Yen Carry Trade and Interest Rate Parity

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Abstract

The "yen carry trade," borrowing in yen and investing in high yield currency prompted by the low Japanese interest rate, has been prevalent for the last ten years or so. We find that the outcome of the 3-month uncovered "yen carry trade", beginning March 1st of each year, tends to be positive for the last ten years. However, the results show that the source of returns on the "yen carry trade" in recent years is not interest rate differentials, but rather, the depreciation in the value of the yen. Interestingly, we find that the Korean won is the most attractive investing currency because returns are consistently positive except for one year, and large enough to exceed typical transaction cost.

I. Introduction

It has been known that the recent global economic crisis was triggered by the burst in the housing price bubble. The burst caused a liquidity crunch by (i) a sudden loss in property value and mortgage backed securities and (ii) increased counterparty risk suspecting integrity of any transaction resulting from failures of Bear Sterns and Lehman Brothers. Interestingly, we found that the first casualty country in liquidity crunch was Iceland during the worldwide financial crisis. The International Monetary Fund provided a $10 billion financial aid package in 2008.

The root of the economic catastrophe experienced by Iceland is 'carry trade' or 'currency carry trade,' a popular tool for investment professionals such as hedge funds or private equities. The idea of carry trade is simple: borrow money in a country at a lower interest rate and invest the money in another country generating higher yields. As long as the exchange rate between the two currencies is stable or the value of the borrowing currency is depreciating, carry traders are able to make profits.

Historically, the interest rates in Iceland tended to be much higher than those in European countries. Also, the exchange rate of the Icelandic krona against the euro, especially against the British pound, has been stable until the global financial crisis started in the second half of 2008. Many European depositors, especially British, deposited their money in Iceland's commercial banks to earn higher yields than their home countries. As a result, Iceland experienced a surge in capital inflows and foreign currency reserves and thus, a stable value of the Icelandic krona.

As the global financial crisis progressed, all depositors from European countries wanted to withdraw their deposits from Icelandic banks and convert to their home currencies such as the euro or the pound. Thus, Iceland caught up with the liquidity crunch and the value of Icelandic krona plunged facing a Wile E. Coyote moment: a sudden drop from a cliff in the value of a currency. Krugman (2007a, 2007b) publicized that the recent value of the U.S. dollar might experience the Wile E. Coyote moment due to huge a cumulative trade deficit of the U.S. But Iceland experienced the moment due to the liquidity crunch resulting from a huge exodus of

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capital in reserve currency such as the euro, British pound and U.S. dollars.

On the other hand, the Bank of Japan, the central bank, maintained a low interest rate policy- close to zero or zero percent in order to revive the economy during the last ten years or so. It is well known that Japan experienced a chronic recession as the bubble in its stock market and real estate market burst in the 1990's. Furthermore, the value of yen against the US dollar has been very stable, if not depreciating, for the last ten years or so as seen in Table 1. Thus, the direction of the yen carry trade by investment professionals is the opposite of carry trade in Iceland: Borrow money in Japanese yen at a very low cost or no cost at all and invest the money mostly in the U.S. markets earning higher yields. It has been known that investment professionals borrowed money heavily in Japanese yen. According to the Economist (2007), the Bank of Japan and the Japanese Treasury officials, in fact, estimated the yen borrowings by foreign banks and investment firms to be $64 billion to $160 billion, much larger than an IMF rescue package of $10 billion for Iceland.

Interestingly, before the current global financial crisis, academic research and many financial press warned about the implications of unwinding of the 'yen carry trade' in global financial markets e.g., Adrian and Shin (2007), Hattori and Shin (2007), Plantin and Shin (2008), Rosenbush (2007) Davies (2008), Dennis (2008), and Economist (2007, 2008). Specifically, Adrian and Shin (2007) and Hattori and Shin (2007) argued that huge borrowings in yen and its multiplier effects of the "yen carry trade" by financial institutions in the U.S. might cause a liquidity crisis when the traders start to unwind the carry trade. In addition to the problems embedded in mortgage backed securities and credit default swaps, it is clear that recent unwinding of the carry trade - converting US dollar to yen to repay the debt in yen as the value of yen starts to appreciate - contributed to the recent liquidity crunch as the value of US dollar faced a Wile E. Coyote moment.

