Are Carry Trade Risks Systematic Risks Now?

-an analysis of the dynamics of carry trade risks

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Abstract

In this paper, I study individual currency pairs and examine the behavior of the cross section of their carry returns with the USD. Developed and emerging market carry trades yield high Sharpe ratios even after adjusting for transaction costs. I show that carry trade risks carry trade risks are dynamic and have become more systematic in recent years. From 1999 onwards, the high carry return currencies have significant coefficients in a time series regression of returns on the US stock market returns, implied volatility innovations of the US stock market options (VIX), TED spreads. In addition to the time series factor loadings, I find that the cross section of carry trade returns can be sorted by betas on the any of these variables- US stock market, VIX innovations and TED spreads. I also document the increasing role of inflation growth in the cross section of currency returns and the increase in carry returns due to the presence of differentially inflation targeting central banks. I find that in both periods, the more negatively a central banks Taylor rule beta with respect to the US central bank is, the higher the return that currency pair achieves. I analyze how this observation may help make hedge funds and investors investing in other countries endogenous in theoretical models.

Introduction

Currencies that are at a forward premium tend to depreciate in a deviation from the uncovered interest rate parity. This presents an anomaly to the financial literature and a trading strategy to the practitioners. The basic carry trade strategy is quite simple: if a currency forward is at a discount to the spot price today, buy it and if the currency forward is at a premium to the current spot, sell it. Wait for the settlement date on the forward. On settlement date, convert the difference between the spot price that day and the purchasing price of the forward price convert your profit to numeraire of choice, typically your home currency[1]. The "carry trade" is widely used; hedge funds and investment banks trade it and sell it to investors in forms such as exchange traded funds (ETF), index linked notes etc.

In this paper, I study individual currency pairs and examine the behavior of the cross section of their carry returns with the USD. I show that this strategy as applied to portfolios of developed and emerging market countries yields high Sharpe ratios even after adjusting for transaction costs. I examine the main players for the carry trade; central banks and the speculators and what the cross section of currency carry returns can tell us about them.

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[1] **Carry Trade Example and commonly used terms:** imagine the one year Japanese Yen (JPY)/United States Dollar (USD) spot rate today is 100, and the one year forward is 95. You enter into a forward contract to buy 1.05 USD in a year's time for 95 Yen/dollar and deposit the dollar you have in the bank at 5%. When a year passes imagine the spot is still at 100. You then cash settle the forward contract and make a profit of1.05*(100-95) = 5.25 JPY. If spot moves, that is added on to or subtracted from the total profit. If the final spot in a year's time was at 105 it means the total payoff from spot movement is 10.5 Yen. This is in excess of the interest you earned in the savings account. To convert the excess payoff to the numreraire of choice, we divide by the current spot rate and get 10*1.05/105, or about 10 cents. In our example the USD interest rate was 5%; your total profit is 15 cents. Note that JPY is called the funding currency or the liability side and USD is called the asset side of the carry trade.

I show that carry trade risks carry trade risks are dynamic and have become more systematic in recent years. From 1999 onwards, the high carry return currencies have significant coefficients in a time series regression of returns on the US stock market returns, implied volatility innovations of the US stock market options (VIX), TED spreads. In addition to the time series factor loadings, I find that the cross section of carry trade returns can be sorted by betas on the any of these variables- US stock market, VIX innovations and TED spreads. I also document the increasing role of inflation growth in the cross section of currency returns and the increase in carry returns due to the presence of differentially inflation targeting central banks. I find that in both periods, the more negatively a central banks Taylor rule beta with respect to the US central bank is, the higher the return that currency pair achieves. I analyze how this observation may help make hedge funds and investors investing in other countries endogenous in theoretical models.

I also document the cross sectional sensitivities of various currency pairs to hedge fund indices and find that they line up with the popular carry trades. Currency pairs that do not have a positive carry return are still not sensitive to the macro variables mentioned above. The increase in assets under management is also differential in the cross section of the currency pairs; emerging market currencies with higher carry were invested in more.

Additionally, I find that in the years from 1999 to 2009 the Yen carry trade was not very profitable against USD. The USDJPY carry trade does not have much variation with the US stock market, a weak relationship with VIX innovations. Most analysis of the Yen carry trade focuses on the portfolio. Generally, the significant portion of a risk results comes from the “Asset side,” such as Australian dollar, New Zealand dollar or emerging markets currencies like the

Brazilian Real. A portfolio consisting of a long position in New Zealand dollar and short of Japanese Yen will load negatively on VIX innovations.

Carry trades are not usually studied in individual currency cross sections. Most approaches in the recent literature either form one portfolio, mostly of the Japanese Yen funded carry trades such as Hattori and Shin (2008) to explain various crises, or construct a few portfolios to study the cross section. A good example of cross sectional analysis of carry trades is an article by Lustig, Roussanov, and Verdelhan (LRV from now) 2009. They identify a slope factor in exchange rates and show high interest rate currencies load more on the slope factor than the low interest rate currencies. They go to suggest that their slope factors capture most of the cross sectional variation in currency markets. However, their model has no particular endogenous time dynamics that can explain my finding of increasing macroeconomic risk and significance of currency return explanatory factors in recent years. To verify my results, I use their portfolios and indeed find that portfolios line up better and have a higher factor loading after 1998.

A paper that address the time dynamic is Jylja, Suominen and Lyytinen (2008). They write a model of hedge fund investors with segmented markets that drive down the carry arbitrage and claim that changes in assets under management lead to lower carry returns. They do consider the effect speculative assets might have on carry returns but do not consider any effect on systematic risks like I do. Additionally, I claim that their analysis of carry returns declining in profitability is flawed.

There is a vast literature that debates the existence of the “forward premium puzzle” and Froot and Thaler (1990) is a good discussion.

Data Details

I use data from 21 countries from Bloomberg since that is a system used by traders to trade. I divide up the countries into two groups; the so called G10 and the emerging markets (EM from now).

G10 countries are important due to the size of the economy as they control such a substantial portion of the world economy and because the rest of the world’s economies and central banks are likely to emulate them. EM countries are important as they have had an increasing share of the GDP and are responsible for a substantial portion of the carry trade returns.

To analyze the Uncovered Interest Rate parity (UIP) conditions I use the data from the following countries with the respective currency symbols in brackets: USA (USD), New Zealand (NZD), Australia (AUD), Britain (GBP), Japan (JPY), Switzerland (CHF), Sweden (SEK), Norway (NOK), European Union (EUR) and Canada (CAD), South Africa (ZAR), Czechoslovakia (CZK), Brazil (BRL),Turkey (TRY), Hungary (HUF), Taiwan (TWD), Thailand (THB), Singapore (SGD), India (INR), Mexico (MXN), South Korea (KRW), Iceland(ISK). The data is obtained from Bloomberg and consists of the U.S. market closing (4:00 p.m. EST) Bid, Ask and Mid Spot, three month euro-deposit rates, 1m forward, 3m forward and 6m forward prices for every currency listed above from 30th December 1988 to 31st December 2009. I collect synchronized closing prices. However, the benefit of

collecting the interest rate and spot rate separately eliminates any problems of asynchronous forward and spot prices. Obviously, this assumes that covered interest parity holds by forces of arbitrage, which is a reasonable assumption for these liquid and major currency pairs. Akram, Rime and Sarno (2008) conclude that covered interest rate parity holds at daily and lower frequencies.

There are some days when data don't match or days that are holidays in some countries like Japan and are not holidays in others, I drop all those data points since they are not germane to the analysis. Since the carry trade needs all currencies for proper comparison the subset of liquid prices when every market is open is the best one. I convert the foreign currency prices such that they are all USD per foreign currency. For example a spot rate of 0.7500 for NZD means that 1 NZD dollar is equal to 0.7500 USD. The bid and ask price data sets don't go as far back for some countries, especially for the forward rates so I use the transaction prices from Burnside et al (2006) TABLE 1.

Bid-Ask Spreads

Table 1 shows the bid-ask spreads for various spot and forward rates for the two time periods- 1990 to 2001 and 2001 to 2007. It is obvious that as in most markets as FX markets have evolved, the bid-ask spreads have come down. Figure 3 shows the behavior of the AUDUSD 6m forward rate bid ask spread decreasing over time. Currently, some hedge funds get bid-ask spreads of less than 0.01 percent. A simple google search for FX Trading reveals that even for retail investors bid-ask spreads have shrunk dramatically. We see that the bid-ask spreads for forwards are somewhat higher than for spot transactions and among the forwards, longer

maturities like 6m forwards command a higher bid-ask than the shorter maturity 1m forwards.

I didn't find much deviation from covered interest rate parity in my analysis.

VIX is the ticker symbol for the Chicago Board Options Exchange Volatility Index, a popular measure of the implied volatility of S&P 500 index options. Referred to by some as the fear index, it represents one measure of the market's expectation of volatility over the next 30 day period. The VIX is calculated and disseminated in real-time by the CBOE. It is a weighted blend of prices for a range of options on the S&P 500 index. The formula uses a kernel-smoothed estimator that takes as inputs the current market prices for all out-of-the-money calls and puts for the front month and second month expirations. The goal is to estimate the implied volatility of a synthetic, at-the-money option on the S&P 500 index, with 30 days to expiration. In 2003, CBOE changed its method of computation for VIX and produced the new VIX. I persist with the "Old VIX." I do check that innovations for old VIX and new VIX have a correlation of 95%.

I get the US Banks Repo Data from the following website.
http://www.newyorkfed.org/markets/gsds/SearchResults.cfm

Short interest rate and Central Bank funds rate are very closely related- 99.8% correlation in levels and 90% in changes. So I use short rate and then interbank rate when central bank rate is not available. I get most of my economic data like GDP, unemployment from the OECD database and the Global Financial Database.

UIP Evidence

Tests of the Uncovered Interest Parity (UIP) are essentially tests of whether the forward rate is an unbiased predictor of the spot rate. Denote the current spot rate by St, the forward rate that settle at time period t+1 as Ft and the settlement day (t+1) spot price as St+1.The following regression is usually tested

$$(S_{t+1}-S_t) / S_t = \alpha + \beta\ (F_t-S_t) / S_t + \varepsilon_{t+1} \qquad (1)$$

Under the null hypothesis that (1) hold α should equal 0, β should equal 1 and the error term εt, should be orthogonal to the time t information. The rejection of the null hypothesis has been widely documented and I update the evidence. I report the results of various regressions. I use the 1m, 3m and 6m forward rates and all reject the UIP. The regressions are run using non overlapping data as well as overlapping data and I end up rejecting both cases. I only display the results for non overlapping data and for the 1m forward for brevity.

Consistent with the literature, I find estimates of β to be significantly different from 1. I also find that the forward premium puzzle exists and the value of β is negative. This implies that instead of appreciating, the foreign currency, when it is at a forward premium compared to the dollar, instead depreciates. Thus an investor could collect a return from the spot depreciation as well as the interest rate differential as pointed out in the carry trade example in the footnote on page 2.

The proposed explanations for the failure of UIP range from time varying risk premia (Fama, 1984), peso problems (Lewis, 1995) to interaction of risk premia and monetary policy (McCallum, 1994), and, behavioral explanations (Thaler and Froot, 1990).

The Carry Trade Mechanics and Performance

I use the convention of converting all currencies into dollars/1 foreign currency unit for spot and forward rates, and use the actual/360-day convention for interest rate computations.

I compute the carry trade return like much of the literature, constructing a log excess return

$$r(t+1) = s(t+1) - f(t).$$

Naturally, this return may be decomposed into an interest rate return and a spot return since

$$f(t) = s(t) + (r(USD) - r(\text{other country})) * \text{contract maturity}$$

$$r(t+1) = s(t+1) - s(t) + (r(\text{other country}) - r(USD)) * \text{contract maturity}$$

Thus, the excess carry return is nearly the sum of spot return and the interest rate return. We can combine the bid-ask spread into the equation in the usual manner and subtract the forward and spot transaction costs from the return. For each currency pair, at the end of each month I take the signal from the existing interest rate: if the interest rate of the foreign currency is higher than the US interest rate, I invest the foreign currency with borrowed dollars and vice-versa. I do this for all the currency pairs (21 in total) that I have data on from 1985 to 2009. However, I only report results for 1989 to 2009 to have more countries. Results don't change much when I use time periods from 1983 onwards.

