Issues in International Finance

Foreign Exchange Fundamentals

UW – Madison // Fall 2018

Roadmap

- This week (*Introduction to Exchange Rates*)
  1. Foreign exchange fundamentals
     - Definitions
     - Comparing cross-country prices
     - Exchange rate regimes
     - Contracts
  2. No-arbitrage conditions
     - Triangle arbitrage, vehicle currencies
     - Covered **interest rate** parity (the forward rate)
     - Uncovered **interest rate** parity (the spot rate)
- Coming up: Price levels and exchange rates
  - **Price level** parity conditions
  - Money and the exchange rate
  - Read: *Exchange Rates I* (Chapter 14 or Chapter 3)

Do not be shy! Ask questions, make comments.

Exchange rates

- Exchange rate (E) = price of one currency in terms of another
- This is a **bilateral exchange rate**

$$E_{\frac{\$}{€}} = 1.16$$

- We need to be careful about units. Read the subscript in the above equation as "dollars per euro"
- Consider this exchange rate

$$E_{\frac{€}{\$}} =$$

- What are the units? What should the value be? Why?

Exchange rates changes

- When $E_{\frac{\$}{€}}$ decreases we say that
  - The appreciated (strengthened)
  - The depreciated (weakened)

- Exchange rate growth rate
- Example
  - $E_{\frac{\$}{€},2017} = 1.19$ and $E_{\frac{\$}{€},2018} = 1.16$

$$\frac{E_{\frac{\$}{€},2018}}{E_{\frac{\$}{€},2017}} - 1 = \frac{1.16}{1.19} - 1 = -0.025$$

Exchange rates changes

- Work with the person next to you
- $E_{\frac{\$}{€},2017} = 1.19$ and $E_{\frac{\$}{€},2018} = 1.16$
- What is $E_{\frac{€}{\$},2018}$?
- What is $E_{\frac{€}{\$},2017}$?
- How much did the dollar appreciate or depreciate against the euro?

Exchange rates changes

- The appreciation rate of the dollar is not exactly the depreciation rate
- This is a property of growth rates. For example

$$(\frac{10}{5} - 1) \times 100 \qquad \text{vs} \qquad (\frac{1/10}{1/5} - 1) \times 100$$

$$100\% \qquad \text{vs} \qquad -50\%$$

- This matters less when the growth rate is close to zero

$$(\frac{1.02}{1.01} - 1) \times 100 \qquad \text{vs} \qquad (\frac{1/1.02}{1/1.01} - 1) \times 100$$

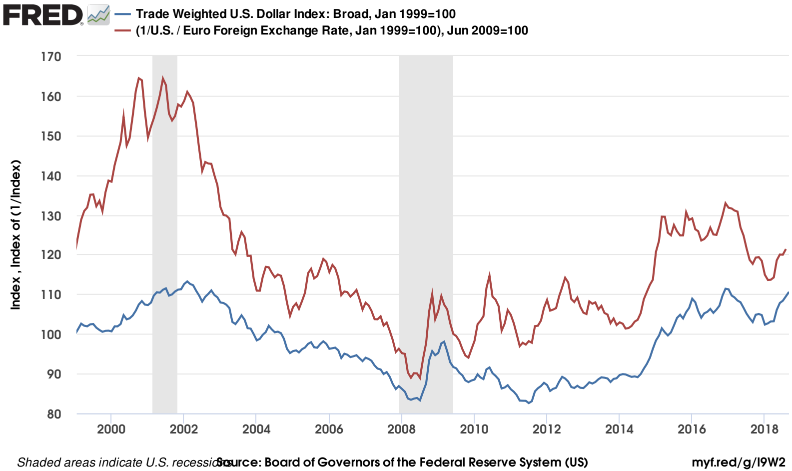
$$0.99\% \qquad \text{vs} \qquad -0.98\%$$

- Approx. growth rates with natural log fixes this (more on this later)

Multilateral exchange rates

- A country has a bilateral exchange rate with every other country in the world: US-UK, US-Canada, US-Thailand, etc.
- The dollar may appreciate against some and depreciate against others
- The effective exchange rate is a trade-weighted average of bilateral exchange rates
- Let *i* index countries. In growth rates:

$$\frac{E_{t+1}}{E_t} - 1 = \sum_i \left[\left(\frac{E_{i,t+1}}{E_{i,t}} - 1 \right) \frac{\text{trade}_i}{\text{total trade}} \right]$$


FRED
Trade Weighted U.S. Dollar Index: Broad, Jan 1999=100
(1/U.S. / Euro Foreign Exchange Rate, Jan 1999=100), Jun 2009=100
Index , Index of (1/Index)
170
160
150
140
130
120
110
100
90
80
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Shaded areas indicate U.S. recessions
Source: Board of Governors of the Federal Reserve System (US)
myf.red/g/l9W2

Exchange rates and prices

- Suppose local-currency prices are sticky in the short run
- Changes in exchange rates may change the price levels and the relative price of goods when expressed in other countries

Exchange rates and prices

- Example from table 13-2:
- Cost in local currency: £2,000 in London; HK$30,000 in Hong Kong; $4,000 in New York
- If $E_{HK\$/£} = 15$ and $E_{\$/£} = 2.0$

$$p_{hk} = 30,000/15 = £2,000$$
$$p_{ny} = 4,000/2 = £2,000$$

- If $E_{HK\$/£} = 16$ and $E_{\$/£} = 1.9$ (what's happened?)

$$p_{hk} = 30,000/16 = £1,875$$
$$p_{ny} = 4,000/1.9 = £2,105$$

- Where do you source?