In the context of an equilibrium in money and exchange markets, however, the profits (or losses) from the carry trade represent a deviation from the uncovered interest rate parity (UIRP) condition, implying that there exists an opportunity for uncovered interest arbitrage (UIA). In this paper, instead of testing whether the interest rate parity holds, covered or uncovered, we calculate the realized return of the of "yen carry trade" investing in 5 currencies: US dollar, Korean won, New Zealand dollar, Australian dollar and Icelandic krona. We also calculate standard deviations of the returns and coefficient of variation for the carry trade strategies.

Considering the significant implications of the "yen carry trade" in global financial markets, it is worthwhile to calculate the realized returns of the carry trade. Thus, the purpose of this paper is to confirm the magnitude of the realized returns on the yen carry trade for the last ten years using the Interest Rate Parity (IRP) concept. Specifically, we obtain real world data from public domain websites and the Bloomberg service. Then, we demonstrate the process of the yen carry trade by calculating realized returns for the last ten years.

II. Interest Rate Parity (IRP)

The return from the covered yen carry trade (r) can be measured as follows,

$$r = (i_{\$} - i_{¥}) - (\frac{F - S_0}{S_0} + \frac{F - S_0}{S_0} i_{¥}) \approx (i_{\$} - i_{¥}) - (\frac{F - S_0}{S_0}) \quad (1)$$

Where F is forward exchange rate and S_0 is spot exchange rate. Exchange rates are in American terms. $i_{\$}$ is US interest rate and $i_{¥}$ is Japanese interest rate. Although $\frac{F - S_0}{S_0} i_{¥}$ can be interpreted as risk premium on holding yen assets (Goyal and McKinnon 2002), it tends to be negligible. We delete the product term since we find it to be negligible with our data.

By replacing F with $\tilde{S}_1$, future spot exchange rate unknown at time 0, the expected return from the uncovered yen carry trade ($E(\tilde{r})$) can be measured as follows,

$$E(\tilde{r}) = (i_{\$} - i_{¥}) - (\frac{E(\tilde{S}_1) - S_0}{S_0} + \frac{E(\tilde{S}_1) - S_0}{S_0} i_{¥}) \approx (i_{\$} - i_{¥}) - (\frac{E(\tilde{S}_1) - S_0}{S_0}) \quad (2)$$

Furthermore, we delete the product term, $\frac{E(\tilde{S}_1) - S_0}{S_0} i_{¥}$, since it is negligible. For simplicity, we use a non-continuous compounding IRP instead of a continuous compounding.

III. Yen Carry Trade

A. Data

We collected the data from 3 sources; www.economagic.com, www.ny.frb.org and the Bloomberg service. In Table 1, we show the LIBOR data retrieved from www.economagic.com and the ¥/$ exchange rate data obtained from www.ny.frb.org. We also collected return on currency carry trade data from the Bloomberg service, which used daily compounding, to verify our results obtained in Table 2 and to calculate the performance of other investing currencies. The Bloomberg service has a section for currency carry trades (FXCT) that calculates historical returns of carry trades with a diverse combination of currencies and positions. We chose the March 1st of each year arbitrarily as the beginning date of the 3-month yen carry trade.

B. Covered Interest Arbitrage (CIA)

The process of the yen carry trade is straightforward. As shown in Table 1, a trader borrows money in the yen at lower LIBOR rate (3rd column) and the trader converts the yen to the U.S. dollar at the current spot exchange rates (5th column), then the trader invests the money in the U.S. money market yielding much higher return (the 2nd column). The trader decides to hedge in terms of the changing value of the yen against the US dollar.

In Table 2, interest rate differentials for the 3-month LIBOR are shown in the 2nd column.

In addition, consistent with the IRP condition, a low interest rate in Japan results in a forward premium on the yen in the forward exchange market as shown in the 3rd column. We calculate the returns on the covered yen carry trade using the forward market hedging by subtracting forward premium from interest rate differentials as in Equation (1).