Implementing the carry trade

There are two main methods of implementing the carry trade that I describe in the following paragraphs. The first method is to imagine that the amount invested everyday is $1 according to the investment rules written above, since the decision criterion is based upon daily observation and we assume that the trader makes the decision daily on whether to invest or not. The reason to use the first method is that it imitates what funds might do in practice to "build up" substantial carry position with minimal price impact and "averaging" the price they get into the carry strategy. Additionally, this method enables investors to change leverage quickly as they update their beliefs about the market. The other benefit of this method is enabling better execution for investors by setting stop and limit orders that capture the high or the low of the day's trading prices. The impact of getting good prices on a strategy's profits is non-trivial since the bid/ask spreads are the order of 0.01% whereas the daily volatility is the order of 1%. Thus, a well placed bid can increase the profits by up to the daily volatility of 1%. I would also like to suggest this as one of the mechanisms used by active investors use to mitigate price pressure and transaction cost impact suggested by Burnside et al (2006) by breaking up the order into small daily or intra-day chunks and placing stop and limit orders.

The second method is to mechanically invest at a horizon of the forward according to the trading rule mentioned in equation 3. So for a strategy that uses the 1m forward, the investor only invests after he realizes the returns from the first investment i.e. after a month. Thus this strategy ensures that there are no

overlapping returns. The reason to use the second method is that it gives non overlapping returns which are easier to work with statistically, though it reduces the sample size substantially. Additionally, it might emulate the behavior of certain investors who may not trade frequently.

Portfolio Construction

For the “asset” side currency pairs (invested in higher yielding foreign currency while borrowing in USD) return generation, the formation is the same as most current literature, such as LRV (2009). However, if I form a “liability” (invested in USD and borrowing in a foreign currency)return, the interest rate differential will still be positive (USD interest rate is higher than the funding currency rate.) Thus liability returns are constructed and analyzed slightly differently than LRV(2009) but will lead to the same result. For example, LRV would subtract two pairs (NZDUSD and JPYUSD) to get a NZDJPY return and I could assign equal weight to my NZDUSD and USDJPY pairs and add them to achieve a similar return for a NZDJPY pair.

After constructing individual carry trade pairs, I use different rules to construct portfolios, such as ranking by previous month’s interest rate differential, previous month’s interest rate differential scaled by realized volatility, ranking by previous two months’ Sharpe ratio and switching to a short carry if the realized volatility exceeds the implied by a certain amount.

Performance Summary Statistics

The individual currency pairs average monthly returns range from 60 bps a month for the USDJPY carry to 1 bp for USDZAR (South African Rand) carry for the

period from 1989 to 1999. The monthly standard deviations range from 1.3% to 3.6%, with the annualized Sharpe ratios ranging from 0.01 (South African Rand) to 0.64 for USDCAD.

The currencies range from some pairs consistently borrowing in the USD (GBP, 100%; NZD, 97%; and AUD 83% higher than the USD) to some pairs generally lending to USD (JPY interest rate exceeds dollar only 27% times). In the middle of these two extremes, there are other currencies like CHF (43% higher than the USD) that switch back and forth. All carry trade currencies show a negative skew, as reported in much of the literature and a few like JPY and GBP exhibit high excess Kurtosis of around 4 when it should be 0 for a normal distribution.

In the next time period, the return properties show a similar behavior in terms of skew and kurtosis. Interestingly, in the cross section, the Kurtosis and skew line up with higher interest rate differentials in both periods. Higher, the interest rate differential, the more negative the realized skewness and higher the realized kurtosis. This is in line with industry knowledge and recent academic literature like Brunnermeier et all (2008).

Correlation Patterns: A first observation of changing risk patterns

The correlations of these carry pair returns with variables like the US stock market return, changes in VIX, TED spread are quite low (average across all of -2% for US stock market) and we observe no significant pattern in relation to high carry returns and a high positive correlation with the US stock market, or VIX or TED spreads in the cross section. These observations are in line with the literature's discovery of low correlation of carry returns with the stock market.

During the period of 1999 to 2009, we have more emerging markets (EM from now) countries in the sample. However, I discuss both the G10 as well as the EM

results. We find that the correlations of currency pairs with the US stock market returns has increased across the G10 countries (to 10% for G10, 20% for EM). VIX show a similar pattern (average across G10 of 2% in 1989 - 1998 to -12% in 1999-2009). More interesting is to observe the cross sectional patterns of these correlations. For carry pairs that have a significant return the increases are significant and for the ones that don't have a significant return the increases aren't very high. For example the AUDUSD pair with an average carry return of 37 bps per month in the first sample (1989-1998) and 63 bps in the second sample (1999-2009) sees an increase in correlation with the US stock market return from -15% to +44%. Similarly for NZD which has an average monthly return of 5 vs. 75 bps per month in the two samples the correlation with the US stock market rise from -9% to +38%. The correlations for the EM currencies are even higher with highly invested carry currencies like BRL, TRY, MXN and INR having correlation of 56%, 49%, 55% and 37% respectively.

Interestingly enough, the carry pairs that don't have a high return like CHF (Swiss Franc) and JPY show a correlation of -1% and +1% respectively even in 1999 to 2009. The story is similar with changes in VIX and the TED spread.

Carry Basket Formation and Performance

For the entire period of 1989 to 2009, an equally weighted portfolio of all carry trades provides a Sharpe ratio of 0.84 as compared to the US stock market Sharpe ratio of 0.44. Both are computed without transactions cost. When I include transactions costs the carry trade Sharpe ratio is still about 0.70.

When I include only G10 currencies, I get a Sharpe ratio of about 0.74. Notice that the equally weighted portfolio is similar to carry baskets marketed by investment

banks. Most baskets comprise of 4 to 6 currencies. In that spirit of basket selection, I select the top two currency pairs each month based on the highest interest rate differential and that basket delivers a Sharpe ratio of 0.65. If I increase the number of currency pairs to three then I get a Sharpe ratio of 0.76.

I also observe that the carry trade basket yields a Sharpe ratio of 1.0 in the time period of 1999 to 2009. This contradicts the results reported by Suominen et all (2009). I think the results in their paper come from averaging Sharpe ratios rather than forming tradable baskets.

For these baskets, the maximum loss in any month is 14 to 16 times their average monthly return: One bad month could wipe out more than a year's worth of good returns. When we look at a similar statistic for the S&P 500 index it is 40! Thus, one bad month in the US stock market could wipe out even more past profits than carry portfolios.

Is Carry Return Completely Explained by Crash Risk ? A Back of the Envelope Analysis

Peso problems are frequently advanced as the reason for the existence of the carry trade profits. There is considerable academic debate on the topic and Farhi et all (2008)refute the claim that all returns are due to peso problems. Farhi et all (2008) estimate the crash risk to account for 25% of the returns. To put this literature in context, I provide a simple back of the envelope calculation. We take the extreme and impractical for investing, case that we dislike all negative returns! Hence we buy at the money put options.

Consider the rate of return on forward with a notional of one unit.

Expected Payoff at the end of time period T = E(R)*T

P (Price of an at the money forward option) <= 0.4*σ(Implied Volatility) *Sqrt(T)*exp(-R(Foreign)*T) (DeRosa, 2000)

Thus Net Payoff of a portfolio of one Forward and one at the money forward Put which is the same as one at the money forward Call (By Put Call Parity) can be written as:

$$E(R)-0.4*\sigma(\text{Implied Volatility})*\sqrt{T}*\text{Exp}(-R(\text{Foreign})*T)$$

$$\text{For the Expected Net Payoff} > 0$$

$$E(R)*\text{Sqrt}(T) / (\sigma(\text{Implied Volatility}) > 0.4*\text{Exp}(-R(\text{Foreign})*T)$$

But $\text{Exp}(-R(\text{Foreign})*T) < 1$ (since the nominal foreign interest rate is positive)

We can simplify this expression to be:

$$E(R)*\text{Sqrt}(T) / \sigma(\text{Implied Volatility}) > 0.4$$

$$\text{Or } E(R)*\text{Sqrt}(T)/ \sigma(\text{Realized Volatility}) > 0.4*\sigma(\text{Implied Volatility})/ \sigma(\text{Realized Volatility})$$

$$\text{Or Realized Sharpe Ratio} > 0.4* \sigma(\text{Implied Volatility})/ \sigma(\text{Realized Volatility})$$

In my sample, the ratio of Implied Volatility to Realized Volatility is not more than 1.1 or 1.2 even for illiquid currency pairs. Thus, any sample with a realized Sharpe ratio of more than 0.44 to 0.48 can be defended as a strategy that is not all based in peso problems. Naturally, this doesn't mean that it will hold in the

future: It could be that the options market didn't "know" that the currency market is subject to big crashes and/or the carry trade returns will have a lower than 0.5 Sharpe ratio.

There are other subtle issues such as credit risk of the Investment Banks writing the options but we ignore them for now.

Carry Trade Basket Performances

If we examine the entire period from 1989 to 2009, the simple method of forming a balanced carry portfolio seems to be hard to improve upon.

Some popular methods of carry performance in the industry such as selecting the currencies with the highest ratio of interest rate differential to previous month's realized volatility delivers an increase in Sharpe ratio from 0.99 to 1.15 from the time period of 1999 to 2009. However, it is not effective if we examine the entire time period from 1989 to 2009. I find the same result for the other popular industry rules described in the tables. Interestingly, one way to decrease carry performance is to sort based on the trailing Sharpe ratio of the previous months. Selecting only the top two best performers of the last 2 months delivers a startlingly low Sharpe ratio of 0.14 in 1999 to 2009.

The key insight seems to be to include EM countries in the carry portfolio in the 1999 to 2009 time period as they have Sharpe ratio of 0.99 as compared to the G10 Sharpe ratio of 0.73 in this time period.

Interest Rate Differences with USD

It is not necessary to have an unconditionally high interest rate differential. EUR and USD have an unconditional interest rate differential of –ve 31 bps but the

average monthly return of trading EURUSD carry is 51 bps. However, an unconditional high interest rate differential naturally implied a conditional high interest rate differential and thus helps generate high carry returns.

LVR(2009) propose two main factors for explaining the cross section of currency returns: the first is the so called slope factor- the difference in the high interest rate currency and the low interest rate currency. According to them, various currencies load differently on the slope factor and hence this factor explains the cross section of carry trade returns. As they explain in their 2009 article, the average returns on the carry trade should be explained by the average interest rate differential.

I test their model on individual currency pairs, which is a harder test than a portfolio based test (Cochrane, 2001). There are two main observations: first, using mostly G10 (except Europe) and South Africa, in the time period of 1989 to 1998, there is not much cross sectional explaining power and a simple OLS regression of the crudest type (entire sample average interest returns vs. sample average interest rate differentials) in fact produces a negative beta; second, the test performs much better in the 1999 to 2009 time period with the correct sign for beta and an OLS Rsq of around 55% for the entire sample (21 countries now) and even for G10 excluding Europe (to compare it to previous time period) it has the right sign, albeit a lower OLS Rsq. Of 14%. So we conclude that EM carry trades are easier to explain through interest rate differential. It is intuitive, since EM countries have more risks like credit and higher inflation risks. The next version of the paper will have more scientific tests than the pure cross sectional regression!

Carry Trade Explanatory Variables and their Dynamics

The main results generated in this section using factor betas confirm the intuition we developed in the previous section from observing currency return correlations with VIX innovations, S&P index and TED spreads changing from the 1989 to 1998 time period to the 1999 to 2009 time period. In this section, I do the analysis more formally with factor loadings across the cross section. To check my results I use data by LRV(2009) but to derive the main results, I continue to use the portfolios I constructed.

I find that the betas of the currency pair on the S&P index, VIX first differences and the TED spread lines up in the cross section of realized carry return, as well as the conditional interest rate differential in the time period of 1999 to 2009. This observation is in contrast to much of the literature, as recent as Suominen et all (2009) who claim that the stock market returns are not substantially correlated with carry trade returns. This result holds if we use G10 only, EM only and both. In fact, if I remove Turkey from the sample with the average interest rate differential of around 30%- an outlier- our fit improves even more.

In the first time period from 1989 to 1998, there is a cross sectional pattern for conditional interest rate differential that has the appropriate positive relationship with the US stock market. But the cross sectional table between stock market beta and realized carry return doesn't show much pattern; in fact a simple OLS regression would generate a negative cross sectional loading for the US stock market (OLS Rsq 8%) . In the second time period of 1999 to 2009 I find a

substantial relationship (OLS cross sectional Rsq of 64%). The regression of the second period is robust to various permutations and combinations of the currency pairs; G10, G10 without Euroland, G10 and EM, EM only. I find a similar pattern in the relationship between each country's own stock market betas and the average carry returns. However the relationship with own country's stock market betas explains less than the US stock market betas. In part, the country's own stock market betas may explain carry returns since in the period of 1999-2009, on average each country's stock market became much more correlated with the US stock market. A crude measure, the average correlation of monthly returns increased from 53% in 1989-1998 to 78% in 1999-2009.(Statistically significant at the 5% level). Likely, foreign country's stock market is a proxy for the US stock market.

