpable explanations for the excess returns to carry trades were out of reach, conditions conducive to carry trades were evident.

The macroeconomic environment of the global financial markets can literally make or break the trades returns. The role of government and central bank policy whether it's to induce demand through economic policy or conduct expansionary monetary policy is crucial to the profitability of the trade (Hutchison and Sushko, 2010). Actions that determine exchange rate movements and interest rate differentials are either to the detriment or delight of carry trade investors (Anzuini & Fornari, 2012). Conditions predating the recession were inherently beneficial to its performance. Depreciating funding currencies in the form of CHF and JPY (Appendix C), reduced volatility (Figure 4.4 & Appendix A) and large interest differentials (Appendix B) made carry trade investment the talk of the town.

Cataclysmic events such as the global financial crisis and the turmoil that followed lay rest to favorable conditions. While some CTs performed well during the recession the overall average was a loss. This was not unexpected. Swiss appreciation in the years after this period meant the CHF trades suffered predominantly negligible returns with an average annualised profit of .10%. On the other hand, JPY funded trades were benefited by the downward pressure on the Yen resulting in JPY CTs having an average annualised return of 4.53%. While overall the average profitability post-financial crisis slumped to 2.36%, Baillie and Cho's (2014) foresight of unprofitability failed to materialize.

Yet, although the CT remained profitable overall its case as a standout investment is not as compelling as it once was. Highly leptokurtic distributions and the proneness to negative skew makes make extreme losses more than plausible. There is more vulnerability to these events than the equites observed in this report. Furthermore, equities buoyed by mass quantitative easing has enabled benchmarks to grow consistently resulting in a post-crisis annualised profit of 13.88%. Highlighting the attractiveness of equities is a high Sharpe ratio of .75, well above and beyond CTs -0.10 for the period in question. This makes the indexes of S&P, FTSE and Nikkei a far better investment than the carry trade over 2009-2015.

5.4: Future Research (Recommendations)

This research project has given light to tangible insight into the carry trade over the period of 2001-2015 from a quantitative perspective. There are some areas for further research to be considered. This area is lacking in real data based on CT activity. Due to the private nature of the nature investment, there is a mystery to how much sums are involved and when it is most popular. When looking at returns over a period of time it is easy to note losses incurred, yet actual investors unwind trades in periods of volatility. This means that may avoid sustained losses that are detailed in this report. This is particularly true when you consider that this work looks at specific time periods, as investors are unaware if they are approaching a trough or peak in an economic cycle. A more qualitative approach based on interviews or surveys with investment managers may reveal pertinent data. This would give a greater insight into the real activity of such an investment strategy.

UIP has been extensively documented to have failed pre crisis, this has paved the way for carry trades to be profitable (Baillie and Cho, 2014). The research here has revealed a deteriorating performance. This makes UIP analysis on featured currencies in this report of significance going forward. The final area of recommendation lies within the alternative currencies available for study. The report here looked at 9 CT pairs but there are other countries that have been used for analysis such as Norwegian Krone (NOK), New Zealand Dollar (NZD), Indian Rupee (INR), Islandic Krona (ISK) and Canadian Dollar (CAD) to name a few. All of these were documented in past literature and are therefore viable for further analysis (Christiansen and Ranaldo, 2011; Gyntelberg and Remolona, 2008). Recent macroeconomic movements in 2016 have shown the JPY to be appreciating (FT, 2016). This has the potential to diminish any returns particularly when performance has already deteriorated over 2009-2015, so the room for further carry trade research is always evolving.

