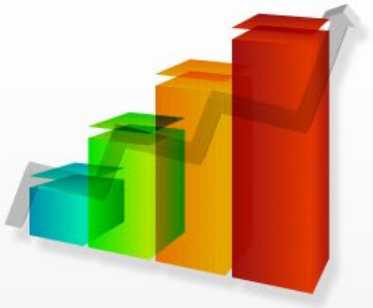
2604697
Financial Markets, Institutions and Instruments

ขอถือคำแนวคนเยอะ ฝาก + เข้าใจหลักการแต่ละชิ้น

Topic 12: International Parity Conditions

MSF Program
Ruttachai Seelajaroen, Ph.D.
Dept of Banking & Finance
Chulalongkorn Business School



Overview

1. Introduction
2. Purchasing Power Parity PPP
3. Generalized Fisher Effect
4. International Fisher Effect IFE
5. Interest Rate Parity IRP
6. Exchange Rate Forecast → forecasting performance of exchange rate model

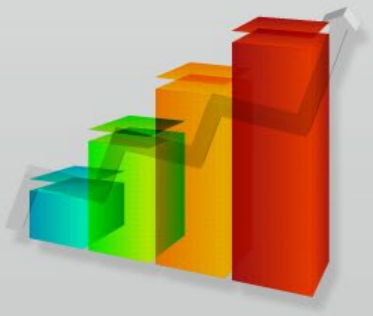
all derived from LOP

1. Introduction

equilibrium condition

1.1 The Law of One Price (LOP)

1.2 International Parity Conditions



1.1 The Law of One Price (LOP)

- Arbitrage
  - Arbitrage is a trading strategy whereby investors simultaneously buy and sell the same asset in different markets to make risk-free profit from price discrepancies.
- The Law of One Price (LOP)
  - In free markets, arbitrage activities will ensure that prices of identical assets, when converted into a common currency, are equal across markets. Price discrepancies may only stay within transaction costs.
  - When the law of one price holds, there will be no arbitrage opportunity.

1.1 The Law of One Price (LOP)

- **EX:** A ton of rice is B5,000 in TH and $150 in the US. The exchange rate is B40/$. Is there an arbitrage opportunity?
  - THB-Price of US rice (P_{US}^{B}) = $P_{US}^{\$} \times S^{B/\$}$ = 150×40 = B6,000
  - **No Arbitrage Condition:** $P_{TH}^{B} = P_{US}^{B}$ ($= P_{US}^{\$} \times S^{B/\$}$)
  - **Current Price Difference:** $P_{US}^{B} - P_{TH}^{B}$ = B1,000/ton
  - The market is not in equilibrium, price in the U.S. is relatively too high. Arbitrage activities will drive P_{TH}^{B} ↑, $P_{US}^{\$}$ ↓ and $S^{B/\$}$ ↓.

1.1 The Law of One Price (LOP)

- Several parity conditions can be derived by applying the LOP to international prices of products and financial assets.
- We will examine;
  - Purchasing Power Parity (PPP)
  - The International Fisher Effect (IFE)
  - Interest Parity (IRP)
- These conditions are equilibrium conditions assuming free and competitive markets.

2. Purchasing Power Parity

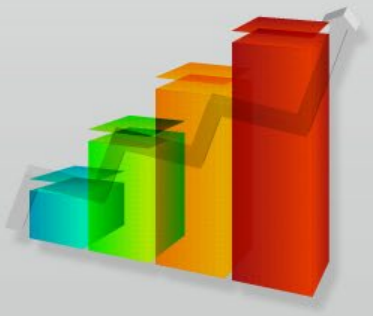
2.1 Absolute PPP

2.2 Relative PPP use this the most

2.3 Real Exchange Rate

2.4 Empirical Evidence

2.5 Applications



apply to a basket of product → called PPP $P_{TH} = P_{US} * S^{฿/\$}$

CPI_t reflect average price of many products in basket

2.1 Absolute Purchasing Power Parity

$P_H = P_F * S^{HC/FC}$ ↓ absolute PPP equation

- Absolute PPP is derived by applying the LOP to each item in baskets of G&Ss from 2 countries.
- The general price levels of G&Ss between the 2 countries must be equal when expressed in a common currency

$$P_{H,t} = P_{F,t} \times S_t^{HC/FC}$$

- Rearrange the equation,

use to forecast ← aggregate price is easier to predict

$$E\left[S_t^{HC/FC}\right] = \frac{E\left[P_{H,t}\right]}{E\left[P_{F,t}\right]}$$