For the beta on VIX first differences, I use the "Old VIX" the implied volatility index of CBOE that is provided by the CSFB TASS database. Data source details are in the appendix. The old VIX is quite similar to the new VIX and has the benefit of being able to be used for our time period. The results are similar to the results for the stock market loading and are robust to various combinations of currency pairs. From the period of 1989 to 1998, the cross sectional patterns of factor loading on VIX first difference exhibit a slight and insubstantial (OLS Rsq of 8%) increasing carry return as the factor loading on VIX first differences increases. However, from the time period of 1999 to 2009, we see a substantial negative factor loading (OLS Rsq of 46% to 59% depending on the sample chosen. This substantiates our previous observations for the S&P index. Since Heston (1993), the literature has documented a negative correlation between the stock market returns and volatility innovations. So naturally if we see a positive factor

loading on the market betas, negative betas on the first differences of VIX innovations are intuitive.

Cross section of TED betas vs. average returns on carry pairs follows the intuitive negative relationship in both time periods. However, the explanatory power increases substantially from the first time period with the OLS cross sectional Rsq of 9% increasing to an OLS cross sectional Rsq of about 23%. TED is the spread between the Treasury or the safe rate and Eurodollar or the interbank deposit rate (with credit risk), and hence can be treated as an "illiquidity" or credit risk measure. TED serves a different purpose than VIX in that it directly reflects a risk to the carry funding institution and so is better at explaining returns in times of crises than in "normal" times. The TED spread may represent "margin calls" from funding institutions. In times of crises, TED and VIX may both increase but in other times, they may not covary much. This fact is reflected in the 12% unconditional correlation which is not significant at the 5% level.

Finally, I construct a carry market portfolio. This portfolio construction is driven by the observation that it is quite difficult to outperform the carry market portfolio. Perhaps we can treat the carry market portfolio as a "tangency portfolio." I construct this portfolio as an equally weighted "basket" of all carry returns against USD. I find that the carry basket portfolio does quite well in describing the cross section. It has an unconditional average of 34 basis points per year for the entire sample. Almost all currency pairs load significantly on the carry market portfolio in both time periods.

To illustrate these results I include sorted tables of various currency pairs. We observe the patterns mentioned above of not much cross sectional variation due to

risk factors in 1989 to 1999 in G10 and a considerable cross sectional variation post 1998.

Results Not Just due to Crises

LRV(2009) remark that the volatility innovation proxies for a global risk and hence is a proxy for their HML_{FX} factor. They also find that in times of crises the carry trade fctor load on the US stock market beta. We could imagine that the reason for the differences in results is due to "more" episodes of crises in the years 1999 to 2009. Yes, the factor loadings and results are especially more significant in times of crises but the contrast of the results from the 1989 to 1998 time period is still maintained. I argue that these crises are not the whole explanation. The first and simplest piece of evidence lies in the periods from 1999 to 2000, and 2003 to the middle of 2007 when the stock market was increasing, the results hold in that period. Also, the big financial crisis for the later sample period has been in 2007- before then we had economic downturns but not fully blown "crises." The differences in average volatility from 1989 to 1998 and 1999 to 2009 are not significant at the 5% level.

Most of the literature combines the two time periods together and that might explain the lack of significant results regarding the stock markets risks.

Fundamental Sources of Risk?

LRV(2009) identify the interest rate differential as a proxy for risk that explains the cross section of currency returns. They present an essentially-affine model of term structure of N countries with a common global factor and a country specific factor. The cross section risk is generated by differential loadings on the common

global shock component. In this model we would find it difficult to endogenously explain the results changing across time. Their model implies that average interest rates should always line up with average carry return and doesn't have much to say on the time dynamics of this relationship or of the factor loadings on VIX or the US Stock market changing. Interestingly, I observe that using their own test portfolios from the period 1983 to 1998 and from 1999 to 2009 the developed countries show the average returns for portfolios 1 to 5 of [6 bps, 5 bps, 23 bps, 11 bps, 23 bps]- not very successful! However, when I examine the 1999 to 2009 time period I find the portfolios line up much better. The average returns are [9 bps, 3 bps, 21 bps, 28 bps and 42 bps]. Notice that the spread between the high and low portfolios also increases from 17 bps to 33 bps! The story is similar in all currencies with the six portfolios being [-6 bps, -2 bps, -13 bps, 18 bps, 16 bps and 20 bps] for 1983 to 1999. Again, the performance is much better for 1999 to 2009 with the six portfolios averaging [-13 bps. -16 bps. 27 bps, 24 bps, 19 bps and 48 bps]. Also the spread between first and the sixth portfolios increases.

The purpose of this exercise was not to critique the LRV (2009) result but to provide some supporting evidence that my results are not driven by pure data mining. Hence I check portfolios of countries different than mine formed from 1983 onwards that include the 1987 crash.

My contribution is to illustrate the time dynamics of the carry trade risk and to inquire more deeply into the empirical observations to explain these risks. A higher interest rate differential, on the surface only means higher returns and it is unclear what the risk, especially in the G10 or developed countries, really is? For EM countries a story of possible hyperinflation or bankruptcy leading to higher returns is easier to believe as in Cochrane (2001) but suggesting that a higher

interest rate G10 currency loads more on a global shock that does not dramatically affect the entire stock market- US and its own, is troublesome! As this paper shows the factor loading changed in recent times. Investment banks having liquidity issues always mattered negatively for carry returns but the stock market has only started mattering. No one model can fully explain any phenomenon so I applaud the contribution of identifying the interest rate factor and move to other models. Suominen et all (2009) make an interesting observation that speculative assets under management have increased substantially and develop a model where these speculative funds arise endogenously and reduce the anomaly by engaging in it. However, they make no attempt to link currency returns to systematic stock market risks and if anything claim that stock market returns do not help explain currency carry returns.

The carry trade depends on front end of the yield curve for various countries to exist and on investors to trade. I examine the carry return question from three perspectives: Central banks, speculative investors and funding institutions of these speculative investors. Thus, the carry trade could be influenced by central banks, if we believe they have any power to move the front end of the yield curve- a not unreasonable belief given the massive interventions of the US Fed in recent times, and the presence of hedgers and speculators who are funded by investment banks.

Risk Propagation through Value at Risk and Portfolio Rebalancing

A simple story for how US stock market shocks are propagated can be a hedge fund having losses in the US equity markets, reaching its Value at Risk (VaR from now) constraints due to both a negative equity return and an increase in volatility. This fund will have to liquidate its leveraged currency positions to bring its

leverage to acceptable limits and/or post collateral by selling off some liquid assets. Foreign exchange is one of the most liquid asset classes. Also, smaller domestic investors of a low interest rate currency such as US could face the same constraint as the hedge fund. The US equity market is one of the largest in the world: The world equity markets are roughly 68 trillion and just the New York Stock Exchange (NYSE) has stocks with market cap of 29 trillion trading on it! Thus, most hedge funds and other investors that invest in equities are quite likely to invest in such a big and liquid market. Additionally, with the current low interest rate of the Federal Reserve that translates into easy capital, many hedge funds are funded from the US. Note that the result discussed above can also follow from domestic US investors investing abroad

Carry Returns Cross Section and Hedge Fund Index Loadings

Similar to Suominen et all (2009), I examine CSFB Tremont hedge fund indices and use Jain and Lo (2010 working paper) factors to explain the returns. I add the G10 currency portfolio and it is significant for convertible arbitrage and fixed income categories. I explain the hedge fund indices time series of returns (available from January 1994 to December 2009) to a similar extent (my Rsq is 49% which is theirs as well) but with only 6 factors (including the carry factor) as compared to their 8 factors. I find that the convertible arbitrage, event driven and fixed income arbitrage funds are better explained using carry trade portfolios. Then I take individual currency pairs and regress them on each hedge fund index while controlling for the other factors (market, momentum, credit spread, treasury return, and commodity return). I find that from 1994 to 2009, NZD, AUD, JPY and CHF carry are significant and load positively load hedge fund indices. Other carry trades do not load positively. I also find that convertible arbitrage, event driven,

fixed income arbitrage and global macro indices are positively related to the JPY carry trade.CHF carry trade loadings are similar to JPY carry loadings. AUD and NZD are also significant for convertible arbitrage and fixed income arbitrage. If we examine the composite hedge fund index then we find that only CHF and JPY carry load positively. This is a good validation of the cross sectional approach and verifies some of the claims in the literature that JPY carry trade was used by hedge funds.

When I perform the regressions for 1999 to 2009 time period, I find that JPY carry remains popular, CHF carry declines, AUD and NZD become more popular, as does GBP. The big news is the popularity of BRL, MXN, ISK and INR. Hedge funds, attracted by the growth stories and the high Sharpe ratios (mentioned in the carry trade performance section), invested heavily in these emerging markets. The investments by hedge funds line are consistent with the high Sharpe ratio currency pairs and average returns of the carry trades in various currencies.

I also show graphs of the assets under management for fixed income and event driven hedge funds. The asset under management for these funds have increased tremendously. When I form G10 portfolios, I find that the TED spread is the most important variable in explaining the carry returns ; in fact neither VIX first differences nor repo growth rates are statistically significant in the horse race. However, when I run the same regression on an EM portfolio consisting of BRL, TRY,HUF and MXN or on an equally weighted EM portfolio, I find that VIX is more important than the TED spread in the regression from 1998 to 2009 as well as in the data from 2007 to 2009 covering the financial crisis. I also find that the repo growth rate plays a more important role for EM than for G10. Also, EM carry is just easier to explain (40% Rsq vs. G10 Rsq 20%).

These observations are in line with our previous empirical facts; EM carry is easier to explain using systematic risk factors and it lines up well with the stock market.

Central Bank Story

If we assume as mentioned above that central banks have some power over the front end of the curve and in keeping the currency in a band or making it appreciate or depreciate, their policies may have had an effect on the carry trade phenomenon. I use the Taylor rule proposed by John Taylor (1993) as an instrument to resolve the nominal short rate endogeneity. The Taylor rule has been well described in the article mentioned above and has subsequently proved to be quite popular among academics and practioners. It postulates that the monetary policy rule followed by central banks is given by the following relation:

i*(Nominal Interest Rate) = r*(equilibrium of real rate) + pi(inflation rate)+ A(1)*y(output gap) + A2*(pi(t)-pi*(target inflation))

Taylor describes the central bank policy of trading off the output gap that can be either the GDP growth or unemployment according to Blinder and Reis(2005), with the inflation in the economy. If the central bank feels that the inflation is above acceptable or target levels then it undertakes open market operation with its instrument of choice, say the overnight lending rate and decreases the amount of liquidity in the economy. Naturally, it can do the reverse open market operation should it feel that inflation is lower than target and the GDP growth is below trend. Notice the asymmetry suggested by Taylor in terms of the response to inflation, his fitted coefficient sum up to of 1.5 for inflation gap and to 0.5 for GDP gap.

I fit the Taylor rule using both GDP growth and Unemployment rate for G10 countries and for some EM countries. As in Adrian and Shin (2008) I use the Rsq to check if the Taylor rule is a "reasonable" fit for the G10 countries. The Rsq with the simplest Taylor rule ranges from around 38% to 77% for the G10 countries from 1989 to 1998 with an overall average of 52% but in the years 1999 to 2009 the fit is much worse and the Rsq drops to an average of 20%. This result hold whether I use GDP or unemployment. Taylor himself remarks on excess liquidity i.e. a high Taylor residual in his 2008 article which is an empirical anlaysis of the financial crisis. He shows that the Fed had an exceptionally loose monetary policy from 2001 to 2005 and also finds a cross sectional pattern using Taylor rule residuals and the housing market. My results for the Federal Reserve and the European Central Bank agree with Taylor(2008).

. Naturally, I could improve the Rsq by using a more sophisticated model but for the purposes of this paper, I wanted to go with the simplest Taylor rule described in the original Taylor paper. Adrian and Shin(2008) use a different specification of a coefficient of 0.8 on the output gap and 1.3 on the inflation rate, in addition to Then, similar to their article, I interpret the Taylor residual to be the Central Bank's "discretion" and check if I can find any patterns in the data with respect to the carry trade.

Carry return, Taylor residual and Central Bank Heterogeneity

Australia, New Zealand, UK, Canada, Norway and Sweden all have a positive Taylor residual in both sample periods. Japan and Switzerland, which were known to be carry funding currencies have a negative Taylor residual in 1989 to 1998 of -300 bps(CHF) and -72 bps (JPY). In this period, the US dollar has a residual of -

83 bps. From 1999 to 2009, we find the USD has a residual of -117 bps on average and -237 bps from 2001 to 2005. The three main carry funding currencies in the second period are CHF, JPY and USD.

Before, we analyze the results from the Taylor rule, we have to consider results of possible misspecifications in the real interest rate levels. It is possible that the Taylor rule creates a country fixed effects that sorts on the interest rates. I sort on Taylor residuals vs. the conditional interest rate difference and fail to find any significant relationship in the cross section in both time periods.

