DRW New-Hire Learning Program

Module: FX, Commodities, and Equities

Session B.1: FX and Carry

Mark Hendricks

Summer 2022

Outline

Rate Parity

Carry - Currency

Notation

S_t denotes the foreign exchange rate, expressed as USD per foreign currencies.

- For notational specificity, we refer to the USD/Euro exchange rate, but the statements apply to any FX rate.
- $R^{f,\$}_{t,t+1}$ denotes the risk-free factor on US dollars (USD).
- $R^{f,€}_{t,t+1}$ denotes the risk-free factor on Euros.

THE UNIVERSITY OF CHICAGO

FX as an asset

Misconception that $\frac{S_{t+1}}{S_t}$ is the return on foreign currency.

- The price of the Euro is S_t dollars.
- In terms of USD, the payoff at time $t+1$ of the Euro riskless asset is $R^{f,€}_{t,t+1} S_{t+1}$.
- That is, we capitalize any FX gains, but we also earn the riskless return accumulated by the foreign currency.

Thus, the USD return on holding Euros is given by,

$$\frac{S_{t+1}}{S_t} R^{f,€}_{t+1}$$

Forward exchange rate

Let F_t^s denote the forward rate on the one-period FX contract, S_{t+1}.

- The forward FX rate, F_t^s, is a rate contracted at time t regarding the exchange of currency at some future time, $t+k$.
- Here, we just consider one-period forward rates. In general, we could write the k-period forward as $F_t^{s,k}$.
- The superscript s is simply to distinguish this as an FX forward versus an interest rate forward.

THE UNIVERSITY OF CHICAGO

Log notation

Denote log quantities:

- $\mathrm{s} \equiv \ln S$
- $f^s \equiv \ln F^s$

Write the log, one-period interest rate as

- $r^f_{t+1} \equiv \ln R^f_{t,t+1}$
- Then r^f_{t+1} is known at time t.

THE UNIVERSITY OF CHICAGO

Covered interest parity

Equation (1) is known as **covered interest parity (CIP)**.

$$f_t^s - \mathtt{s}_t = \mathtt{r}_{t,t+1}^{f,\$} - \mathtt{r}_{t,t+1}^{f,€} \tag{1}$$

Or in levels,

$$\frac{F_t^s}{S_t} R_{t,t+1}^{f,€} = R_{t,t+1}^{f,\$}$$

CIP and Law of One Price

Consider two ways of moving USD from t to $t+1$.

1. Invest in the USD risk-free rate.
2. Invest in the Euro risk-free rate.
   - Buy Euros, invest in the Euro risk-free rate
   - simultaneously use a forward contract to lock in the time $t+1$ price of selling the Euros back for USD.

The second strategy replicates the first, so CIP follows just from the assumption of the Law of One Price.

THE UNIVERSITY OF CHICAGO

CIP in the data

Given that CIP follows from Law of One Price, it generally holds in the data.

Most deviations from CIP...

- stem from the credit risk of the counterparty on the forward contract
- concern about whether one of the so called risk-free rates is at risk.