The results are shown in the CIA column. Since the benefit of a lower interest rate in Japan tends to be less than or equal to the cost of hedging, measured by the forward premium, the returns on the 3-month covered yen carry trade are negative or zero except for one year (2003). Conversely, the size of return on reverse positions (dollar carry trade), borrowing in the US dollar and investing in Japanese yen, appears to be too small to cover the transaction cost. Thus, the result implies that covered IRP tends to hold for a 3-month period because an arbitrage profit is not possible using the forward contract. In Figure 1, we observe graphically that there exists no distinction between the interest rate differential and forward premium, implying no arbitrage opportunity with CIA. In Figure 2, we also observe that the return on a 3 month CIA with U.S. dollar (USD-F) is negligible or negative compared with the return on the UIA with other investing currencies.

In Table 2, we also provide summary statistics for the interest rates, exchange rates and returns. While the mean interest rate differential is 0.850% for a 3-month period, the mean forward premium is 0.994% on average for the same period. Although not reported here, we also calculated returns on the 3- , 6- and 9-month covered interest arbitrages. The returns are mostly negative and are very similar in magnitude, implying that there exists no covered interest arbitrage opportunity.

C. Uncovered Interest Arbitrage (UIA)

1. *Short in Yen and Long in US dollar*

Our results indicate that covered IRP tends to hold for a 3-month period because an arbitrage profit is not possible using the forward contract. Thus, the traders tend to resort to currency speculation rather than currency hedging. We calculate the returns on the 3-month uncovered yen carry trades (or uncovered interest arbitrages) in Table 2. Interestingly, the value of yen tended to depreciate for the period between March 1st and June 1st each year for eight out of the last ten years as shown in Table 2 (4th column).

As specified in Equation (2), the return on 3-month uncovered yen carry trade is calculated by subtracting the change in 3 month spot (4th column) from the interest rate differential (2nd column). If the trader speculated between March 1 and June 1 each year, the yen carry trade was mostly profitable because the trader earned a positive return in the money market and another positive return in the exchange market due to depreciation in the value of yen in the spot market. Interestingly, the outcome of the uncovered yen carry trade (6th column) shows positive returns for eight out of the last ten years. In Figure 1, we observe the depreciation in the value of yen for 8 out of 10 years in addition to the positive return (or interest rate differential) in

the money market.

The size of returns on the uncovered yen carry trade is surprisingly large considering that these are returns for a three month period. Thus, the arbitrage opportunity, triggered by low interest rate in Japan, is far too attractive to pass up for the traders even with the transaction costs represented by the typical bid-ask spread. This implies that uncovered interest rate parity (IRP) is not holding as long as a trader is able to make a profit on the yen carry trade by doing currency speculation.

We retrieved the returns of the carry trade from the Bloomberg service (7^{th} column) to compare with our results. On the FXCT page of the Bloomberg service, as we specify positions and weights of each currency and time period, we can easily obtain the returns from the cumulative indexes. Specifically, we obtain the cumulative index by specifying 100% short position for the yen and 100% long position for the U.S. dollar. As we compare the two returns, they are very close, but not exactly the same due to the difference in the method of compounding: The Bloomberg service uses daily compounding for calculation of the indexes while we use quarterly compounding.

In addition to the mean interest rate differential of 0.850%, the mean depreciation of the value of yen is 0.389% on average during the same period. This implies that the traders might have arbitrage opportunities by making profits from exchange market as well as from the money market. The coefficient of variation (2.869) is quite large, implying the high risk to obtain the returns. Although not reported here, the size of annualized returns on the 6-month UIA trade tends to be smaller than the 3-month yen carry trade. It may indicate that the time horizon of speculation in currency trading is a critical factor in determining the magnitude of returns on the yen carry trade. Generally speaking, the traders with a longer time horizon are exposed to higher currency risk than the traders with a shorter time horizon because it is more difficult to predict the change in future spot exchange rates.