↓ do empirical test

- $P_{H,t}$ and $P_{F,t}$ are general price indices from the 2 countries measured from the same basket of G&Ss and base year.

observe HC & FC 's CPI

$CPI_H / CPI_F \longleftrightarrow S^{HC/FC}$

Compare

! drawback → H&F have diff basket

↓

not theory false

2.1 Absolute Purchasing Power Parity

- EX: On 1/1/04, one Big Mac cost B52 in TH, and $2.43 in US. According to absolute PPP, what should $S^{B/\$}$ and $S^{\$/B}$ be?
  - $S^{B/\$}$ = B52 / $2.43 = B21.40/$
  - $S^{\$/B}$ = $2.43 / B52 = $0.047/B

exchange rate implied by theory <PPP>

≠ actual exchange rate

① If believe PPP is correct, the mkt rate is not in equilibrium → expect $ to depreciate to ฿21.4/$

② PPP is not correct

- If the market exchange rate is B30/$, does it mean that the FX market is not in equilibrium or PPP is incorrect?
  - Based on PPP, $P_{TH}^{\$}$ = 52/30 = $1.73
  - Based on PPP, USD is overvalued by

    (30–21.4) / 21.4 = 0.4019 or 40.19%
  - Is this an arbitrage opportunity?

can do arbitrage ฿30/$ × $2.43

$P_{US}^{฿}$ = ฿72.90 per piece

with commodity
- high transaction cost
- various!
- no arbitrage might not equation to hold in practice

2.1 Absolute Purchasing Power Parity

- Absolute PPP fails in empirical tests. This should come as no surprise.
  - PPP is usually tested on general price indices such as national CPIs, which do not represent exactly same baskets of G&Ss.
  - Not all items in CPIs are tradable internationally. LOP is not applicable to non-tradable G&Ss (i.e., labor and land).
  - There are also effects of market frictions such as tariff, transportation costs and pass through policies.

2.2 Relative Purchasing Power Parity

- Relative PPP states that the relative value between two currencies (i.e., exchange rate) will adjust to reflect changes in their relative price levels (i.e., inflationary differential).
- That is, the rate of change in exchange rate between two currencies will exactly offset inflationary differential between the two countries.
- The idea is that, at any point in time absolute PPP may not hold. However, the movement of relative price and spot rate should be toward the direction of absolute PPP.

Illustration of Absolute vs. Relative PPP

change in prices over time → more dynamic

relation btw price level & exchange at a point
↳ static : time 0 & time 1

0 — 1

$P_{H,0}$ → $P_{H,1}$ → $(P_{H,1} / P_{H,0}) = 1+\pi_H$

$P_{F,0}$ → $P_{F,1}$ → $(P_{F,1} / P_{F,0}) = 1+\pi_F$

$S_0^{HC/FC}$ → $S_1^{HC/FC}$ → $(S_1^{HC/FC} / S_0^{HC/FC}) = 1+c$ (c: change in exchange rate)

$\frac{33}{30} = 1 + 0.10$

$S_0^{HC/FC} = \frac{P_{H,0}}{P_{F,0}}$ $\quad S_1^{HC/FC} = \frac{P_{H,1}}{P_{F,1}}$

$\frac{S_1^{HC/FC}}{S_0^{HC/FC}} = \frac{(1+\pi_H)}{(1+\pi_F)}$

rate of change in exchange rate
↳ if it ≠ 1 → then, there is change

↳ if ≠ 1, inflations are different

- c is the rate of change in the exchange rate. c > 0 means FC appreciates against HC.
- $[(1+\pi_H)/(1+\pi_F)] - 1$ = Inflation Differential

change of exchange rate must equal to

2.2 Relative Purchasing Power Parity

- Relative PPP can be written as;

e.g. exchange rate at time 4

$$\frac{S_t^{HC/FC}}{S_0^{HC/FC}} = \frac{(1+\pi_H)^t}{(1+\pi_F)^t}$$

- In other words, "1+c = 1+Inflation differential"
- If t=1,

$$\frac{S_1^{HC/FC} - S_0^{HC/FC}}{S_0^{HC/FC}} \approx \pi_H - \pi_F$$

- For forecasting purposes, 0 is the present time, S_0 is the current spot exchange rate, and π_H and π_F are expected inflation rates in the 2 countries.

ppp:

$$\frac{S_1^{Hc/Fc}}{S_0^{Hc/Fc}} - 1 = \frac{1+\pi_H}{1+\pi_F} - 1$$

$$\frac{S_1^{Hc/Fc} - S_0^{Hc/Fc}}{S_0^{Hc/Fc}} = \frac{(1+\pi_H)-(1-\pi_F)}{1+\pi_F}$$

rate of change in exchange rate

$$\frac{\pi_H - \pi_F}{1+\pi_F} \approx \pi_H - \pi_F$$

inflation differential approximation for 1 period

$1+\pi_F$ approximately 1

$1 < \frac{S_t^{HC/FC}}{S_0^{HC/FC}} = \frac{(1+\pi_H)^t}{(1+\pi_F)^t}$ if $\pi_H > \pi_F$ > 1 * if home country has higher π_H, HC should depreciate against FC

FC appreciates due to low π_F by $\pi_H - \pi_F \approx 9\%$.