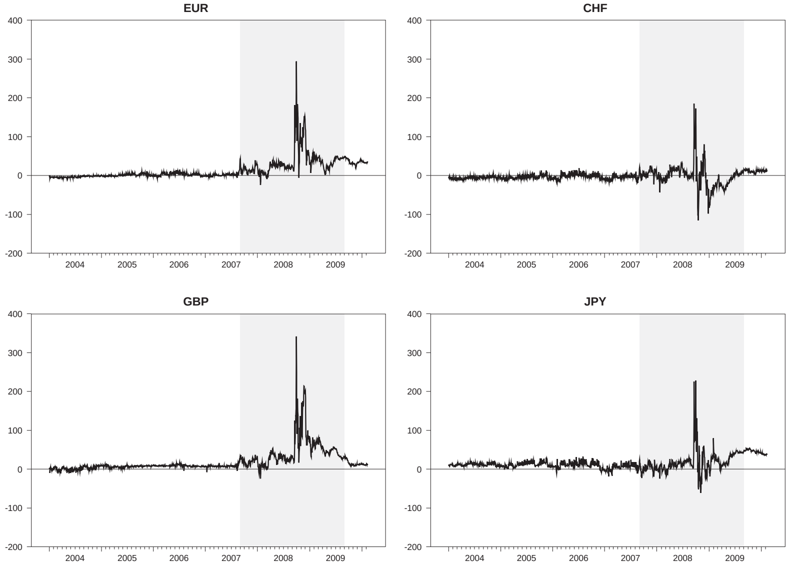

Figure: Source: Chen (2012).

Forward premium

The (log) **forward premium** on Euros refers to

$$f_t^s - \mathtt{s}_t$$

Because CIP is so accurate, the forward premium is often used to measure the difference in interest rates across countries,

$$f_t^s - \mathtt{s}_t = \mathtt{r}_{t+1}^{f,\$} - \mathtt{r}_{t+1}^{f,€}$$

Outline

Rate Parity

Carry - Currency

Uncovered interest parity

Uncovered interest parity (UIP) is a popular model for FX.

$$\mathbb{E}_t\left[\frac{S_{t+1}}{S_t}\right] = \frac{R^{f,\$}_{t+1}}{R^{f,€}_{t+1}}$$

- Similar to CIP, but replace the FX-forward rate with the time $t+1$ FX spot rate, S_{t+1}.
- CIP is a no-arbitrage condition, while UIP is a theory.
- In logs,

$$\ln \mathbb{E}_t\left[S_{t+1}\right] - \mathtt{s}_t = \mathtt{r}^{f,\$}_{t+1} - \mathtt{r}^{f,€}_{t+1} \tag{2}$$

THE UNIVERSITY OF CHICAGO

Uncovered FX trading

Consider two ways of moving USD from t to $t+1$.

1. At time t, one could simply invest in the USD risk-free rate.

2. Invest in the Euro risk-free rate:
   - At time t, one could buy Euros to invest in the Euro risk-free rate.
   - Then at time $t+1$ convert the payoff back to dollars.

- The first investment is riskless while the second involves uncertainty about the future exchange rate.

- UIP claims the expected depreciation of the USD will exactly offset any interest rate premium over the Euro.

THE UNIVERSITY OF CHICAGO

UIP and FX risk

UIP assumes that FX risk is not priced, and generates no risk premium.

- The UIP equation holds if on average, investors do not require compensation for FX volatility exposure.
- Notice the words, "on average". Even UIP is consistent with the idea that some investors dislike FX volatility and want to hedge.
- It simply states that FX hedging is idiosyncratic.
- The overall market does not demand a premium to hedge it, as most investors are not sensitive to this risk.

UIP for forward premium

UIP relates expected FX growth to interest rate differential:

$$\ln \mathbb{E}_t [S_{t+1}] - \mathtt{s}_t = \mathtt{r}^{f,\$}_{t+1} - \mathtt{r}^{f,€}_{t+1}$$

Rewrite the UIP condition, using CIP to sub out the interest rate differential for the forward premium.

$$\ln \mathbb{E}_t [S_{t+1}] - \mathtt{s}_t = f^s_t - \mathtt{s}_t$$

Conceptually, UIP says that the forward rate is the best predictor of the future spot rate.

$$\ln \mathbb{E}_t [S_{t+1}] = f^s_t$$

THE UNIVERSITY OF CHICAGO

Testing the UIP in logs

Standard to test $\mathbb{E}_t\left[\mathrm{s}_{t+1}\right]$ as an approximation of $\ln \mathbb{E}_t\left[S_{t+1}\right]$.

- Theory on previous slide is in levels, so there is a difference of a Jensen's inequality term.
- But this term tends to be very small, unimportant.

UIP regression tests

Consider the regression tests for these two UIP statements.

1. Using the interest rate differential,

$$\mathtt{s}_{t+1} - \mathtt{s}_t = \alpha + \beta \left(\mathtt{r}^{f,\$}_{t+1} - \mathtt{r}^{f,€}_{t+1} \right) + \epsilon_{t+1} \tag{3}$$

(Noting yet again that r^f_{t+1} is known at time t.)