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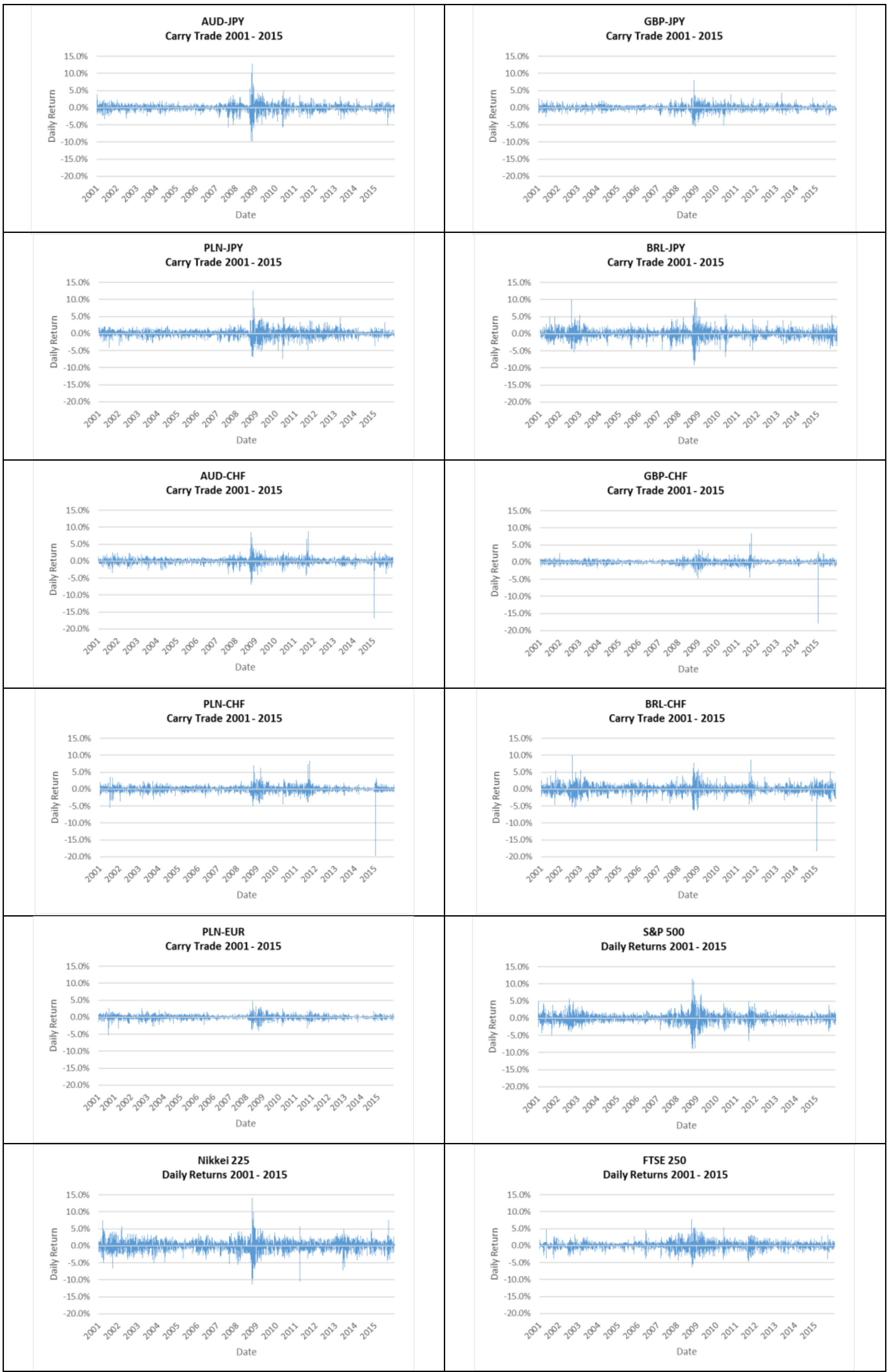