2.2 Relative Purchasing Power Parity

$E[S_1^{฿/\$}] \approx ฿40/\$ \times 1.09 = ฿43.6/\$$

- EX: Over one-year period, P_{TH} and P_{US} are expected to rise from 105 to 115.5 and 100 to 101, respectively. If $S_0^{B/\$}$ is B40/\$, what is $E[S_1^{B/\$}]$?
  - $1 + \pi_{TH} = 115.5 / 105 = 1.10$ → $1 + E[\pi_{TH}]$ (expect π_{TH} to be 10%)
  - $1 + \pi_{US} = 101 / 100 = 1.01$ → $1 + E[\pi_{US}]$ (expect π_{US} to be 1%)
  - $E[S_1^{B/\$}] = (1.10/1.01) \times B40/\$ = B43.56/\$$ (if you believe in PPP) — very close
- EX: US and SW are running π of 5% and 3% pa, respectively. If S_0 is \$0.75/SFr, what is the expected exchange rate 3 years' time? (should increase)

  $\pi_{US}^H = 5\%$, $\pi_{SW}^F = 3\%$

  ↳ USD depreciates ↳ SW appreciates by 2% per year
  - $E[S_3^{\$/SFr}] = (1.05^3 / 1.03^3) \times \$0.75/SFr = \$0.79/SFr$

$= 0.75 \times \left(\frac{1+0.05}{1+0.03}\right)^3$

Start with S_0 = ฿40/$ ⊕ effect of inflation π_{US} = 1%, π_{TH} = 10%

cost increase by just 1%

cost of production in TH increases by 10%

↳ TH becomes expensive relatively 9% if same exchange rate

↳ TH competitive ↓ → TH export ↓ import ↑

↓

TH run trade deficit

↓

USD becomes stronger

↳ benefit from lower π_{US} is cancelled

↓↓

becomes equilibrium

2.2 Relative Purchasing Power Parity

- The logic underlying Relative PPP.
- From the previous EX: Once the effects of inflations take place and at the same exchange rate (S_0=B40/$), the U.S. G&Ss will enjoy price advantage over TH G&Ss. This is because the U.S. G&Ss will be 8.90% relatively cheaper (1.10/1.01 = 1.089) than TH G&Ss.
- The change in demands for the U.S. and TH G&Ss will cause USD to appreciate or $S^{B/\$}$ to increase.
- Once USD appreciates against THB by the same rate as the change in relative price level, the price advantage of US G&S's will be fully eliminated. Then, the FX and the product markets will be back in equilibrium.

- Nominal exchange rate
- Nominal interest rate = 5%

  ⇓ purchasing power might not increase by 5% bcs increase in price level

  need to calculate real interest rate = nominal rate $- \pi^e$

2.3 Real Exchange Rate

- According to relative PPP, price advantage between 2 nations arising from inflation differentials will be eliminated through changes in nominal exchange rates, and vice versa.
- In equilibrium, the real purchasing power of one currency relative to another is always constant.
- In international context, the real purchasing power of a currency is affected by: (1) domestic inflation (2) foreign inflation and (3) nominal exchange rate.

• Nominal exchange rate

$S_0^{฿/\$} = ฿40/\$$

$S_1^{฿/\$} = ฿43.6/\$$

THB weaker → TH exporter gain
US manufacturer will lose out price competitiveness

↳ According to PPP, USD becomes stronger due to $\pi_{TH} > \pi_{US}$
real exchange rate ⇒ look at Δ in nominal exchange rate
& different in inflation
want to see price competitiveness

2.3 Real Exchange Rate

under absolute PPP

$$\frac{S^{\$/B} \times P_{US}}{P_{TH}} = S^{\$/B} \times \frac{P_{US}}{P_{TH}}$$

nominal exchange rate; price level

- From the LOP example;

[1] in same currency: $P_{TH} = B5{,}000$ (price of rice in TH)