Exchange rates and prices

- When the home country's currency depreciates:
- What happens to the price of home's exports in foreign currency?
- What happens to the price of foreign imports in the home currency?
- How does this depend on price stickiness?

Exchange rate regimes

- Fixed versus floating exchange rates
- Fixed: government sets the price of the currency
  - Pegs, currency boards, no domestic currency
  - Often lead to problems
- Floating: the market sets the price for the currency
  - Bands, managed floats, free floats
  - Often volatile
- We see both fixed and floating regimes in the world, so we will study both
- Why choose one over the other?
  - Why might China want a fixed exchange rate?
  - More on this later.

Currency markets

- How are currencies traded?
  - Over the counter market (dealers vs. central exchange)
  - Mostly banks
  - Mostly in the US, UK, Japan
- What gets traded?
  - Spot contracts: exchange instantly
  - Derivative contracts: **forwards**, swaps, futures, and options
- Forward: two parties agree on the price and quantity to exchange in the future. Settlement (exchange of currencies) happens in the future.
  Example: agree to exchange \$1,100 for €1,000 in one year from today.
  The forward rate is $F_{\frac{\$}{€}} = 1.1$.
  https://www.hsbcnet.com/gbm/fwcalc-disp

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Arbitrage

- Arbitrage: Exploit price differences to profit
- In our context, prices = exchange rates
- Simple example: Suppose $E_{\frac{£}{\$}} = 0.55$ in London and $E_{\frac{£}{\$}} = 0.50$ in NY
- What trades allow you to profit?
- Why would markets respond to these prices? What do you expect to happen?
- What might keep you from profiting?

Arbitrage with three currencies

- $E_{\frac{€}{\$}} = 0.8$, $E_{\frac{£}{€}} = 0.7$, $E_{\frac{£}{\$}} = 0.50$
- Assume no transaction costs. Is there an arbitrage? (Yes)
- Start with $1. What are the three trades?
  1.

  2.

  3.

Arbitrage with three currencies

- To eliminate arbitrage, we need

$$E_{\frac{£}{\$}} = E_{\frac{£}{€}} \times E_{\frac{€}{\$}}$$

- Given $E_{\frac{€}{\$}} = 0.8$, $E_{\frac{£}{€}} = 0.7$, $E_{\frac{£}{\$}} = 0.50$ the no-arbitrage pound-dollar rate should be

$$E_{\frac{£}{\$}} = 0.7 \times 0.8 = 0.56$$

- Notice that if I know two of the exchange rates, I can always calculate the third. This is how it is typically done in practice. http://www.wsj.com/mdc/public/page/2_3021-forex.html

Arbitrage and interest rates: CIP

- Covered interest parity
- Start with \$1. Would like earn interest and have dollars one year from now. Two possibilities

1. Buy a U.S. t-bill with interest rate $i_{\$}$
2. Buy a Euro bond with interest rate $i_{€}$

- Option 2. requires foreign exchange risk. We **cover** the transaction by using a forward contract to eliminate the risk.

Covered interest parity

- Return on buying in the U.S. is simply $\$1 \times (1 + i_{\$})$
- Return on buying in Europe with a forward is

$$\$1 \times \frac{1}{E_{\$/€}} \times (1 + i_{€}) \times F_{\$/€}$$

- Both of these strategies are riskless, so we need **covered interest parity**:

$$\frac{1}{E_{\$/€}} \times (1 + i_{€}) \times F_{\$/€} = (1 + i_{\$})$$

- Rearranging this expression gives us the forward rate equation

$$F_{\$/€} = \frac{1 + i_{\$}}{1 + i_{€}} E_{\$/€}$$

Covered interest parity

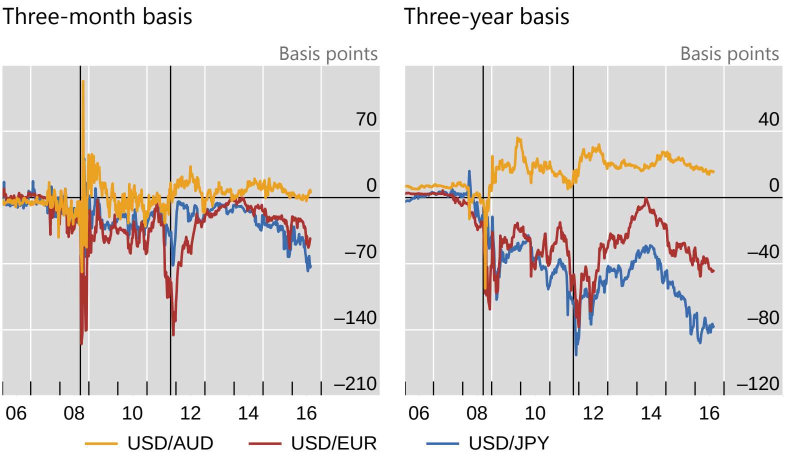
- CIP generally holds in the data, but…
- There have been systematic deviations from CIP since the financial crisis
- Let's plot

$$\frac{F_{\$/€}}{E_{\$/€}}(1 + i_€) = (1 + i_\$)$$

$$\text{profit} = \frac{F_{\$/€}}{E_{\$/€}}(1 + i_€) - (1 + i_\$)$$

- CIP says profit ≈ 0
- What does it mean for profit to be positive? Negative?