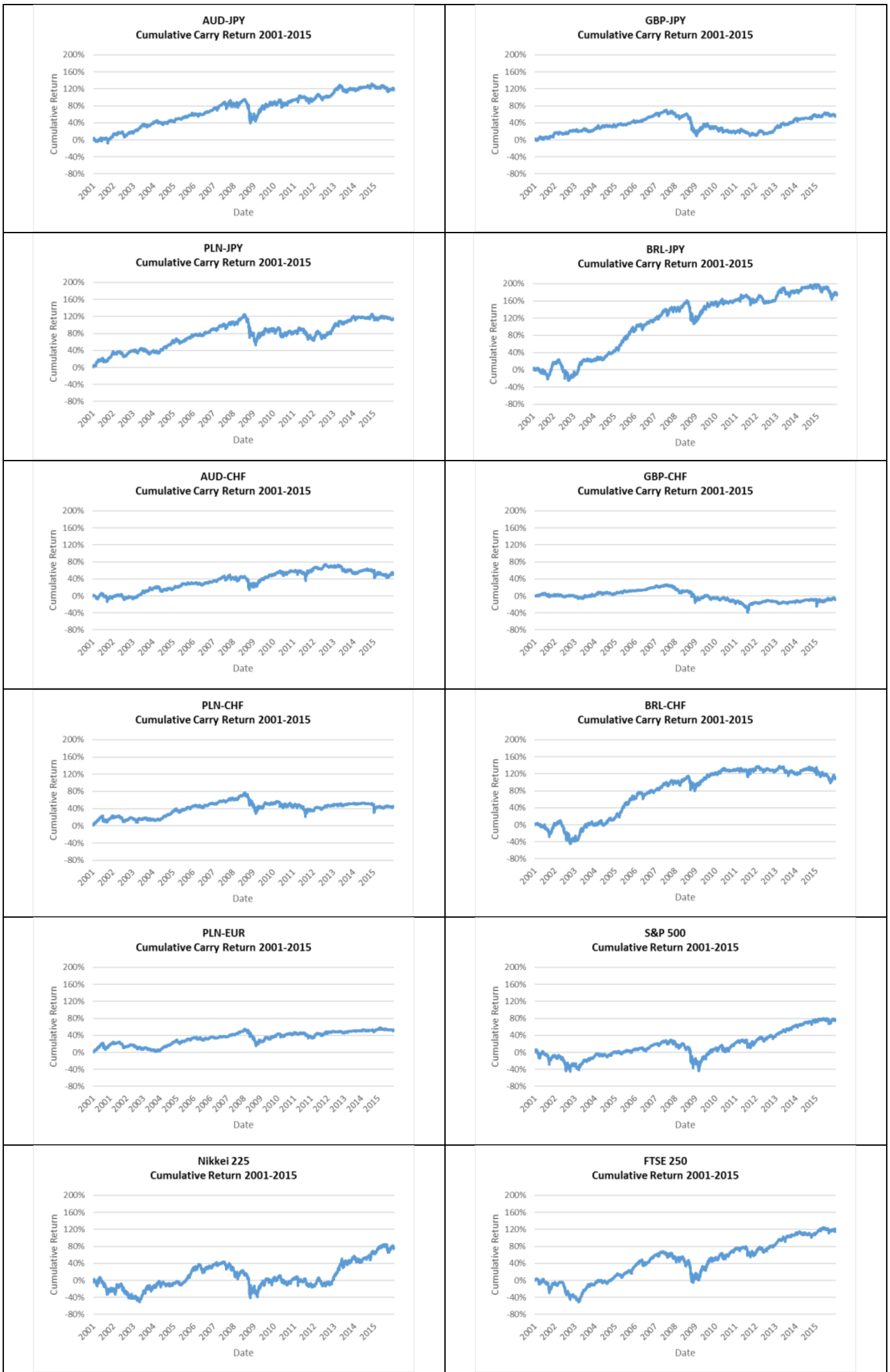
Appendices