For both 1989 to 1998 and 1999 to 2009 time periods, I construct each country's Taylor residual beta with respect to the US Central Bank (The Federal Reserve) residual. I use the entire samples to compute the beta and then compare the average carry return for those currency pairs to the Taylor rule betas. I find that the more negative the loading on the US Taylor rule beta for a country, the higher the carry return. This relationship is quite strong in the cross section and provides a clue to the dynamics of the currency pair central bank relationships. An intuition for this may be that in G10 countries with open trade and easy capital flow, the real interest rates may not be too far from each other but in Wall street jargon, a "Hawkish" (inflation targeting with a higher Taylor coefficient) central bank may posit the nominal interest rates to be higher and result in a carry trade. Similarly a "Dovish" (easier on inflation) central bank may set the nominal interest rate in the front end to be lower and result in a carry trade with the "Hawkish" central bank currency. The more heterogeneity we have in the sample, the easier it will be to make carry returns.

Central Banks and Endogenous Hedge Funds

Taylor residuals are usually highly autocorrelated. We can interpret that to mean that banks usually follow a "regime" or tight or loose monetary policy. In addition, we observe that some countries may persistently stay as "funding currencies" and some as "asset currencies."

If we extend the idea of heterogeneity further, the central bank with looser monetary policy will deliver a country full of investors that fund the country with tighter monetary policies. This also provides a model of cross sectional fund flows that is generally not seen in the literature. Japan's investors and the US investors have been investing in foreign assets. These investors need not only engage in the classic carry trade via foreign exchange, they could easily obtain exposure to carry trade by buying currency unhedged foreign stocks, bonds and commodities. Thus this setup may help deliver endogenous cross country hedge funds without much difference in real rates.

Bad News about Inflation: Good news for Carry Cross Section?

I study the cross sectional characteristics of inflation and GDP growth, the two main components of the Taylor rule for both G10 and EM in this section. I find that from 1999 to 2009, the inflation growth in a country, especially in EM is very strongly cross sectionally linked with carry returns. In the recent years, especially since 1999 quite a few EM central banks have become explicitly inflation targeting. As Clarida and Waldman (2008) find "bad news for inflation is good news for the exchange rate", I find that bad news for inflation is not only good news for the specific currency carry return but it also helps sort carry returns in

the cross section. This can be interpreted to mean there is a linear inflation risk premium for carry returns- something that is postulated in the macroeconomics literature. However, the dynamics we find – no sorting in the first period and a sorting in the second period is interesting. This provides further circumstantial evidence that central bank policies may matter. Again, the results are not free of endogeneity bias since central bank deciding to change its policy cannot be identified separately from an economic shock.

The sorting of CPI growth and carry returns is strong for both G10 and EM and pooled (OLS cross section Rsq of 54% for pooled, 70% for EM and 31% for G10) in the 1999 to 2009 period. In the 1989 to 1998 period, I find that inflation growth does not help sort the cross section of carry returns for G10. A suggestive fact is that as central banks become inflation targeting the carry returns start lining up cross sectionally.

Fund Flow Stories and Relation to Carry Returns

I use data from the Bank of International Settlements to examine the currency flow. I identify various hedge fund indices that covary with currency carry returns and find that hedge fund indices load positively on currency carry returns that are high. However, in contrast to Suominen et all (2008) I find that carry trade returns are not declining. In fact, it is possible to achieve a Sharpe ratio of 1.0 in the period of 1999 to 2009. Additionally, for effective Sharpe ratios- I notice that the spreads decline dramatically, volatility was low and tremendous leverage was available. Practically, it was easy for a speculator to obtain funding, execute the trades with lower tracking error, and trade more frequently and automatically in more instruments with lower bid-ask spread.

I notice that the currency flow to EM countries which have yielded a high Sharpe ratio of around 1.0 in the years 1999 to 2009 in the currency carry goes from 3% of total currency flows to around 20% in 2007. The currency flow itself has grown tremendously from 1.4 Trillion a day in 1998 to 3 Trillion a day in 2007. Thus in terms of actual volume, EM countries has increased 1400% from 1998 to 2007.

The Other financial institutions which are mostly hedge funds, pension funds and speculative investors in general, have grown from 0.28 Trillion a day to 1.24 Trillion. Thus the speculative fund flow to EM countries has increased about 6400%!This increase can also be observed in assets under management for hedge funds. It is possible that an increased capital flow of this magnitude may have an effect on assets. Foreign exchange is not traded for carry returns, it is also traded when funds buy stocks and bonds in these countries. Thus we should see an increase in correlations with US market risk for these asset classes. I do find an increased correlation among the EM market stocks with the carry trade returns as well as within themselves and with the US stock market. It would be interesting to check the correlations of the bond indices or ETFs that load on various EM risks.

Possible Theoretical Models

Any theoretical model that ignores the dynamics of the cross section and the time series may miss important facts in the data. Model with declining Sharpe ratios or ones that doesn't address central bank behavior such as increased inflation targeting may also have serious empirical disconnects. I think models with endogenous credit constrained hedge funds that engender increases in systematic risk in addition to differentially inflation targeting central banks will be more successful.

Conclusion

This paper documents several empirical facts about the cross section of currency carry returns. I show that carry trade risks carry trade risks are dynamic and have become more systematic in recent years. From 1999 onwards, the high carry return currencies have significant coefficients in a time series regression of returns on the US stock market returns, implied volatility innovations of the US stock market options (VIX), TED spreads. In addition to the time series factor loadings, I find that the cross section of carry trade returns can be sorted by betas on the any of these variables- US stock market, VIX innovations and TED spreads. I also document the increasing role of inflation growth in the cross section of currency returns and the increase in carry returns due to the presence of differentially inflation targeting central banks. I find that in both periods, the more negatively a central banks Taylor rule beta with respect to the US central bank is, the higher the return that currency pair achieves. I analyze how this observation may help make hedge funds and investors investing in other countries endogenous in theoretical models.

I also document the cross sectional sensitivities of various currency pairs to hedge fund indices and find that they line up with the popular carry trades. Currency pairs that do not have a positive carry return are still not sensitive to the macro variables mentioned above. The increase in assets under management is also differential in the cross section of the currency pairs; emerging market currencies with higher carry were invested in more.

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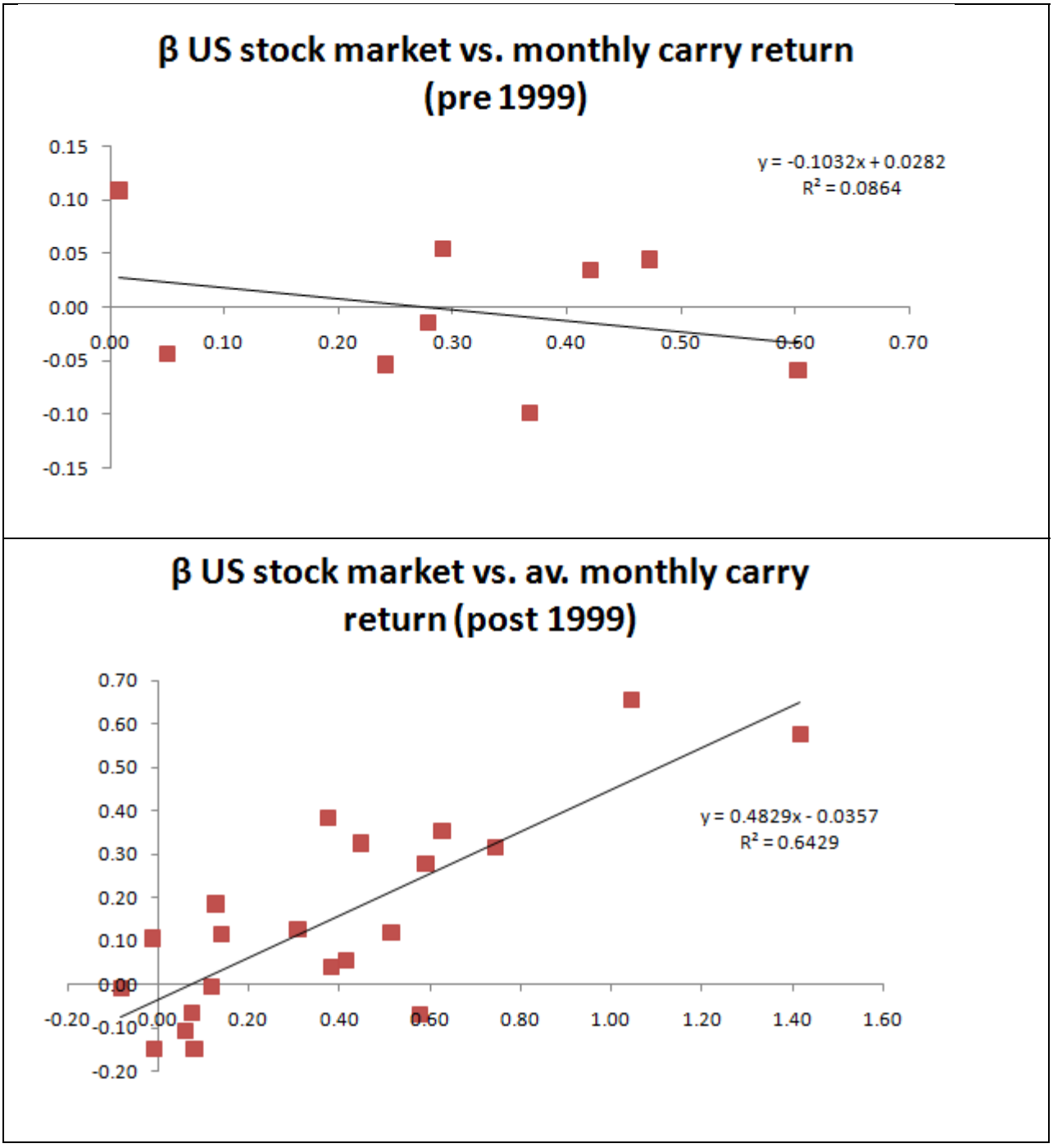
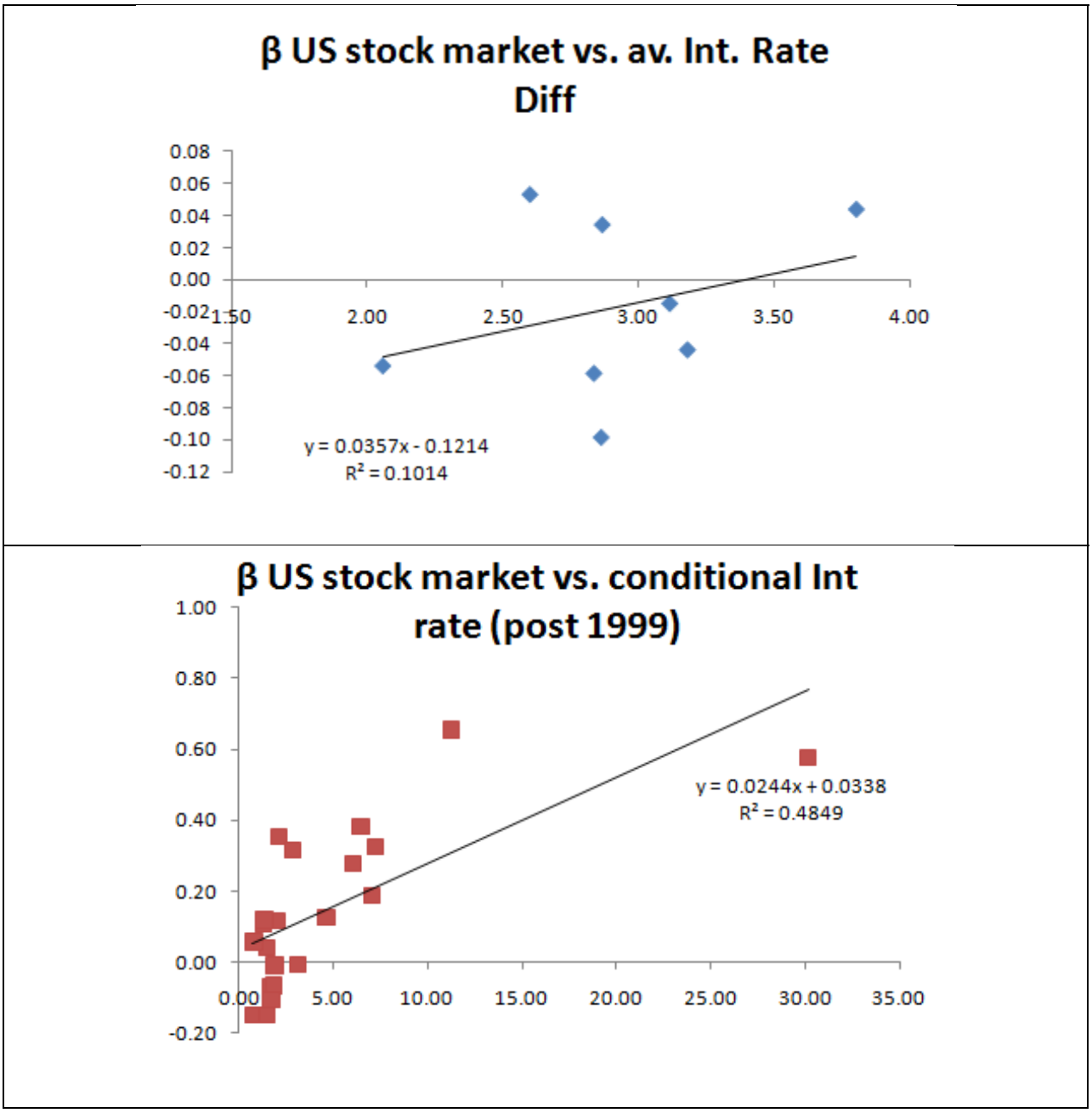
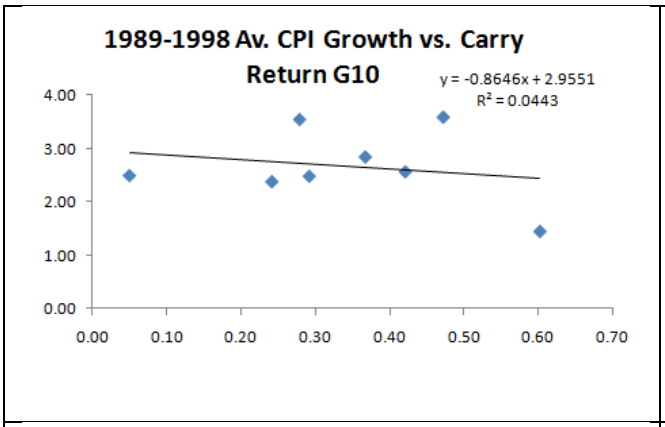
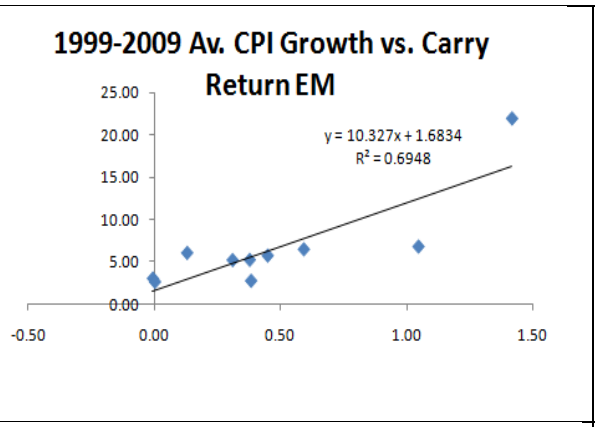
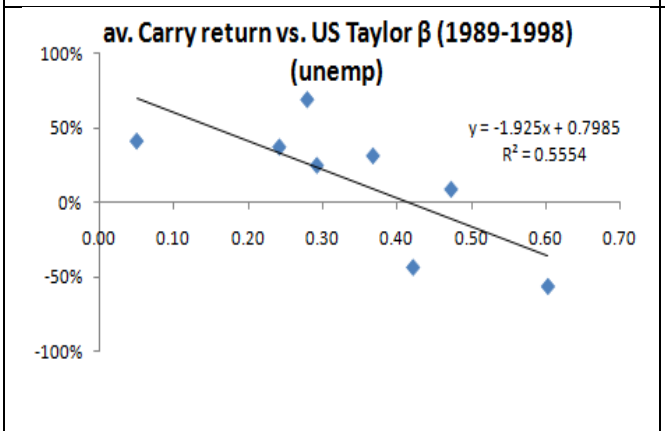
Figures