[2] $P_{US}^{B} = P_{US} \times S^{B/\$} = 150 \times 40 = B6{,}000$ (price of US rice in THB)

must be equal; if not → no equilibrium

USD should depreciate

FC is too strong in real term

too expensive

[2]/[1]: $S^{*} = S^{B/\$} \times (P_{US}/P_{TH}) = 1.20$ (real exchange rate)

1 ton of rice in the US worth 1.2 ton in Thailand

- S* is called the real exchange rate of USD. So, currently 1 ton of the U.S. rice is worth 1.2 tons of rice in TH.
- Based on Absolute PPP, $S^{B/\$} = P_{TH}/P_{US}$. In equilibrium S*=1.
- At S*=1.2, the real exchange rate of USD is too high causing the U.S. to lose out on price competitiveness. As $S^{B/\$}$ and S* decrease the market will move toward equilibrium.

2.3 Real Exchange Rate

- The real exchange rate (S*) is a measure capturing changes in real purchasing power of one currency relative to another.
- The real exchange rate of an FC can be calculated as;

$$\text{Absolute PPP:} \quad S_t^* = S_t^{HC/FC} \times \frac{P_{F,t}}{P_{H,t}}$$

$$\text{Relative PPP:} \quad S_t^* = S_t^{HC/FC} \times \frac{(1+\pi_F)^t}{(1+\pi_H)^t}$$

- S_t is the nominal exchange rate of an FC against the HC.
- S_t^* is the real exchange rate of an FC measured against the HC. Unlike nominal exchange rate (S), S* is unitless.

at time 0; $S_0^* = S_0$

	S^*
0	$S_0^* \mid S_0 = 1$
1	$S_1^* \mid S_0$
2	.
3	.
4	!

2.3 Real Exchange Rate

- In the base year, $S_0^* = S_0$ (for relative PPP).
- Over time, if changes in nominal exchange rate exactly offset the inflation differential, S* will remain constant. That is, $S_t^* = S_0^* = S_0$.
- Hence, a change in S* indicates deviation from relative PPP.
- $S_t^* > S_0^*$ implies that between time 0-t, FC has gained purchasing power relative to HC. This would cause country F to lose price competitiveness to H.

$S_{80} = ¥226.63/\$$

$S_{95} = ¥93.96/\$$

nominal exchange rate

manufacturers used to exchange $1 price in foreign country = 226.63 ¥

↳ lose out price competitiveness bcs they need to rise foreign price of product to maintain margin when exchange rate becomes ¥93.96/$

↳ expects higher π_{US} → cancelled the price competitiveness of US

2.3 Real Exchange Rate

15 yrs later

- EX: Between 1980–1995, $S_0^{¥/\$}$ had dropped from ¥226.63 to ¥93.96/$. During the 15 years period, the U.S. CPI has risen from 82.4 to 152.4, while CPI in JP has risen from 91.0 to 119.2.

$\frac{CPI_{US,95}}{CPI_{US,80}} = \frac{152.4}{82.4}$ } $1+\pi_{US} = 1.85$ (per 15 yrs) — US has high π as expected