2. Alternatively, using the forward premium,

$$\mathtt{s}_{t+1} - \mathtt{s}_t = \alpha + \beta \ (f^s_t - \mathtt{s}_t) + \epsilon_{t+1} \tag{4}$$

In either test, UIP implies that $\beta = 1$ and $\alpha = 0$.

THE UNIVERSITY OF CHICAGO

The carry trade

The **carry trade** refers to trading on uncovered foreign riskless assets.

- Go long in a currency with a high risk-free rate relative to the U.S.
- UIP says that after exchange rate transactions, there will be no excess return.
- Empirically, what happens?

THE UNIVERSITY OF CHICAGO

Evidence: Carry-trade returns

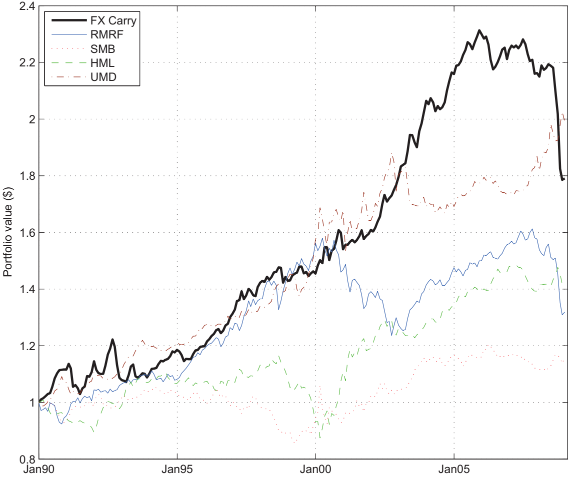

Figure: Carry-trade (black) versus excess market return (solid blue). Source: Jurek (2009).

Carry trade premium

Historically, the excess return on the carry trade has been significant.

- A widely-used trading strategy.
- At times presented like an arbitrage, it is not.
- If there is systematic risk in FX volatility, then it is a premium for this exposure.

Even so, potentially attractive in that the risk premium is not explained by obvious factors like market beta.

Peso problems

As is seen in the picture, the carry trade is subject to large crashes. Referred to as a "peso problem".

- In the 1970's, Mexico had pegged their FX rate to the USD for over a decade.
- Yet, a significant interest rate differential persisted.
- Seemingly a lucrative trade: higher interest rate, no FX volatility.
- But what about risk of infrequent, sudden, and large depreciation?

In fact, there eventually was a large depreciation of the peso.

Evidence: Carry-trade returns

Historical returns:

- Before (USD/G10; monthly, 1990:1-2007:03)

	RMRF	SMB	HML	UMD	FX Carry
Mean	0.0730	0.0227	0.0477	0.0985	0.0478
t-stat	2.13	0.75	1.72	2.51	3.91
St. dev.	0.1422	0.1261	0.1153	0.1630	0.0507
Skewness	-0.68	0.81	0.11	-0.66	-0.95
SR	0.51	0.18	0.41	0.60	0.94

- After (USD/G10; monthly, 1990:1-2008:10)

	RMRF	SMB	HML	UMD	FX Carry
Mean	0.0477	0.0191	0.0392	0.1060	0.0331
t-stat	1.39	0.68	1.50	2.83	2.55
St. dev.	0.1485	0.1223	0.1136	0.1628	0.0563
Skewness	-0.84	0.83	0.11	-0.60	-1.63
SR	0.32	0.16	0.35	0.65	0.59

Figure: Source: Jurek (2009).

THE UNIVERSITY OF CHICAGO

Currency trade and options

Given that exchange rates are subject to large sudden movements,

- Carry trade premium is similar to writing far out of the money puts.
- Make a consistent, small premium, but subject to big losses in a catastrophe.
- But some research shows that even after hedging extreme movements with options, the carry trade has excess returns.

What economic factors explain this premium?