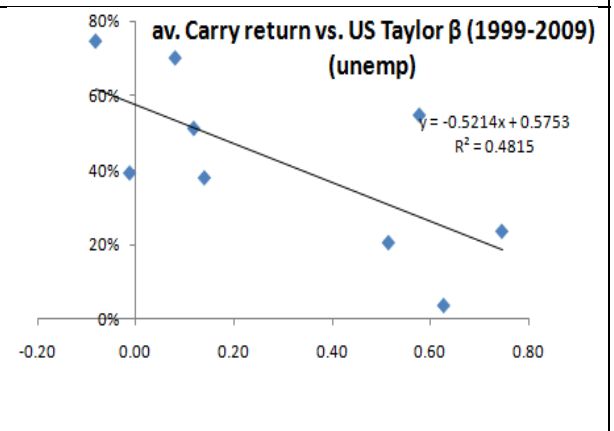

β US stock market vs. monthly carry return (pre 1999)
y = -0.1032x + 0.0282
R² = 0.0864
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
β US stock market vs. av. monthly carry return (post 1999)
y = 0.4829x - 0.0357
R² = 0.6429
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60

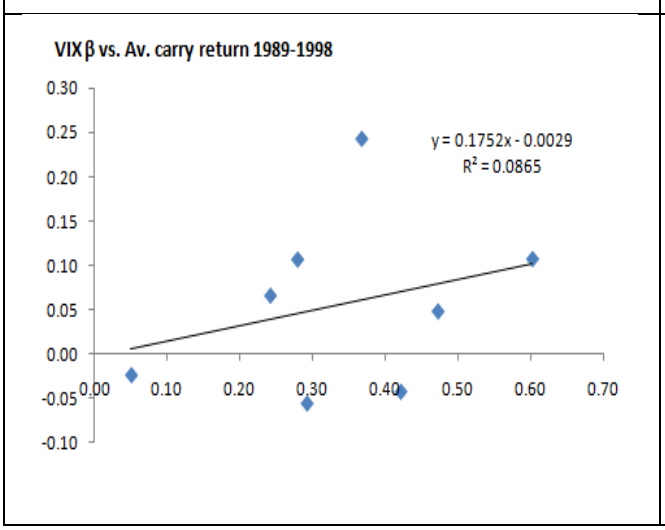

β US stock market vs. av. Int. Rate Diff
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
1.50
2.00
2.50
3.00
3.50
4.00
y = 0.0357x - 0.1214
R² = 0.1014
β US stock market vs. conditional Int rate (post 1999)
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
y = 0.0244x + 0.0338
R² = 0.4849

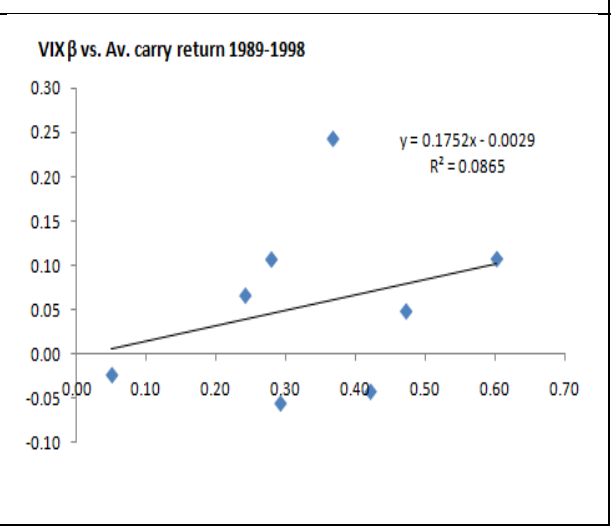

1989-1998 Av. CPI Growth vs. Carry Return G10
y = -0.8646x + 2.9551
R² = 0.0443
4.00
3.00
2.00
1.00
0.00
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70

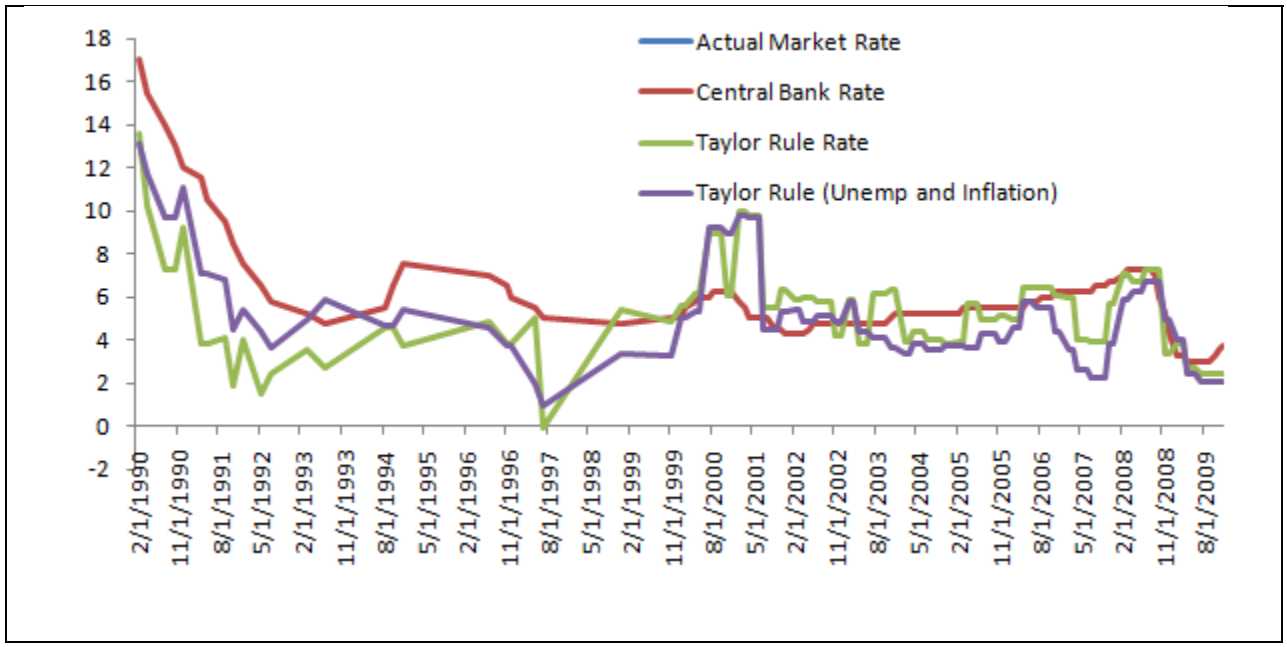

1999-2009 Av. CPI Growth vs. Carry Return EM
y = 10.327x + 1.6834
R² = 0.6948
25.00
20.00
15.00
10.00
5.00
0.00
-0.50 0.00 0.50 1.00 1.50


av. Carry return vs. US Taylor β (1989-1998) (unemp)
y = -1.925x + 0.7985
R² = 0.5554
100%
50%
0%
-50%
-100%
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70