2. *Short in Yen and Long in Other Currencies*

Using the Bloomberg service, we report the results of the yen carry trade taking a long position in currencies other than the US dollar in Table 3 and Figure 2. We also provide summary statistics for the returns. Although the Australian dollar has the highest mean return (2.314%) out of the five investing currencies, its coefficient of variation (2.469) is much higher than that of the Korean won (1.917). A long position in the Korean won (KRW) produced positive realized returns consistently except once in 2008. The coefficient of variation is also smallest for KRW, implying the low risk per normalized return. As seen in Figure 2, the volatility of Australian dollar is more pronounced than that of the Korean won. All in all, the results of Korean won (KRW) are far better than taking a long position in the U.S. dollar (USD), New Zealand dollar (NZD), Australian dollar (AUD) or Iceland Kroner (ISK). This is likely due to the exchange rate between the Korean won and Japanese yen is generally stable. Also, the predictability of the exchange rate is relatively higher compared to other exchange rates.

D. Interest Rate Differentials or Yen/Dollar Exchange Rate

It is obvious that although the primary trigger of the yen carry trade was the low interest rate in Japan, return on the carry trade is not dependent upon interest rate differential, but rather, it is dependent upon the value of the yen against the US dollar in the spot market. As shown in Tables 1 and 2, for 8 out of the last 10 years, the future spot exchange rates realized in 3 months show depreciation rather than appreciation in contrast to the forward premium on yen observed at the beginning of the trade on March 1st each year. Thus, our results suggest that the forward rate might not be a predictor of the future spot exchange rate for the Japanese yen. However, the results seem to be consistent with the skewness of FX returns and stochastic bifurcations suggested in Plantin and Shin (2008). Although not reported here, our results are also consistent with the intuition: the longer the time horizon for currency speculation in yen, the less for the returns on the yen carry trade since it is more difficult to predict the future spot exchange rate.

IV. Conclusion

The "yen carry trade," borrowing in yen and investing in high yield currency prompted by the low Japanese interest rate has been prevalent for the last ten years or so. Recently, as the value of yen starts to appreciate, the traders are in hurry to unwind the carry trade averting losses. Thus, it has been alleged that activities of carry traders, who repay the yen borrowings as soon as possible, contributed to the liquidity crunch during the global financial crisis in 2008 and 2009.

We show the process of the "yen carry trade" by calculating realized returns for the last ten years. We find that the outcome of the 3-month uncovered yen carry trade, beginning March 1st of each year, tends to be positive for the last ten years. However, the results show that the source of returns on the yen carry trade in recent years is not interest rate differentials, but depreciation in the value of the yen. Thus, the carry trade is an arbitrage opportunity not accompanied by currency hedging (or covered IRP), but accompanied by speculation (or uncovered IRP). Interestingly, we find that the Korean won is the most attractive investing currency in that returns are consistently positive except for a year (2008) and large enough to exceed typical transaction cost.

Table I
Interest Rates (LIBOR) and Exchange Rates (Spot and Forward)

Year	Interest Rates			Exchange Rates		
	3/1/yyyy [a]			3/1/yyyy [b]		6/1/yyyy [b]
	3 month LIBOR (annualized)[a]		Interest rate differential	¥/$ spot	¥/$ 3-month forward	¥/$ Spot
	$i_{\$}$	$i_{¥}$	$(i_{\$}-i_{¥})/4$	S_0	F	S_1
1999	5.028	0.276	1.188	119.66	120.97	118.21
2000	6.110	0.129	1.495	108.01	108.82	106.36
2001	5.089	0.270	1.205	117.14	118.97	115.72
2002	1.901	0.114	0.447	133.28	123.69	132.66
2003[a]	1.339	0.058	0.320	117.93	119.27	117.59
2004	1.120	0.051	0.267	108.93	110.45	108.64
2005	2.930	0.051	0.720	104.37	108.42	103.53
2006	4.830	0.093	1.184	116.18	112.43	114.51
2007	5.348	0.721	1.157	117.53	122.10	115.84
2008[a]	3.014	0.968	0.512	103.57	105.29	102.36

a) yyyy represents the year specified in each row. For 2003 and 2008, LIBOR rates are collected for 3/3, due to observed holidays. Data source: www.economagic.com.
b) yyyy represents the year specified in each row. For 2003 and 2008, exchange rates are collected for 3/3 and 6/3 to be consistent with the money market. Data source: www.ny.frb.org.

