

# Futures, forwards and carry

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- $\text{Future} > \text{spot}$  is *contango*
- $\text{Future} < \text{spot}$  is *backwardation*

# Price of futures 1

When the only cost is the cost of finance

$$F(t, T) = S(t) \times (1 + r)^{(T-t)} \quad (1)$$

or, in continuous time

$$F(t, T) = S(t)e^{r(T-t)} \quad (2)$$

Where  $t$  is today,  $T$  is the exercise date,  $r$  is the interest rate,  $F$  is the future price and  $S$  is the spot price.

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# Covered interest parity

$$\frac{F_{t,j}}{S_t} \times (1 + i_{t,j}) = (1 + i_{t,j}^*)$$

Where,  $F_{t,j}$  is the forward rate in terms of foreign currency for domestic at time  $t$  for  $j$  periods ahead,  $S_t$  is the spot rate,  $i_{t,j}$  is the nominal interest rate at time  $t$  for  $j$  periods ahead and  $i^*$  is the foreign rate.

# Forward rate 1

$$F_{t,j} = S_t \times \frac{(1 + i_{t,j}^*)}{(1 + i_{t,j})} \quad (3)$$

Calculate the 1-year forward for USD-JPY with spot at JPY 150; the US 1-year rate at 1.0% and the Japanese 1-year rate at zero.



# Forward rate 2

Action	USD	JPY
Borrow USD	1,000,000	
Owe	1,010,000	
Buy JPY		150,000,000
Receive		150,000,000
Sell	$\frac{150,000,000}{148.5149} = 1,010,000$	

Table: Covered interest parity

# Covered interest parity 3

From Equation 3

$$\frac{F_{t,j}}{S_t} = \frac{(1 + i_{t,j}^*)}{(1 + i_{t,j})}$$

Taking 1 from each side and re-arranging.

$$\frac{F_{t,j} - S_t}{S_t} = \frac{(i_{t,j}^* - i_{t,j})}{(1 + i_{t,j})} \quad (4)$$

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- *Rational expectations* assumes that economic agents form their expectations on the basis of the underlying economic model that is being used
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- If not, there is an **arbitrage opportunity**



# Expectations and forward rate 1

Action	USD	JPY
Borrow USD	1,000,000	
Owe	1,010,000	
Buy JPY		150,000,000
Receive		150,000,000
Sell	$\frac{150,000,000}{150.00} = 1,000,000$	

Table: Expected rate is above forward: Loss

# Expectations and forward rate 2

Action	USD	JPY
Borrow USD	1,000,000	
Owe	1,010,000	
Buy JPY		150,000,000
Receive		150,000,000
Sell	$\frac{150,000,000}{145.00} = 1,034,483$	

Table: Expected rate is below forward: gain

# Uncovered interest parity 2

The expected future rate is equal to the forward rate so,

$$E[s_{t+j}] - s_t = \frac{(i_{t,j}^* - i_{t,j})}{(1 + i_{t,j})} \quad (5)$$

or approximately,

$$E[\Delta s_{t+j}] = i_{t,j}^* - i_{t,j} \quad (6)$$

$$\Delta s_t = i_{t,j}^* - i_{t,j} \quad (7)$$

Where  $\Delta s_t$  is  $\log(s_t) - \log(s_{t-1})$

# Testing UIP 1

A usual test of UIP is

$$\Delta s_{t+j} = \beta_0 + \beta_1 f_{t+j} + \varepsilon \quad (8)$$

Where  $f_{t+j}$  is the *forward premium* and UIP would mean that  $\beta_0 = 0$  and  $\beta_1 = 1$

Many tests find that  $\beta_1 < 0$

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- See CHF

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- UIP failure: are there market frictions that prevent arbitrage?

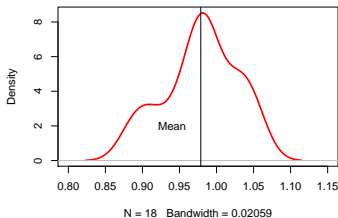
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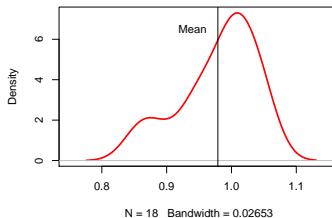
- UIP failure: are there market frictions that prevent arbitrage?
- Expectations failure: is there a risk premium that explains the divergence?

# Carry returns in calm and crisis

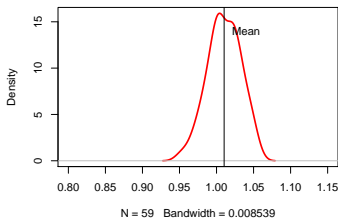
PLNCHF Carry Trade



PLNUSD carry in Crisis



PLNCHF carry in Moderation



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