$\frac{CPI_{JP,95}}{CPI_{JP,80}} = \frac{119.2}{91.0}$ } $1+\pi_{JP} = 1.31$

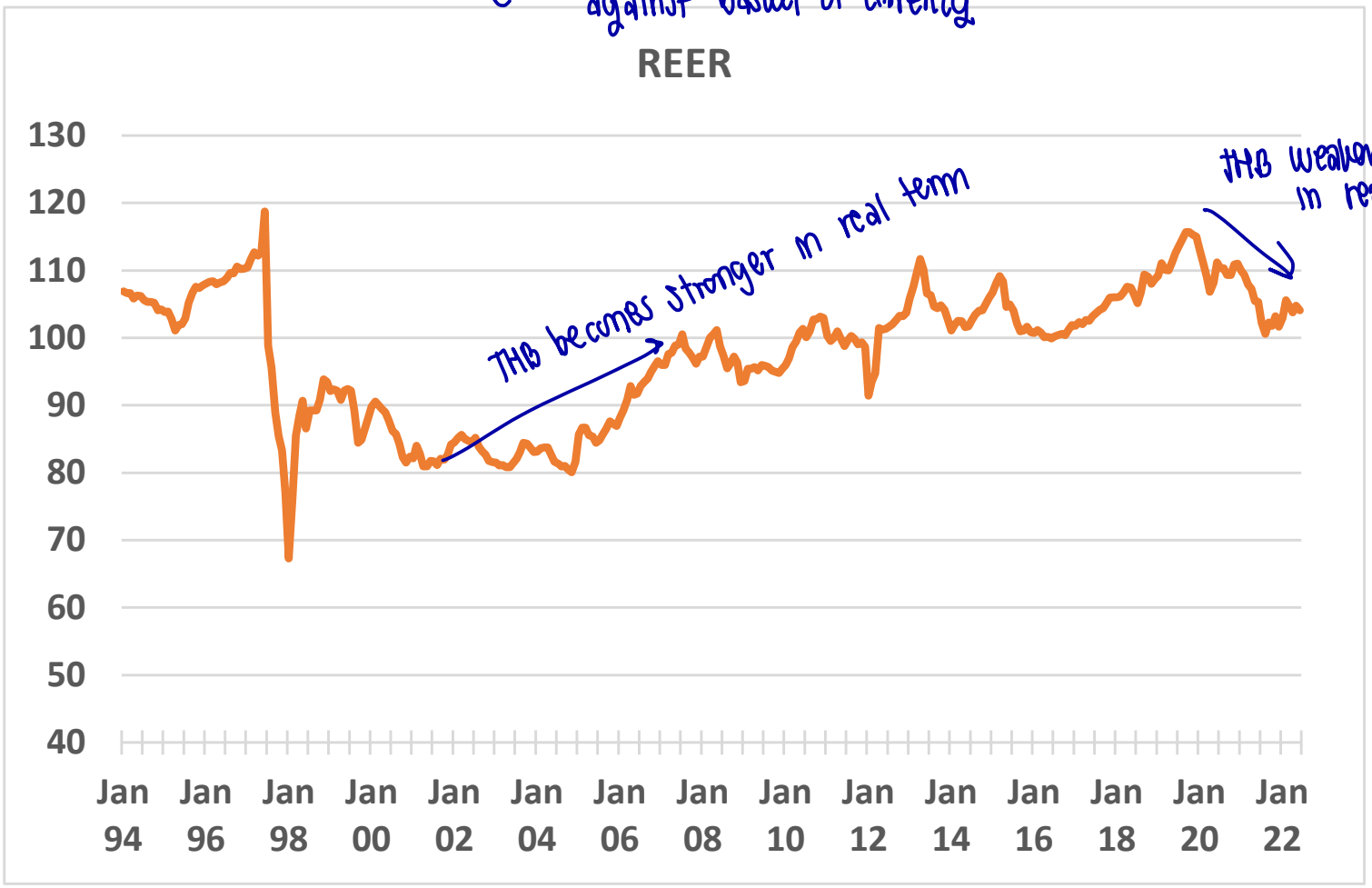
  - If PPP holds over this period, what would $S^{¥/\$}$ be in 1995?
    - check whether ppp hold
    - $E[S_{1995}^{¥/\$}] = ¥160.51/\$ = S_{80}^{¥/\$} \times \frac{1.31}{1.85}$ ($S_{80} = 226.63$)
    - * actual $S_{95}^{¥/\$}$ is ¥93.96/$ — nominal rate for US depreciates too much
    - * US manufactures will gain price competitiveness
  - What happened to the real value of ¥ in terms of $ during this period?
    - real exchange rate on dollar → smaller
      - ↳ dollar becomes too weak in real term
    - $S_{1995}^{*} = S_t^{¥/\$} \times \frac{(1+\pi_{US})}{(1+\pi_{JP})} = 93.96 \times \frac{1.85}{1.31}$
    - For USD, $S_{1980}^{*} = 226.63$, and $S_{1995}^{*} = 132.67$ ← US manufacturers gain price competitiveness
    - For JPY, $S_{1980}^{*} = 0.0044$, and $S_{1995}^{*} = 0.0075$ ($\frac{1}{93.96} \times \frac{1.31}{1.85}$)
  - Who had lost price competitiveness?
    - change foreign price ↑ → quantity demand may not change due to inelastic product
    - US is expected to have less deficit against Japan as it gain price competitiveness
    - BUT actual → US has more deficit against Japan → bcs US economy ↑ → wage ↑ → loss price competitiveness
      - ↑ need to relocate their factories to other country

real exchange rate

trade waited exchange rate

THB Real Effective Exchange Rate (REER)