Table II
Return on 3-month Yen Carry Trade (%)

Date	Money market	Exchange market		Return on 3-month Yen Carry Trade		
	Interest rate differential $(i_{\$}-i_{¥})/4$	3 month forward premium[a] $(F-S_0)/S_0$	Change in 3 month spot[a] $(S_1-S_0)/S_0$	Using 3 month forward (CIA)	Using 3 month spot (UIA)	Bloomberg[b]
(1)	(2)	(3)	(4)	(5) [=(2)-(3)]	(6) [=(2)-(4)]	(7)
3/1/1999	1.188	1.227	-1.083	-0.039	2.271	1.715
3/1/2000	1.495	1.551	-0.744	-0.056	2.239	2.399
3/1/2001	1.205	1.227	-1.538	-0.022	2.743	2.302
3/1/2002	0.447	0.467	7.753	-0.020	-7.306	-6.755
3/3/2003	0.320	0.289	-1.124	0.031	1.444	1.456
3/1/2004	0.267	0.267	-1.376	0.000	1.643	1.405
3/1/2005	0.720	0.811	-3.735	-0.091	4.455	4.855
3/1/2006	1.184	1.458	3.335	-0.274	-2.151	-1.889
3/1/2007	1.157	1.459	-3.743	-0.302	4.900	4.912
3/3/2008	0.512	1.182	-1.634	-0.670	2.146	1.549
Summary Statistics						
Mean	0.850	0.994	-0.389	-0.144	1.238	1.195
Std Dev	0.444	0.497	3.458	0.216	3.553	3.385
CV [c]	0.522	0.500		n/a	2.869	2.833

a) Forward premium and changes in spot exchange rates are calculated using the exchange rate data in Table 1.
b) Return on the 3-month yen carry trade calculated from the FX Carry-Trade Index (FXCT). Data source: The Bloomberg service.
c) CV: Coefficient of Variation, n/a for zero or negative CV

Table III
Return on 3-month Yen Carry Trade Using High-Yield Currencies (%)

	Borrow in yen					Borrow in euro
	Invest in high-yield currencies					Invest in krona
Start date	USD	KRW	NZD	AUD	ISK	Euro/ISK
3/1/1999	1.715	4.934	1.835	5.558	0.163	3.053
3/1/2000	2.399	2.038	-3.929	-3.357	0.064	2.431
3/1/2001	2.302	0.509	-2.962	-1.286	-14.592	-7.500
3/1/2002	-6.755	1.580	6.779	2.654	4.056	3.008
3/3/2003	1.456	1.234	5.458	10.316	9.540	-0.330
3/1/2004	1.405	3.663	-6.200	-5.809	-0.541	-0.750
3/1/2005	4.855	4.304	1.641	0.589	-0.339	3.022
3/1/2006	-1.889	0.366	-6.573	-1.433	-9.727	-14.012
3/1/2007	4.912	5.629	13.416	11.651	16.357	9.141
3/3/2008	1.549	-6.394	0.440	4.258	-9.636	-12.776
Summary Statistics						
Mean	1.195	1.786	0.991	2.314	-0.466	-1.471
Std Dev	3.385	3.424	6.307	5.713	9.272	7.541
CV	2.833	1.917	6.368	2.469	n/a	n/a

a) For 2003 and 2008, returns are collected for 3/3, due to observed holidays.
b) Return on the 3-month yen carry trade based on the FX Carry-Trade Index (FXCT) obtained from Bloomberg.
c) USD: US dollar; KRW: Korean won; NZD: New Zealand dollar; AUD: Australian dollar ; ISK: Icelandic krona
d) CV: Coefficient of Variation, n/a for zero or negative CV