Appendix A



Appendix A: Daily Return 2001-2015

Appendix B

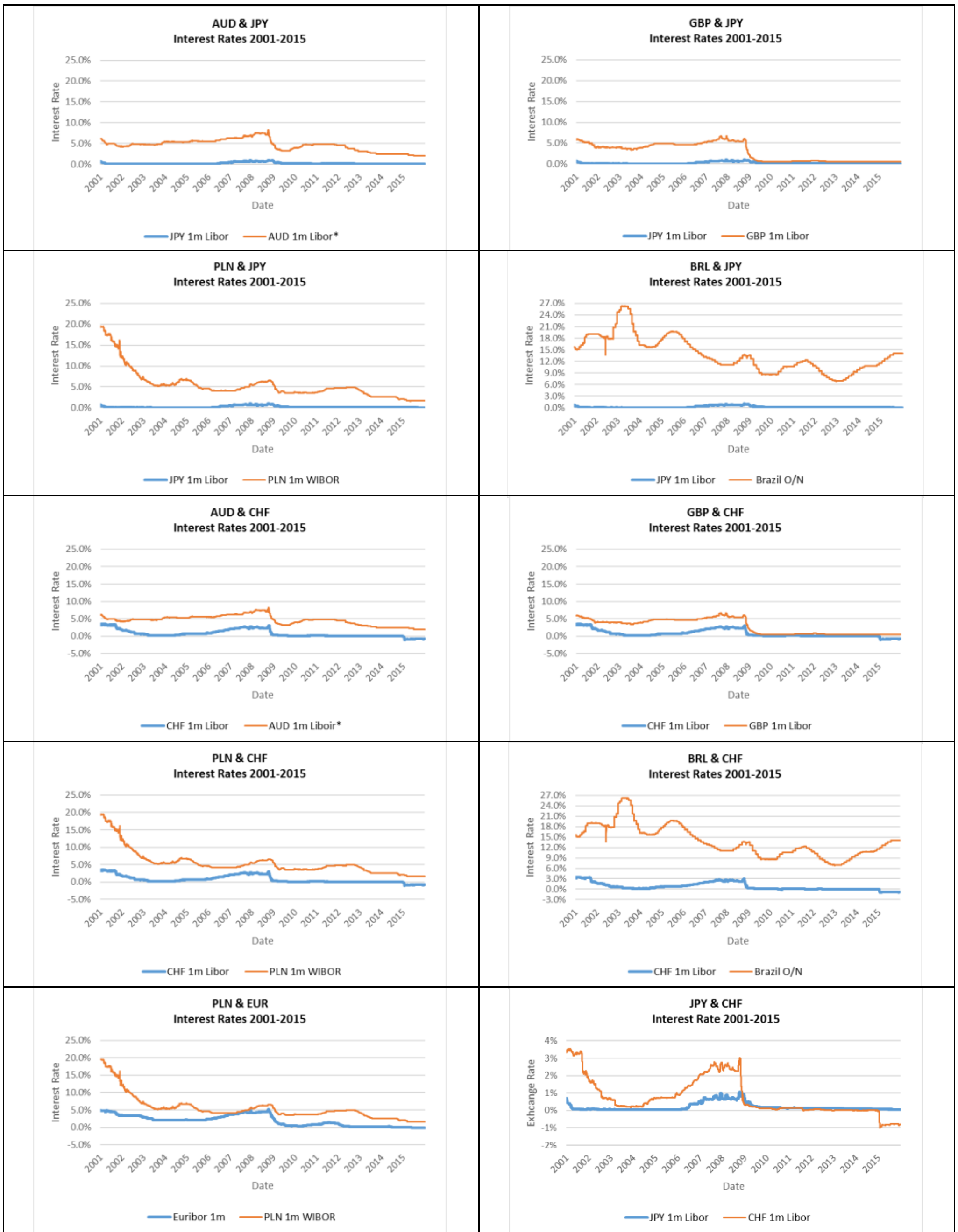


Appendix B: Cumulative Return 2001-2015

Appendix C

Appendix C: Exchange Rates 2001-2015

Appendix D



Appendix D: Interest Rate Differentials 2001-2015