against basket of currency



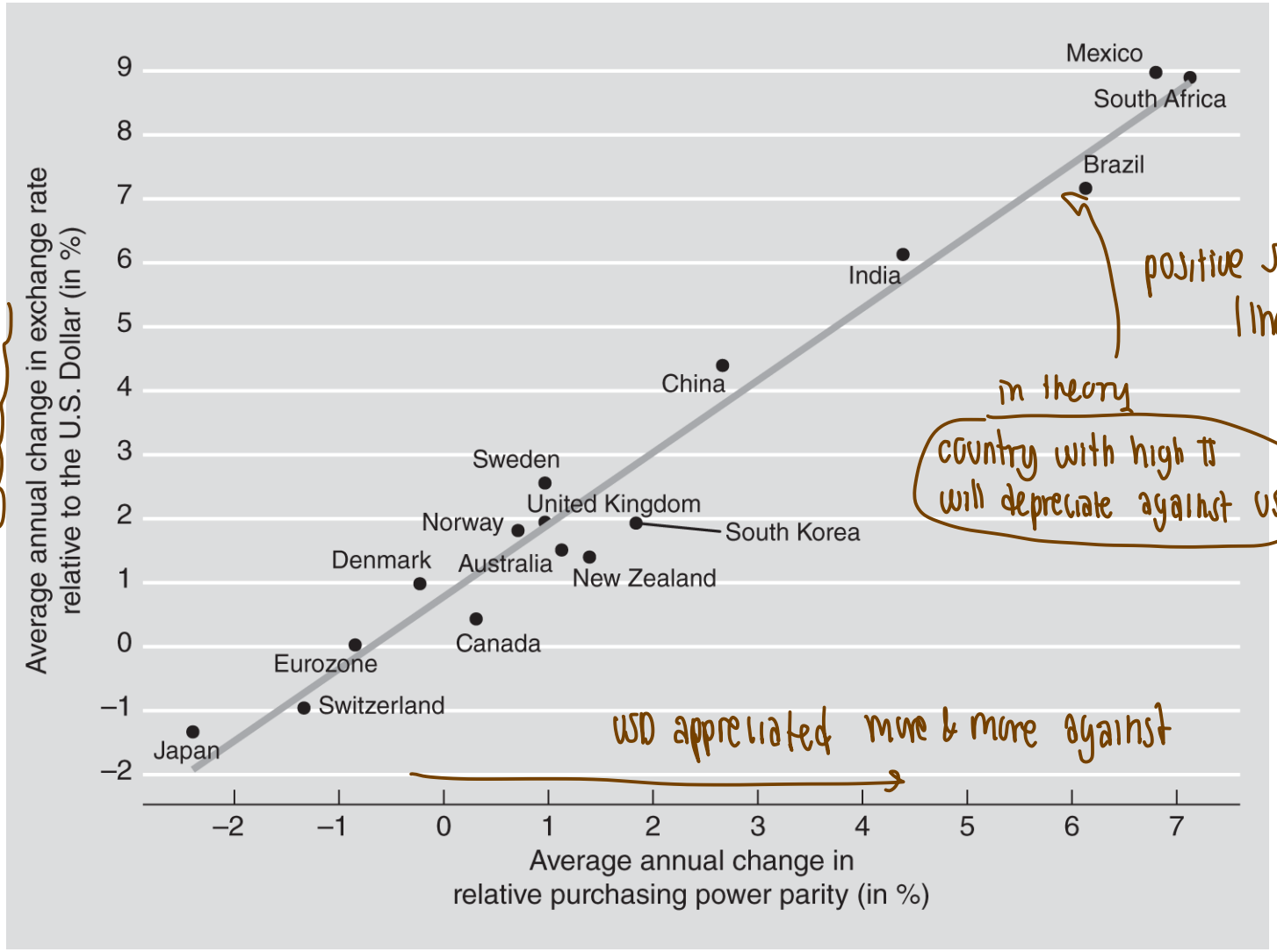
Ref: BoT

2.4 Empirical Evidence

- Exchange rates are more volatile than corresponding national price levels.
- The currencies of countries that had very high inflation rates relative to trading partners experienced rapid depreciation.
- Empirically, PPP holds better in the long-run than in the short-run.
- There have been both substantial and prolonged deviation from relative PPP which have frequently been reversed.
- Rogoff (1996) estimated the PPP's half-life, which is the time it takes in years to correct 50% of a previous deviation from PPP, to be 3–5 years.

inflation differencial against us

Relative PPP in the Long-Run (1981-2017)