CIP deviations



Covered interest parity

- CIP generally holds in the data, but…
- There have been systematic deviations from CIP since the financial crisis
- What happened to arbitrage?
  - Arbitrage usually involves leverage: borrowing
  - Borrowing (of all types) has some risk
  - Risk aversion has increased since the crisis
  - Balance sheet size is under greater scrutiny
- Even though the CIP trade is "riskless," the borrowing needed to arbitrage a CIP deviation has become harder to obtain

Arbitrage and interest rates: UIP

- Uncovered interest parity
- Start with \$1. Would like earn interest and have dollars one year from now. Two possibilities

1. Buy a U.S. t-bill with interest rate $i_{\$}$
2. Buy a Euro bond with interest rate $i_{€}$

- Option 2. requires foreign exchange risk. We do not use a forward contract. We buy at the spot price in t and sell at the spot price in $t+1$.
- This requires a guess at the future spot price. . .

Uncovered interest parity

- Return on buying in the U.S. is simply $\$1 \times (1 + i_{\$})$
- Return on buying in Europe **without** a forward is

$$\$1 \times \frac{1}{E_{\$/€,t}} \times (1 + i_{€}) \times E^{e}_{\$/€,t+1}$$

- Where $E^{e}_{\$/€,t+1}$ is the expectation of the $t + 1$ spot rate at time t
- This is not a pure arbitrage. There is risk involved. We might expect, however that **uncovered interest parity will hold**:

$$\frac{1}{E_{\$/€,t}} \times (1 + i_{€}) \times E^{e}_{\$/€,t+1} = (1 + i_{\$})$$

- Rearranging this expression gives us the spot rate equation

$$E_{\$/€,t} = \frac{1 + i_{€}}{1 + i_{\$}} E^{e}_{\$/€,t+1}$$

UIP and the carry trade

- The carry trade is a strategy in which you borrow in the low-interest currency and lend in the high-interest currency without a forward cover
- The investor hopes that the exchange rate will not appreciate enough to wipe out the gains

UIP and the carry trade

- Work with the person next to you
- $E_{\frac{¥}{\$}} = 111$, $i_{¥} = -0.12\%$, and $i_{\$} = 2.83\%$
- If you expect the exchange rate to remain unchanged, where do you borrow? Where do you lend? What is the profit on \$1 traded?
- For what value of $E^e_{\frac{¥}{\$}}$ does the trade break even?

A useful approximation

- Interest parity conditions are multiplicative
- Transform them into additive approximations using natural logs
- Rule: If ϵ is close to zero, then $\ln(1 + \epsilon) \approx \epsilon$
- Apply this to UIP

A useful approximation

$$\ln\left(\frac{E^e_{\$/€,t+1}}{E_{\$/€,t}}(1+i_€)\right) = \ln\left((1+i_\$)\right)$$

- logs make multiplication addition

$$\ln\left(\frac{E^e_{\$/€,t+1}}{E_{\$/€,t}}\right) + \ln(1+i_€) = \ln\left((1+i_\$)\right)$$

- Use $\ln(1+\epsilon) \approx \epsilon$

$$\ln\left(\frac{E^e_{\$/€,t+1}}{E_{\$/€,t}}\right) + i_€ \approx i_\$$$

- Let $d^e_{\$/€}$ be the expected depreciation rate of the dollar

$$\ln\left(1 + d^e_{\$/€}\right) + i_€ \approx i_\$$$

$$d^e_{\$/€} + i_€ \approx i_\$$$

A useful approximation

- Interest parity conditions are multiplicative
- Transform them into additive approximations using natural logs
- Rule: If ϵ is close to zero, then $\ln(1+\epsilon) \approx \epsilon$
- Apply this to UIP

$$d^e_{\$/€} + i_{€} \approx i_{\$}$$

$$d^e_{\$/€} \approx i_{\$} - i_{€}$$

- Expect high interest currencies to
- Expect low-interest currencies to

Interest parity conditions

- While interest parity conditions do not always hold exactly, we will assume that they do when we build our models.
- If I know $i_{\$}$, $i_{€}$, and $E^{e}_{\$/€,t+1}$ $\rightarrow$ I can find $E_{\$/€}$ and $F_{\$/€}$
- CIP and UIP tell us that the forex market depends on
  - Arbitrage
  - Expectations
- Where do $i_{\$}$, $i_{€}$, and $E^{e}_{\$/€,t+1}$ come from? We need to more theory.