Figure 1

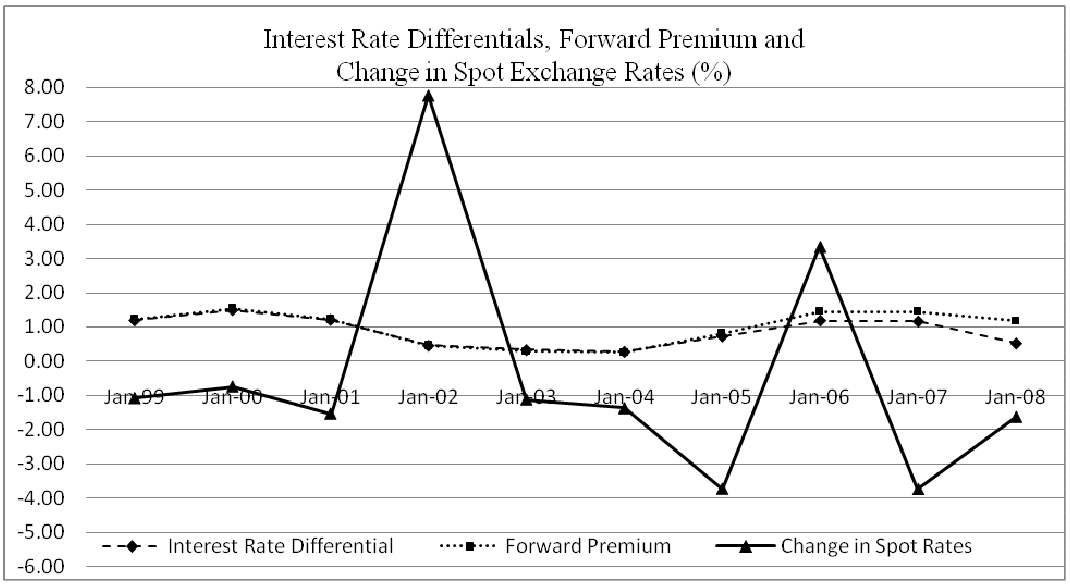
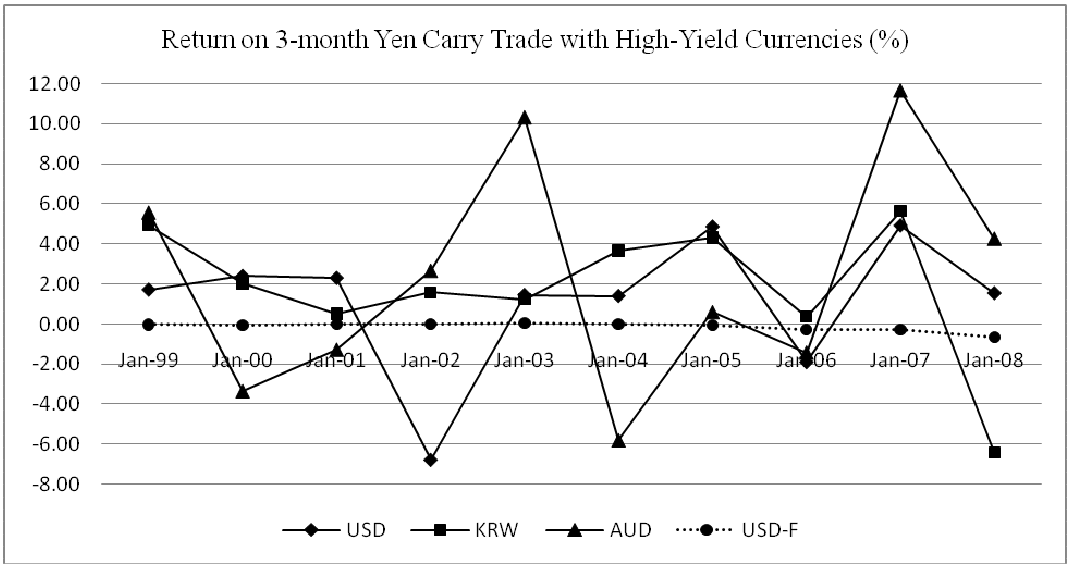


Figure 2



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