$S_1^{FC/\$}/S_0^{FC/\$} - 1$

positive sloped line

in theory

country with high π will depreciate against USD

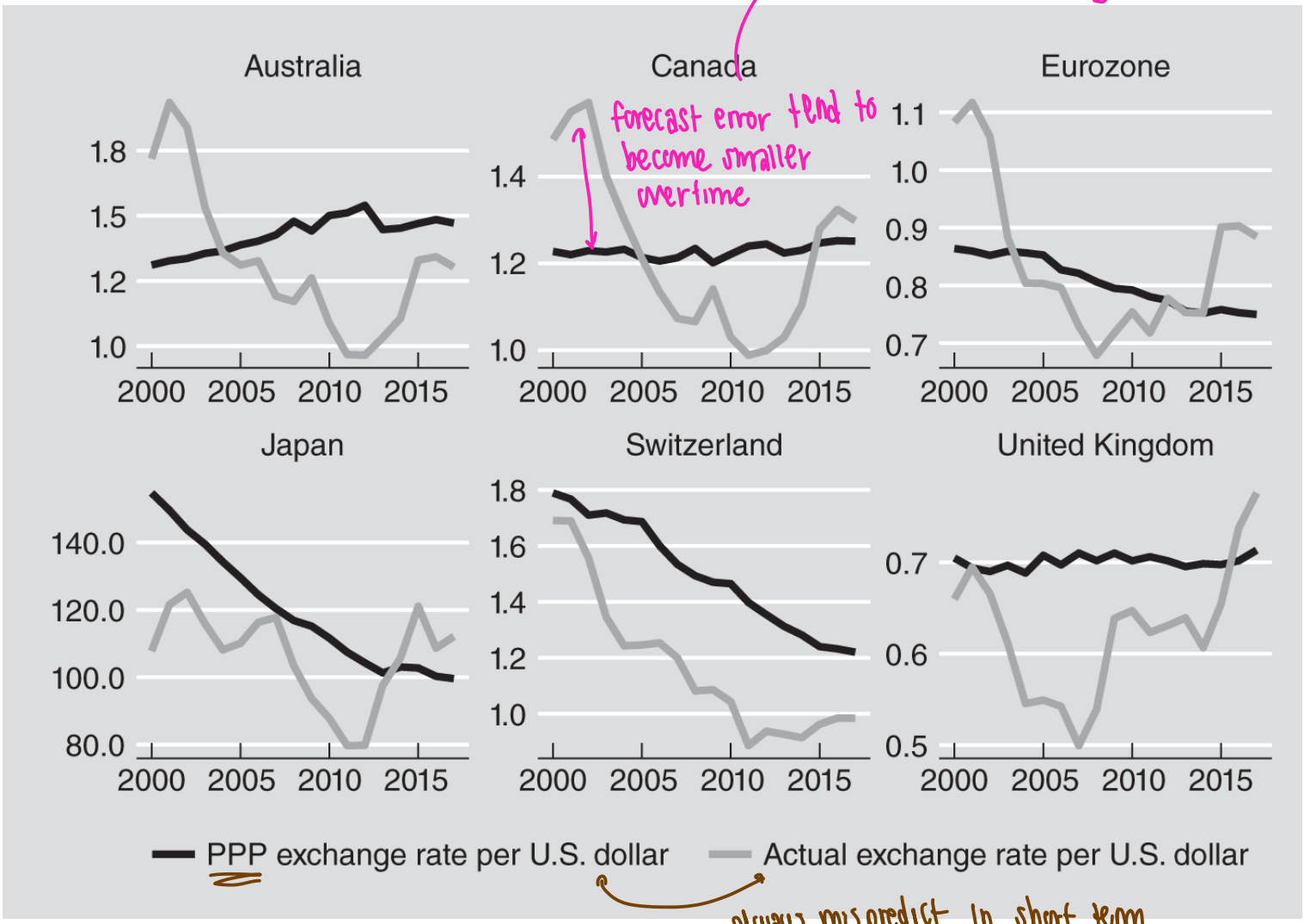
USD appreciated more & more against

$(1+\pi_F)/(1+\pi_{US}) - 1$

force to bring exchange rate to equilibrium
↓
but must is overshoot

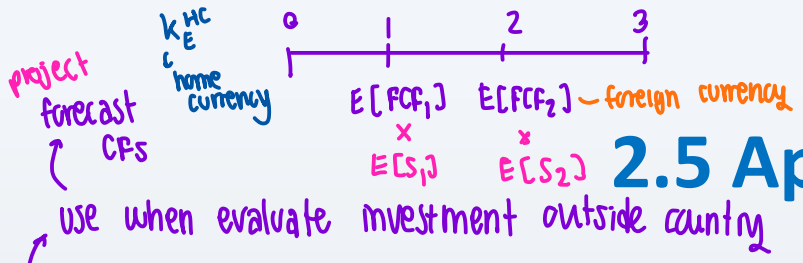
Actual vs. Relative PPP Exchange Rates

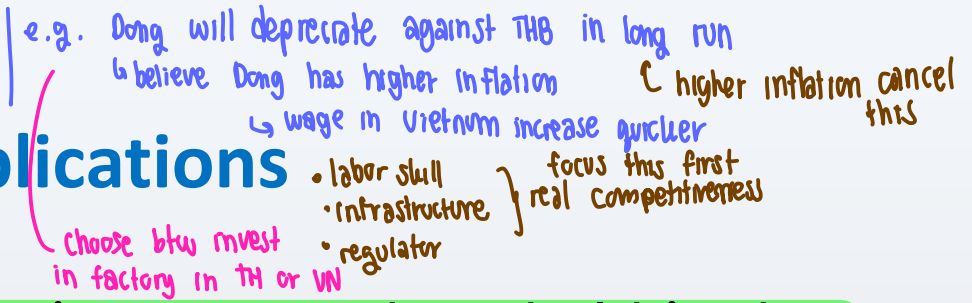
mean reversion property



always mispredict in short term

2.5 Applications





- Currency Forecast: Since Relative PPP tends to hold in the long-run, it is often used as a benchmark for forecasting exchange rate in the long-run.

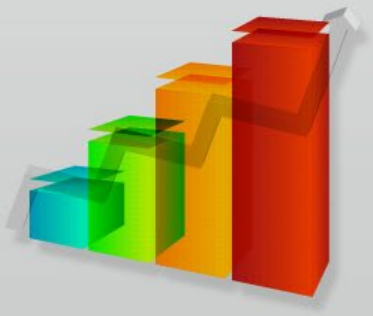
- Production Location Decisions: If relative PPP holds, firms should select production location based only on comparative advantages without concerning that movement in exchange rate or inflation will alter their competitiveness.

3. Generalized Fisher Effect

3.1 Real vs. Nominal Interest Rates

3.2 The Generalized Fisher Effect

3.3 Empirical Evidence



3.1 Real vs. Nominal Interest Rates

- Nominal return (i) measures the rate of change in $-wealth.
- Real return (r) measures the rate of change in purchasing power.
- EX: Consider a bank 1-year term deposit paying 6% pa. Assume during the investment period the inflation is 3% pa.
  - Nominal return = 6% pa.
  - Real interest rate = (1.06/1.03) – 1 = 0.0291 or 2.91%
  - Approximately, r = 0.06 – 0.03 = 0.03 or 3%

3.1 Real vs. Nominal Interest Rates