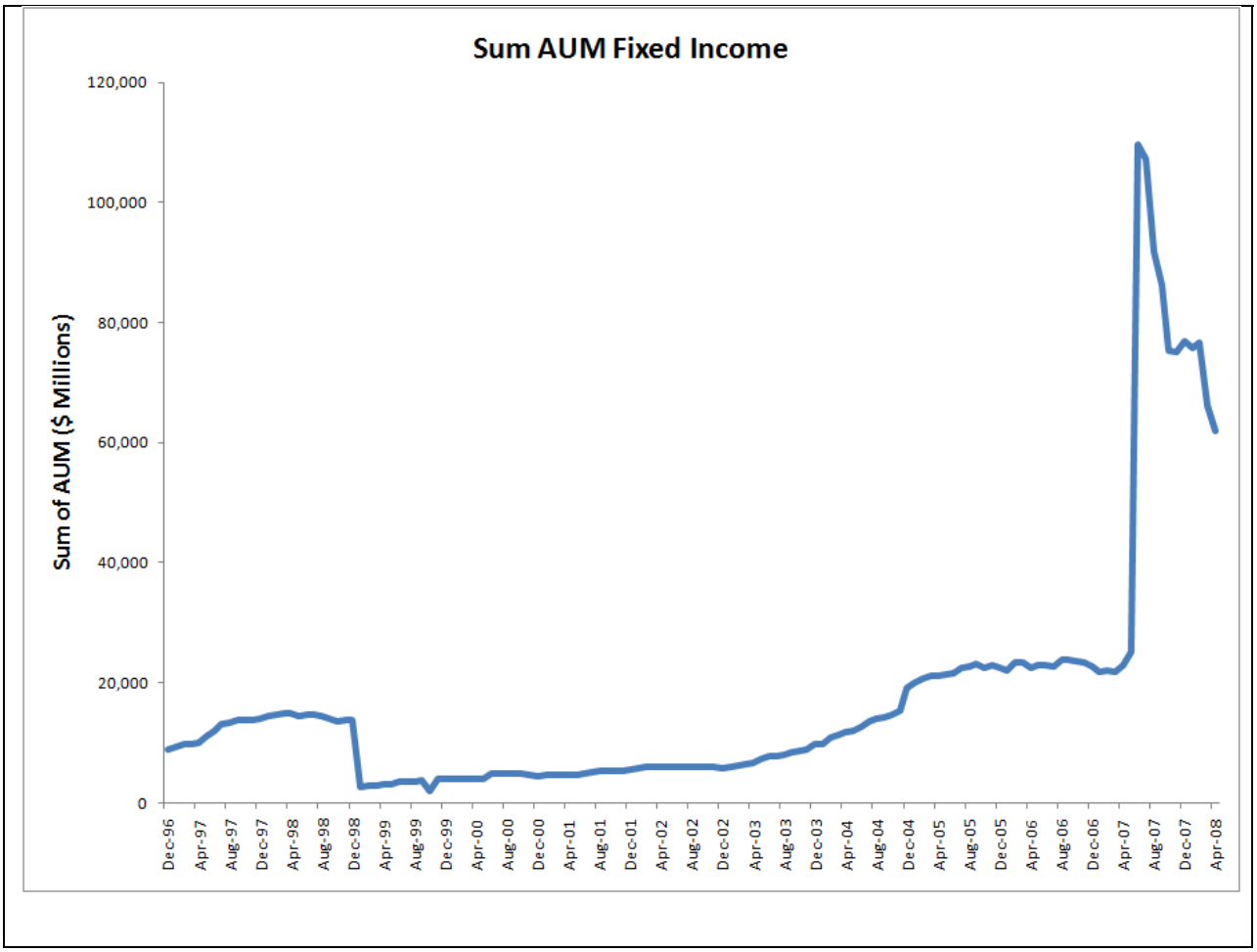

av. Carry return vs. US Taylor β (1999-2009) (unemp)
y = -0.5214x + 0.5753
R² = 0.4815
80%
60%
40%
20%
0%
-0.20 0.00 0.20 0.40 0.60 0.80


VIX β vs. Av. carry return 1989-1998
y = 0.1752x - 0.0029
R² = 0.0865
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70


VIX β vs. Av. carry return 1989-1998
y = 0.1752x - 0.0029
R² = 0.0865
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70



AUD Taylor Rule



Assets Under Management for Fixed Income Hedge Funds (USD Based)

1 Tables

Bloomberg Symbols Table.

Name	Symbol	Fields chosen
AUDUSD spot	AUD curncy	Px_Last, Px_Bid, Px_Ask
AUDUSD 1m Forward	AUD1m cmpn curncy	Px_Last, Px_Bid, Px_Ask
VIX	VIX Index	Px_Last
CVIX	CVIX Index	Px_Last
Fed Funds Rate	FEDL01 INDEX	Px_Last

Rest of the symbols can be made by replacing AUD with other currencies.
The Bloomberg function used was BDH.

Example of Bid-Ask spreads after 2001 in basis points (bps)

Name	AUD	NZD	GBP	CAD	NOK	SEK	CHF	JPY
Spot	1.9	2	2	2.1	3	3.4	2.3	1.5
1m FWD	1.9	3.1	2.1	1.9	3.2	4.1	2.5	2
3m FWD	2	4	3.2	3.6	5.7	6.1	3.3	2
6m FWD	2.9	5.1	1.4	4.8	7.1	7.5	3.2	2.7

Uncovered Interest Rate Parity Regression 1m example

	1m							
	AUD	NZD	GBP	CAD	NOK	SEK	CHF	JPY
α	-0.0009	0.0016	0.0006	0.0005	0.0031	0.0013	0.0052	0.0039
S.E.	(0.0018)	(0.0022)	(0.0019)	(0.0012)	(0.0021)	(0.0021)	(0.0025)	(0.0029)
β	-0.5718	0.3668	-0.4605	-0.457	1.2603	0.97	-2.4214	-1.3059
S.E.	(0.4315)	(0.5927)	(0.8016)	(0.6668)	(0.6688)	(0.8201)	(0.9302)	(0.8831)
R Sq	0.0061	0.0017	0.0018	0.002	0.0298	0.0169	0.0285	0.009

Note: More UIP regressions are available in an earlier version of the paper.
Standard errors are NW corrected.

Summary Statistics for period 1989 to 1998 (AUD through ZAR)

	AUD Carry	NZD Carry	GBP Carry	CAD Carry	NOK Carry	SEK carry	CHF Carry	JPY Carry	EUR Carry	BRL Carry	ZAR Carry
Interest rate - USD interst rate	2.69	3.15	3.12	1.35	2.03	3.26	-0.75	-2.37			9.03
Conditional Interest Rate Differential	2.87	3.18	3.12	2.06	2.87	3.80	2.60	2.84			
Monthly Mean Return (%)	0.37	0.05	0.28	0.24	0.42	0.47	0.29	0.60			0.01
Monthly Std. Dev (%)	2.30	1.90	3.05	1.30	2.91	3.39	3.37	3.61			2.61
Annualized Sharpe Ratio	0.55	0.09	0.32	0.64	0.50	0.48	0.30	0.58			0.01
% times Short USD	83%	97%	100%	70%	64%	75%	43%	29%			100%
Skew	-0.20	-0.87	-1.16	-0.38	-0.49	-1.35	-0.54	-1.19			-1.03
Kurtosis	-0.14	1.17	3.76	1.08	1.05	5.02	0.32	4.14			8.29
Correlation with US stock market	-15%	-9%	-2%	-16%	5%	5%	6%	-6%			16%
Correlation with Δ VIX	27%	-3%	9%	14%	-4%	4%	-4%	8%			-24%
Correlation with TED	-10%	-10%	-8%	13%	0%	-4%	-11%	-7%			2%
Correlation with Repo Growth	NA	NA	NA	NA	NA	NA	NA	NA			NA
Correlation with Credit Return	-8%	13%	-8%	-7%	-18%	-8%	-15%	-16%			-1%
Correlation with GSCI	8%	21%	7%	5%	5%	-2%	-5%	-7%			8%
Correlation with Own Stock Market	6%	15%	-29%	-22%	-27%	-20%	-2%	7%			1%

*Data for rest of the currency pairs is not available in this period

Conditional interest rate differential takes the direction of carry into account and thus will never be negative. Unconditional interest rate differential simply averages the short end of the yield curve for the country in question and subtracts the USD front end interest rate

Summary Statistics for period 1999 to 2009 (AUD through ZAR)

	AUD Carry	NZD Carry	GBP Carry	CAD Carry	NOK Carry	SEK carry	CHF Carry	JPY Carry	EUR Carry	BRL Carry	ZAR Carry
Interest rate - USD interst rate	1.99	2.74	1.18	0.01	1.24	-0.31	-1.91	-3.11	-0.31	11.18	6.48
Conditional Interest Rate Differential	2.14	2.88	1.34	0.76	2.03	1.67	1.91	3.15	1.35	11.27	6.48
Monthly Mean Return(%)	0.63	0.75	-0.01	0.08	0.14	0.58	-0.08	0.12	0.51	1.05	0.38
Monthly Std. Dev (%)	3.78	3.87	2.53	2.73	3.15	3.34	3.06	2.89	2.98	5.43	5.07
Annualized Sharpe Ratio	0.57	0.67	-0.02	0.10	0.15	0.60	-0.09	0.14	0.60	0.67	0.26
% times Short USD	82%	83%	78%	48%	67%	43%	2%	0%	51%	98%	100%
Skew	-1.02	-0.60	-0.42	0.28	-0.72	-0.21	-0.60	0.19	-0.36	-0.77	-0.47
Kurtosis	3.18	2.23	2.66	4.01	2.07	0.71	1.31	0.24	1.61	3.98	0.58
Correlation with US stock market	44%	38%	20%	-25%	17%	-10%	-1%	-1%	19%	56%	35%
Correlation with Δ VIX	-44.1%	-37.1%	-8.8%	16.0%	-22.9%	4.7%	9.3%	-11.2%	-25.2%	-50.1%	-38.8%
Correlation with TED	-30.8%	-29.3%	-31.3%	9.6%	-36.3%	-16.0%	5.8%	-16.7%	-25.5%	-22.9%	-21.4%
Correlation with Repo Growth	13%	6%	18%	-18%	20%	0%	-13%	0%	18%	14%	-2%
Correlation with Credit Return	10%	1%	12%	-22%	5%	0%	11%	15%	-13%	39%	11%
Correlation with GSCI	41%	36%	36%	-32%	24%	-17%	-21%	4%	18%	20%	23%
Correlation with Own Stock Market	36%	13%	15%	-32%	11%	-13%	12%	14%	6%	62%	18%

Summary Statistics for period 1989 to 1998 (CZK through SGD)

	CZK Carry	TRY Carry	HUF Carry	MXN Carry	THB Carry	KRW Carry	ISK Carry	INR Carry	TWD Carry	SGD Carry
Interest rate - USD interst rate	0.02	30.15	6.06	7.21	0.56	0.74	7.04	4.62	-0.85	-1.71
Conditional Interest Rate Differential	1.51	30.15	6.07	7.22	0.82	1.50	7.04	4.66	1.88	1.72
Monthly Mean Return(%)	0.38	1.42	0.59	0.45	0.41	-0.01	0.13	0.31	0.07	0.06
Monthly Std. Dev (%)	3.60	5.48	4.05	2.76	1.86	3.50	4.57	1.60	1.36	1.52
Annualized Sharpe Ratio	0.37	0.90	0.51	0.56	*0.77*	-0.01	0.10	0.67	0.19	0.14
% times Short USD	59%	100%	100%	100%	73%	64%	100%	97%	24%	3%
Skew	-0.33	-2.14	-1.42	-1.53	0.06	-0.28	-1.19	-0.27	-0.31	0.15
Kurtosis	0.51	12.18	5.77	9.54	1.66	4.77	6.38	4.43	0.47	1.44
Correlation with US stock market	5%	49%	32%	55%	14%	-20%	19%	37%	-22%	-32%
Correlation with Δ VIX	-4.4%	-41.8%	-35.2%	-44.0%	-9.7%	18.1%	-30.0%	-41.8%	18.7%	28.7%
Correlation with TED	-13.8%	-21.5%	-24.7%	-28.3%	-8.5%	-3.4%	-46.2%	-28.4%	11.8%	13.5%
Correlation with Repo Growth	4%	9%	12%	11%	20%	-14%	24%	24%	-8%	-21%
Correlation with Credit Return	-13%	19%	-5%	13%	-7%	8%	24%	28%	0%	0%
Correlation with GSCI	2%	24%	33%	33%	8%	-17%	24%	20%	-17%	-29%
Correlation with Own Stock Market	5%	37%	32%	38%	NA	-19%	23%	14%	-18%	-37%

Time Series regression of macro factors on carry trade returns

1989-1999	AUD Carry	NZD Carry	GBP Carry	CAD Carry	NOK Carry	SEK carry	CHF Carry	JPY Carry
Av. Conditional Int. Rate Diff	2.87	3.18	3.12	2.06	2.87	3.80	2.60	2.84
Av. Carry Return (monthly in %)	0.37	0.05	0.28	0.24	0.42	0.47	0.29	0.60
β US stock market	-0.10	-0.04	-0.01	-0.05	0.03	0.04	0.05	-0.06
t stat	-1.17	-0.85	-0.23	-1.54	0.55	0.75	0.75	-0.78
β carry market	0.52	0.30	1.46	0.23	1.50	1.69	1.48	0.97
t stat	3.56	2.41	7.65	3.60	13.56	9.27	8.82	3.10
β Δ VIX	**0.17**	-0.02	**0.08**	0.05	-0.03	0.03	-0.04	0.08
t stat	2.32	-0.30	2.05	1.23	-0.70	0.82	-0.71	0.66
β TED	-0.86	-0.69	-0.88	0.58	0.04	-0.53	-1.34	-0.92
t stat	-0.79	-1.03	-1.37	1.34	0.05	-0.68	-1.28	-0.78
β Repo Growth	NA	NA	NA	NA	NA	NA	NA	NA
t stat								
β Credit Return	-0.13	0.16	-0.15	-0.06	-0.33	-0.17	-0.32	-0.37
t stat	-0.87	1.49	-0.72	-0.74	-1.72	-0.76	-1.43	-2.77
β GSCI	0.04	0.09	0.05	0.01	0.03	-0.01	-0.04	-0.06
t stat	0.76	2.87	0.98	0.76	0.58	-0.23	-0.58	-1.24

All t stats are computed using NW corrections.

