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 Dollar appreciated (strengthened)
  - The Euro depreciated (weakened)
- Exchange rate growth rate
- Example
  - $E_{\frac{\$}{€},2017} = 1.19$ and $E_{\frac{\$}{€},2018} = 1.16$

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

2.5 % app dollar

Exchange rates changes

- Work with the person next to you
- $E_{\frac{\$}{€},2017} = 1.19$ and $E_{\frac{\$}{€},2018} = 1.16$
- What is $E_{\frac{€}{\$},2018}$?

$$= \frac{1}{1.16} = 0.862$$

- What is $E_{\frac{€}{\$},2017}$?

$$= \frac{1}{1.19} = 0.840$$

- How much did the dollar appreciate or depreciate against the euro?

$$\left(\frac{0.862}{0.840} - 1\right) \times 100 = 2.62\%$$

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)

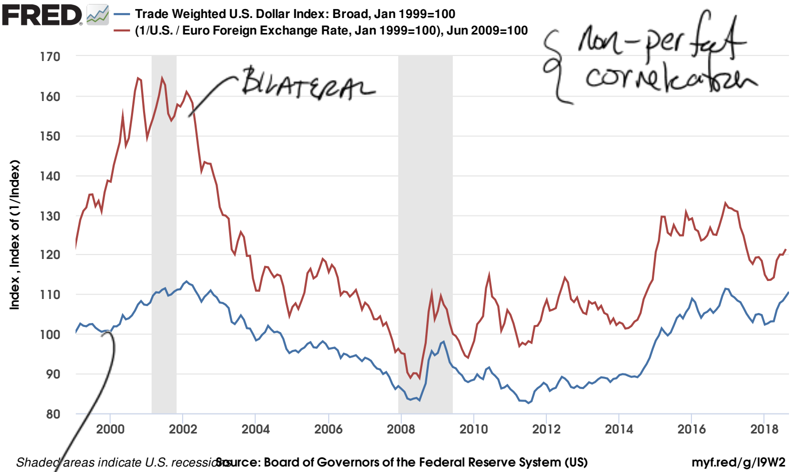
x_t, x_{t+1} aprox growth rate $\ln\left(\frac{x_{t+1}}{x_t}\right) \times 100$

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:

country $i = \{$CAN, BRA, CHN, ...$\}$

$$\underbrace{\frac{E_{t+1}}{E_t}}_{\text{growth rate (effective rate)}} - 1 = \sum_i \left[\underbrace{\left(\frac{E_{i,t+1}}{E_{i,t}} - 1\right)}_{\text{growth rate of bilateral exchange rate with country } i.} \underbrace{\frac{\text{trade}_i}{\text{total trade}}}_{\text{"weight" importance of ctry } i \text{ in U.S. trade.}} \right]$$



Non-perfect correlation

MULTILATERAL = Less Variable

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 what is the £-cost of good?
- If $E_{HK\$/£} = 15$ and $E_{\$/£} = 2.0$

$$p_{hk} = \underbrace{30,000/15}_{\cancel{HK\$}/\text{unit}\,/\,\cancel{HK\$}/£} = £2,000 \quad \frac{£}{\text{unit}}$$

$$p_{ny} = 4,000/2 = £2,000$$

depreciation

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

appreciation.

$$p_{hk} = 30,000/16 = £1,875$$

$$p_{ny} = 4,000/1.9 = £2,105$$

- Where do you source? Hong Kong is cheapest.

Exchange rates and prices

- When the home country's currency depreciates:
- What happens to the price of home's exports in foreign currency?

→ exports are cheaper in foreign currency.

- What happens to the price of foreign imports in the home currency?

→ foreign imports are more expensive in home currency.

- How does this depend on price stickiness?

① fx rates matter more when prices are stickier

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? VEHICLE CUR.
  - 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

Fiji → PALAU
Fiji → US \$
US\$ → PALAU

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Arbitrage

RISKLESS 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?

  Sell in London buy in NY

- Why would markets respond to these prices? What do you expect to happen?

  buying in NY $E\uparrow$; selling in LND $E\downarrow$

- What might keep you from profiting?

  [Fees, regulations, thin markets, ability to borrow]

  ↳ "capital control"

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. $\cancel{\$}1 \times 0.8 \frac{€}{\cancel{\$}} = 0.8 €$
2. $0.8 € \times 0.7 \frac{£}{€} = 0.56 £$
3. $0.56 £ / 0.50 \frac{£}{\$} = \$1.12$

12% RoI ~ Not observed

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

1. ▶ Return on buying in the U.S. is simply $\$1 \times (1 + i_{\$})$

2. ▶ Return on buying in Europe with a forward is

Euros @ t+1

$$\underbrace{\$1 \times \frac{1}{E_{\$/€}}}_{\text{Euros @ } t} \times (1 + i_{€}) \times F_{\$/€}$$

▶ 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

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

FORWARD IS A DERIVATIVE

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?

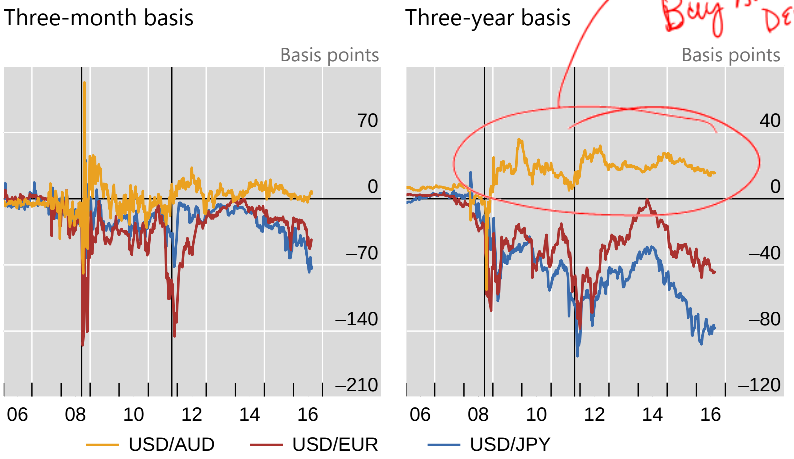
profit > 0 → FOREIGN RETURN > DOMESTIC

< 0 → <

CIP deviations

Borrow in $

Buy Australia Debt



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? GENERAL REGULATION
  - 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

Expected

expectation

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

- 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**:

Expected RATES OF RETURN

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

- 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

Diff in i-rates.

- 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?

$$\text{PROFIT} = (1-0.0012)\frac{111\ ¥/\$}{111\ ¥/\$} - (1+0.0283)$$

$$= -0.0295 \longrightarrow 2.95\%$$

- For what value of $E^e_{\frac{¥}{\$}}$ does the trade break even?

$$0 = (1-0.0012)\frac{X}{1/111\ \$/¥} - (1+0.0283)$$

$$E_{¥/\$} = 108$$

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

$$\ln(1.02) \approx 0.02$$

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

$1+d_{\$/€}$

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

- 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

$$\boxed{\begin{aligned} d^e_{\$/€} + i_€ &\approx i_\$ \\ d^e_{\$/€} &\approx i_\$ - i_€ \end{aligned}}$$

- 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.