These are regressions of individual carry trade returns against the USD for each currency against the macroeconomic varible noted. Note how the carry market beta is quite significant but stock market betas are generally not significant. Credit beta is significant for JPY carry trades and even TED spread isn't significantly relatd in the time series. The next table simply sorts by the average carry return

Sorting based on realized averge carry return G10 from 1989-1999

Carry Return	Av. Carry Return (monthly in %)	Av. Conditional Int. Rate Diff	β US stock market	β carry market	β Δ VIX	β TED
NZD Carry	0.05	3.18	-0.04	0.30	-0.02	-0.69
CAD Carry	0.24	2.06	-0.05	0.23	0.05	0.58
GBP Carry	0.28	3.12	-0.01	1.46	0.08	-0.88
CHF Carry	0.29	2.60	0.05	1.48	-0.04	-1.34
AUD Carry	0.37	2.87	-0.10	0.52	0.17	-0.86
NOK Carry	0.42	2.87	0.03	1.50	-0.03	0.04
SEK carry	0.47	3.80	0.04	1.69	0.03	-0.53
JPY Carry	0.60	2.84	-0.06	0.97	0.08	-0.92

Time Series regression of macro factors from 1999-2009 time period G10

1999-2009	AUD Carry	NZD Carry	GBP Carry	CAD Carry	NOK Carry	SEK carry	CHF Carry	JPY Carry	EUR Carry
Av. Conditional Int. Rate Diff	2.14	2.88	1.34	0.76	2.03	1.67	1.91	3.15	1.35
Av. Carry Return (monthly in %)	0.63	0.75	-0.01	0.08	0.14	0.58	-0.08	0.12	0.51
β US stock market	**0.35**	**0.32**	0.11	-0.15	0.12	-0.07	-0.01	-0.01	0.12
t stat	3.22	2.79	1.36	-1.71	1.03	-1.24	-0.11	-0.07	1.27
β carry market	**2.15**	**2.01**	**1.02**	-0.01	**1.33**	**0.70**	**-0.63**	**0.13**	**1.38**
t stat	10.29	7.13	6.34	-0.03	6.34	2.21	-2.53	0.48	8.58
β Δ VIX	**-0.35**	**-0.30**	-0.05	0.09	-0.15	0.03	0.06	-0.07	-0.16
t stat	-4.01	-4.47	-0.79	1.51	-1.72	0.61	0.57	-1.26	-1.56
β TED	**-2.35**	**-2.29**	**-1.60**	0.53	**-2.31**	-1.08	0.36	-0.97	**-1.53**
t stat	-2.31	-2.78	-2.72	0.69	-2.82	-1.86	0.57	-1.80	-2.91
β Repo Growth	0.07	0.03	0.06	-0.07	0.09	0.00	-0.06	0.00	0.08
t stat	1.21	0.49	1.46	-1.39	1.73	-0.02	-1.75	-0.01	1.89
β Credit Return	0.16	0.02	0.13	-0.25	0.07	0.01	0.15	0.18	-0.16
t stat	0.72	0.09	1.08	-1.85	0.48	0.04	1.12	1.43	-1.06
β GSCI	**0.22**	**0.20**	**0.12**	**-0.12**	0.11	**-0.08**	**-0.09**	0.02	0.07
t stat	3.00	2.98	2.43	-2.48	1.47	-2.00	-2.77	0.28	1.39

These are regressions of individual carry trade returns against the USD for each currency against the macroeconomic varible noted. Note how the carry market beta is quite significant but in this period stock market betas have become quite significant but only for currencies that have positive carry. We see the same pattern in VIX loadings.

Time series regression of macro factors on individual currency returns EM

1999-2009	BRL Carry	ZAR Carry	CZK Carry	TRY Carry	HUF Carry	MXN Carry	THB Carry	KRW Carry	ISK Carry	INR Carry	TWD Carry	SGD Carry
Av. Conditional Int. Rate Diff	11.27	6.48	1.51	30.15	6.07	7.22	0.82	1.50	7.04	4.66	1.88	1.72
Av. Carry Return (monthly in %)	1.05	0.38	0.38	1.42	0.59	0.45	0.41	-0.01	0.13	0.31	0.07	0.06
β US stock market	**0.65**	**0.38**	0.04	**0.58**	**0.28**	**0.33**	0.06	-0.15	0.19	**0.13**	-0.07	**-0.10**
t stat	5.41	3.62	0.45	4.75	2.17	3.37	1.22	-1.04	1.07	2.89	-1.63	-2.61
β carry market	**2.36**	**2.02**	**1.28**	**2.37**	**1.69**	**1.12**	**0.30**	**0.02**	**1.91**	**0.55**	**-0.24**	**-0.47**
t stat	8.92	7.96	3.09	6.98	4.72	3.75	2.57	0.04	4.48	3.37	-1.86	-3.74
β Δ VIX	**-0.58**	**-0.42**	-0.03	**-0.49**	**-0.30**	**-0.26**	-0.04	0.13	-0.29	**-0.14**	0.05	**0.09**
t stat	-4.98	-4.72	-0.48	-4.94	-2.80	-4.26	-1.22	0.97	-1.40	-3.22	1.79	2.03
β TED	-2.51	**-2.19**	-1.00	**-2.38**	**-2.02**	-1.57	-0.32	-0.24	**-4.26**	-0.92	0.32	0.40
t stat	-1.67	-2.27	-1.86	-2.13	-2.13	-1.45	-1.23	-0.30	-3.05	-1.81	0.98	1.15
β Repo Growth	0.10	-0.02	0.02	0.07	0.07	0.04	**0.05**	-0.07	0.15	0.05	-0.01	**-0.05**
t stat	1.24	-0.23	0.51	1.09	1.47	0.65	2.98	-1.30	2.07	2.58	-1.11	-3.39
β Credit Return	**0.89**	0.23	-0.19	**0.45**	-0.08	0.16	-0.06	0.11	0.46	0.19	0.00	0.01
t stat	3.20	0.96	-1.01	2.12	-0.28	1.41	-1.32	0.72	1.36	2.61	0.03	0.11
β GSCI	0.15	**0.16**	0.01	**0.18**	**0.19**	0.13	0.02	-0.08	0.15	0.05	-0.03	**-0.06**
t stat	1.49	2.20	0.18	2.53	3.07	1.56	0.82	-1.87	1.85	1.42	-1.61	-3.59

Same results in emerging markets. US stock market becomes quite important as do changes in VIX and the TED spread. Repo growth is slightly more significant here. Commodity exporting currencies do well when GSCI (Goldman Sachs Commodity Index) increases.

Sorting carry returns based on av. carry return from 1999 to 2009

Carry Return	Av. Carry Return (monthly in %)	Av. Conditional Int. Rate Diff	β US stock market	β carry market	β Δ VIX	β TED
CHF Carry	-0.08	1.91	-0.01	-0.63	0.06	0.36
GBP Carry	-0.01	1.34	0.11	1.02	-0.05	-1.60
KRW Carry	-0.01	1.50	-0.15	0.02	0.13	-0.24
SGD Carry	0.06	1.72	-0.10	-0.47	0.09	0.40
TWD Carry	0.07	1.88	-0.07	-0.24	0.05	0.32
CAD Carry	0.08	0.76	-0.15	-0.01	0.09	0.53
JPY Carry	0.12	3.15	-0.01	0.13	-0.07	-0.97
ISK Carry	0.13	7.04	0.19	1.91	-0.29	-4.26
NOK Carry	0.14	2.03	0.12	1.33	-0.15	-2.31
INR Carry	0.31	4.66	0.13	0.55	-0.14	-0.92
ZAR Carry	0.38	6.48	0.38	2.02	-0.42	-2.19
CZK Carry	0.38	1.51	0.04	1.28	-0.03	-1.00
THB Carry	0.41	0.82	0.06	0.30	-0.04	-0.32
MXN Carry	0.45	7.22	0.33	1.12	-0.26	-1.57
EUR Carry	0.51	1.35	0.12	1.38	-0.16	-1.53
SEK carry	0.58	1.67	-0.07	0.70	0.03	-1.08
HUF Carry	0.59	6.07	0.28	1.69	-0.30	-2.02
AUD Carry	0.63	2.14	0.35	2.15	-0.35	-2.35
NZD Carry	0.75	2.88	0.32	2.01	-0.30	-2.29
BRL Carry	1.05	11.27	0.65	2.36	-0.58	-2.51
TRY Carry	1.42	30.15	0.58	2.37	-0.49	-2.38

Sorting by average carry return has power to sort interest rate, the betas on the US stock market, VIX, TED etc. The same results hold if we only look at the G10 currencies.

Average Returns of LRV(2009) Portfolios in two time periods

All Currencies	**Portfolio1**	**Portfolio2**	**Portfolio3**	**Portfolio4**	**Portfolio5**	**Portfolio6**
1983 to 1998	-0.06%	-0.02%	-0.13%	0.18%	0.16%	0.20%
1999 to 2009	-0.13%	-0.16%	0.27%	0.24%	0.19%	0.48%
Developed Countries						
1983 to 1998						
0.06%	0.05%	0.23%	0.11%	0.23%		
1999 to 2009						
0.09%	0.03%	0.21%	0.28%	0.42%		

LRV(2009) sort their portfolios on the slope factor. This table computes the average returns of these portfolios that should be monotically increasing in the "risk factor". We notice how from 1983 to 1998 the risk factor does much worse than 1999 to 2009

Variation of Central Bank rates explained by Taylor rules forG10

	USD	AUD	NZD	GBP	CAD	NOK	SEK	CHF	JPY	EUR
1989-1998 GDP	38%	77%	67%	58%	52%	54%	49%	72%	49%	NA
1999-2009 GDP	29%	9%	25%	9%	19%	13%	29%	14%	21%	35%
1989-1998 Unemp	20%	67%	23%	66%	40%	4%	37%	76%	45%	2%
1999-2009 Unemp	9%	20%	14%	28%	41%	9%	25%	25%	3%	20%

This table shows the R sq of the regression of actual central bank instrument rate (dependent variable) on the taylor rule predicted rate (independent variable). I report the fit results for both the GDP and unemployment. Note that Europe data wasn't available until 1999

Taylor rule residuals and betas on US Taylor rule

1989-1998									
	AUD Resid	NZD Resid	GBP Resid	CAD Resid	NOK Resid	SEK Resid	CHF Resid	JPY Resid	EUR Resid
Av. Taylor Resid	1.46	2.64	1.94	0.95	1.46	0.57	-0.61	-0.67	
abs(av Taylor - USD av. Taylor)	2.36	3.54	2.83	1.84	2.36	1.47	0.29	0.23	
av. Carry return	0.37	0.05	0.28	0.24	0.42	0.47	0.29	0.60	
US Taylor Beta	31%	41%	69%	37%	-43%	9%	25%	-56%	
1999-2009									
Av. Taylor Resid	0.77	2.27	1.94	0.09	0.66	-0.50	-1.23	-0.89	-0.12
av Taylor - USD av. Taylor	1.92	3.42	3.09	1.24	1.81	0.65	-0.08	0.26	1.03
av. Carry return	0.63	0.75	-0.01	0.08	0.14	0.58	-0.08	0.12	0.51
US Taylor Beta	4%	24%	39%	70%	38%	55%	75%	51%	21%

The Taylor rule betas are computed over the entire sample periods they represent

Taylor rule beta of G10 countries on US vs. av. carry

	1989-98	1999-2009
α	0.38	0.69
US Taylor Rule β	-0.28	-0.92
T statistic for β	-2.73	-2.55
Rsq.	55%	48%

This table shows the results of the cross sectional regression of av. carry return on the Taylor rule betas of the various G10 countries

Av.carry ceturns against USD vs. av. CPI (1999-2009)

Country	Av. Yearly Carry Return(%)	Av. Yearly CPI
Japan	1.42	-0.32
Switzerland	-0.98	0.96
Sweden	6.93	1.43
United Kingdom	-0.15	1.81
Norway	1.68	2.09
Canada	0.96	2.12
New Zealand	8.94	2.56
United States	0.00	2.57
Czech Republic	4.58	2.69
Korea	-0.09	2.95
Australia	7.52	3.04
European Union	6.17	3.46
India	3.70	5.13
South Africa	4.51	5.17
Mexico	5.37	5.67
Iceland	1.53	5.99
Hungary	7.09	6.42
Brazil	12.54	6.74
Turkey	17.00	21.89

Time period is 1999-2009. Notice the pattern with low CPI leading to low carry returns in the cross section. The result is robust to various compositions of the country list.

G10 carry returns vs. CPI growth (1989-1998)

Country	Av. Carry Return	Av. CPI Growth
Japan	7.23	1.45
Canada	2.90	2.37
Switzerland	3.50	2.48
New Zealand	0.60	2.49
Norway	5.05	2.56
Australia	4.41	2.83
United Kingdom	3.35	3.53
Sweden	5.67	3.58

Time period is 1989-1998. Not much pattern here.

The percentage share of various counterparties in FX transactions

	1992		1995		1998		2001		2004		2007	
	Amount	% share	Amount	% share	Amount	% share	Amount	% share	Amount	% share	Amount	% share
Total	776	100	1,137	100	1,430	100	1,173	100	1,794	100	3,081	100
reporting dealers	540	70	729	64	908	64	688	59	956	53	1,319	43
other financial institutions	**97**	**13%**	**230**	**20%**	**279**	**20%**	**329**	**28%**	**585**	**33**	**1,235**	**40%**
non-financial customers	137	18	178	16	242	17	156	13	252	14	527	17
Local	317	41	526	46	657	46	499	43	695	39	1,185	38
Cross-border	392	51	611	54	772	54	674	57	1,099	61	1,896	62

Data collected from BIS reports

BIS report on currency pair volume (1992-2001)

Currency distribution of reported foreign exchange market turnover[1]

Percentage shares of average daily turnover in April

	1989	1992	1995	1998[2]	2001
US dollar	90.0	82.0	83.3	87.3	90.4
Euro	...	...	...	...	37.6
Deutsche mark[3]	27.0	39.6	36.1	30.1	...
French franc	2.0	3.8	7.9	5.1	...
ECU and other EMS currencies	4.0	11.8	15.7	17.3	...
Japanese yen	27.0	23.4	24.1	20.2	22.7
Pound sterling	15.0	13.6	9.4	11.0	13.2
Swiss franc	10.0	8.4	7.3	7.1	6.1
Canadian dollar	1.0	3.3	3.4	3.6	4.5
Australian dollar	2.0	2.5	2.7	3.1	4.2
Swedish krona[4]	...	1.3	0.6	0.4	2.6
Hong Kong dollar[4]	...	1.1	0.9	1.3	2.3
Singapore dollar[4]	...	0.3	0.3	1.2	1.1
Emerging market currencies[4, 5]	...	0.5	0.4	3.0	5.2
Other	22.0	8.5	7.9	9.3	10.1
All currencies	200.0	200.0	200.0	200.0	200.0

[1] Because two currencies are involved in each transaction, the sum of the percentage shares of individual currencies totals 200% instead of 100%. The figures relate to reported "net-net" turnover, ie they are adjusted for both local and cross-border double-counting, except for 1989 data, which are available only on a "gross-gross" basis. More details about emerging market and other currencies are provided in Annex Tables E.1.1 and E.1.2. [2] Revised since the previous survey. [3] Data for April 1989 exclude domestic trading involving the Deutsche mark in Germany. [4] For 1992–98, the data cover home currency trading only. [5] For 1992 and 1995, South African rand; for 1998 and 2001, Brazilian real, Chilean peso, Czech koruna, Indian rupee, Korean won, Malaysian ringgit, Mexican peso, Polish zloty, Russian rouble, Saudi riyal, South African rand, Taiwan dollar and Thai baht.

Table B.4

BIS report on currency pair volume (2001-2007)

Currency distribution of reported foreign exchange market turnover[1]

Percentage shares of average daily turnover in April 2007

	2001	2004[2]	2007
US dollar	90.3	88.7	86.3
Euro	37.6	36.9	37.0
Yen	22.7	20.2	16.5
Pound sterling	13.2	16.9	15.0
Swiss franc	6.1	6.0	6.8
Australian dollar	4.2	5.9	6.7
Canadian dollar	4.5	4.2	4.2
Swedish krona	2.6	2.3	2.8
Hong Kong dollar	2.3	1.9	2.8
Norwegian krone	1.5	1.4	2.2
New Zealand dollar	0.6	1.0	1.9
Mexican peso	0.9	1.1	1.3
Singapore dollar	1.1	1.0	1.2
Won	0.7	1.2	1.1
Rand	1.0	0.8	0.9
Danish krone	1.2	0.9	0.9
Rouble	0.4	0.7	0.8
Zloty	0.5	0.4	0.8
Indian rupee	0.2	0.3	0.7
Renminbi	0.0	0.1	0.5
New Taiwan dollar	0.3	0.4	0.4
Brazilian real	0.4	0.2	0.4
All currencies	200.0	200.0	200.0
Emerging market currencies[3]	16.9	15.4	19.8

[1] Because two currencies are involved in each transaction, the sum of the percentage shares of individual currencies totals 200% instead of 100%. Adjusted for local and cross-border double-counting. [2] Data for 2004 have been revised. [3] Defined as the residual after accounting for the top eight currencies, the Norwegian krone, the New Zealand dollar and the Danish krone. Table B.6

T statistics for regression of Hedge Fund Indices

t stats	α	Market t stat	Momentum t stat	Dow Credit Spread t stat	Dow Treasury Credit t stat	GSCI t stat	R sq.
Convert Arb	**2.77**	1.80	0.45	**4.63**	**3.84**	1.84	41%
Short Bias	1.24	0.41	-1.25	-0.14	0.47	**-8.88**	55%
Emerging Mkts	0.91	**2.06**	**2.10**	**2.55**	0.80	**7.04**	33%
Eq. Mkt Neutral	1.47	1.63	-0.69	-0.32	-0.97	**2.11**	16%
Event Driven	**4.64**	**3.30**	**3.31**	**4.98**	1.43	**5.82**	48%
Fixed Income	1.73	**2.10**	0.20	**3.17**	**2.65**	1.68	30%
Global Macro	**3.87**	1.33	**3.12**	**2.25**	**3.91**	**2.54**	17%
Long Short Equity	**3.16**	**4.50**	**3.77**	**4.91**	**3.86**	**10.90**	63%
Managed Futures	**2.48**	**2.45**	1.72	0.07	1.62	-1.19	10%
Hedge Fund Index	**3.89**	**3.92**	**4.16**	**4.38**	**3.63**	**8.23**	48%

The sample covers the entire time period of 1994 to 2009. The return attribution factors used are Market, Momentum, Credit Spread, Treasury return, and GSCI return

T statistics for Hedge Fund Indices after including carry trade returns

t stats	α	Market t stat	Momentum t stat	Dow Credit Spread t stat	Dow Treasury Credit t stat	GSCI t stat	All Carry t stat	R sq.
Credit Suisse/Tremont Hedg	**2.12**	1.75	0.68	**5.10**	**3.84**	1.30	**2.56**	44%
Credit Suisse/Tremont Hedg	0.72	-0.03	-1.19	-0.60	-0.04	**-9.97**	1.58	57%
Credit Suisse/Tremont Hedg	0.29	1.34	**2.20**	1.37	0.03	**5.18**	**2.62**	36%
Credit Suisse/Tremont Hedg	1.01	1.86	-0.63	-0.48	-0.96	**2.37**	0.81	17%
Credit Suisse/Tremont Hedg	**4.56**	**3.08**	**3.53**	**4.50**	0.98	**4.98**	**2.17**	49%
Credit Suisse/Tremont Hedg	0.73	**2.08**	0.56	**3.46**	1.88	1.15	**3.24**	39%
Credit Suisse/Tremont Hedg	**2.71**	0.61	**3.22**	1.58	**2.94**	**2.06**	**1.88**	19%
Credit Suisse/Tremont Hedg	**3.07**	**4.40**	**3.75**	**4.76**	**3.74**	**10.78**	-0.27	63%
Credit Suisse/Tremont Hedg	**2.33**	**2.42**	1.73	0.02	1.47	-1.24	0.15	10%
Credit Suisse/Tremont Hedg	**2.80**	**3.35**	**4.15**	**3.24**	**2.38**	**7.22**	**2.95**	50%

The sample covers the entire time period of 1994 to 2009

T stats for Individual G10 carry after controlling for all previous factors

Hedge Fund Type	AUD Carry t stat	NZD Carry t stat	GBP Carry t stat	CAD Carry t stat	NOK Carry t stat	SEK carry t stat	CHF Carry t stat	JPY Carry t stat
Convert Arb	**2.64**	**2.29**	1.38	-1.40	1.07	-1.10	**2.40**	**3.23**
Short Bias	0.92	0.24	1.91	-0.27	**2.20**	**2.43**	-0.50	1.43
Emerging Mkts	0.68	1.01	-0.92	-1.58	-0.15	-0.59	**2.51**	1.57
Eq. Mkt Neutral	-0.08	1.13	1.88	-0.66	1.45	1.18	-1.12	-0.64
Event Driven	0.36	1.55	-0.46	-0.72	-0.74	0.37	**2.61**	**2.99**
Fixed Income	**2.89**	**2.67**	1.63	-1.17	0.90	-1.06	0.85	**3.04**
Global Macro	1.24	-0.73	-0.80	-1.39	-0.03	-0.77	**2.37**	**3.91**
Long Short Equity	0.03	-0.28	-0.87	-0.86	-1.03	**-2.70**	0.15	0.90
Managed Futures	-0.24	-0.35	0.52	0.09	0.43	0.95	-1.36	-1.14
Hedge Fund Index	1.68	0.25	-0.88	-1.20	0.12	-1.24	**2.13**	**4.20**

The sample covers the entire time period of 1994 to 2009

Hedge fund indices regressed on individual G10 carry trade*

Hedge Fund Type	AUD Carry t stat	NZD Carry t stat	GBP Carry t stat	CAD Carry t stat	NOK Carry t stat	SEK carry t stat	CHF Carry t stat	JPY Carry t stat	EUR Carry t stat
Convert Arb	**3.19**	**3.05**	**2.46**	-0.88	**2.01**	-1.08	1.36	**2.42**	1.74
Short Bias	0.34	0.98	1.17	-0.38	**2.29**	**2.60**	-0.53	0.42	1.84
Emerging Mkts	0.51	-0.35	1.15	-1.28	-0.88	-0.89	1.10	0.65	-0.32
Eq. Mkt Neutral	0.74	1.32	**2.41**	-0.66	1.57	1.32	-1.28	-1.02	1.22
Event Driven	**2.02**	**2.39**	0.73	0.31	0.56	0.55	0.98	**2.25**	0.86
Fixed Income	**3.39**	**3.14**	**2.08**	-1.07	1.34	-1.66	-0.55	**2.04**	1.34
Global Macro	0.65	-0.30	1.48	-1.56	-0.42	-0.64	-0.71	1.05	-1.18
Long Short Equity	0.58	0.46	0.23	-0.55	0.27	-1.64	-0.47	0.68	0.14
Managed Futures	-0.35	-0.11	0.32	0.18	-0.24	1.65	**-2.09**	0.14	-0.19
Hedge Fund Index	1.73	1.46	1.45	-1.08	0.72	-0.81	-1.01	1.60	0.11

* The usual controls are in place. Sample period 1999-2009.

Hedge fund indices regressed on individual EM carry trade*

Hedge Fund Type	BRL Carry t stat	ZAR Carry t stat	CZK Carry t stat	TRY Carry t stat	HUF Carry t stat	MXN Carry t stat	THB Carry t stat	KRW Carry t stat	ISK Carry t stat	INR Carry t stat	TWD Carry t stat	SGD Carry t stat
Convert Arb	-0.26	0.60	-0.75	-0.31	-0.23	1.89	0.95	0.57	**2.55**	1.24	-0.17	1.69
Short Bias	0.67	-1.21	0.08	-1.57	0.84	**2.01**	1.42	0.02	1.22	1.71	-0.22	-1.82
Emerging Mkts	**2.67**	1.38	-1.30	**2.94**	0.74	**3.04**	1.26	1.08	1.64	**2.03**	-0.99	-0.92
Eq. Mkt Neutral	0.36	0.22	1.27	-1.45	1.20	**2.18**	1.48	-1.46	1.45	1.38	-1.59	-1.28
Event Driven	**2.48**	1.48	0.82	0.42	0.16	1.75	0.91	1.58	**2.96**	**2.19**	-0.60	0.84
Fixed Income	0.87	1.73	-1.07	0.42	1.45	**2.03**	0.99	-0.50	**3.63**	1.91	-0.69	0.14
Global Macro	0.43	0.19	-1.08	1.81	1.21	0.57	**2.19**	0.89	**2.13**	1.77	-1.59	-0.94
Long Short Equity	1.43	1.19	0.54	1.52	1.11	0.21	1.02	0.20	1.92	**2.00**	-0.97	-0.48
Managed Futures	-0.96	0.38	1.39	1.19	1.73	-1.03	-0.67	0.75	1.47	1.55	**-2.00**	-1.51
Hedge Fund Index	1.27	1.43	0.47	1.85	1.64	0.93	**1.95**	0.43	**4.41**	**2.90**	-0.97	-0.83

* The usual controls are in place. Sample period 1999-2009.Notice how important ISK (Iceland Krona) carry trade is. This carry trade is poster child for the esoteric investments made in EM due to attractive returns. Also notice how Mexico, Brazil and India are quite popular. T stats for individual currencies really line up with their carry performance.