- EX: Mr. A deposits \$1 for 1 year earning 10% pa interest rate. During the year, the average price of products increases by 5% from \$0.20 to \$0.21/unit. What is the change in Mr. A's purchasing power (PP) from the investment?

  [1] PP at 0: $\$1/P_0 = \$1/\$0.20$

  [2] PP at t: $\$1(1+i)/P_0(1+\pi) = \$1(1+0.10)/\$0.20(1+0.05)$

  [3] Real interest rate (r) $= ([2]/[1]) - 1$

  $= ((1+i)/(1+\pi)) - 1$

- Hence,

$$(1+r)^t = \frac{(1+i)^t}{(1+\pi)^t}$$

3.2 The Generalized Fisher Effect

- The Generalized Fisher Effect assumes that investors are only concern with real return on alternative investments. Thus, real returns on investments of identical risk should be equal across markets.

$$(1+r_H)^t \quad = \quad (1 + r_F)^t$$

- From $(1+r)^t = (1+i)^t / (1+\pi)^t$,

$$\frac{(1 + i_H)^t}{(1 + i_F)^t} = \frac{(1 + \pi_H)^t}{(1 + \pi_F)^t}$$

- If $t = 1$, $r \approx i - \pi$. We obtain

$$i_H - i_F \approx \pi_H - \pi_F$$

- Note: i is observed at the onset, while π is expected inflation.

3.2 The Generalized Fisher Effect

- EX: It is expected that π_{US}=7% and π_{UK}=4% pa. What should be the nominal interest differential between USD and GBP.
  - $i_{US} - i_{UK} \approx 0.07 - 0.04$ or 3% pa
- Higher i is required from a currency whose expected π is relatively high in order to compensate for the expected loss in purchasing power.
- If i_{US}=9% and i_{UK}=4%, fund will flow from the U.K. to the U.S. This will drive $i_{UK}\uparrow$ and $i_{US}\downarrow$ until $i_{US} - i_{UK}$ = 3% pa.

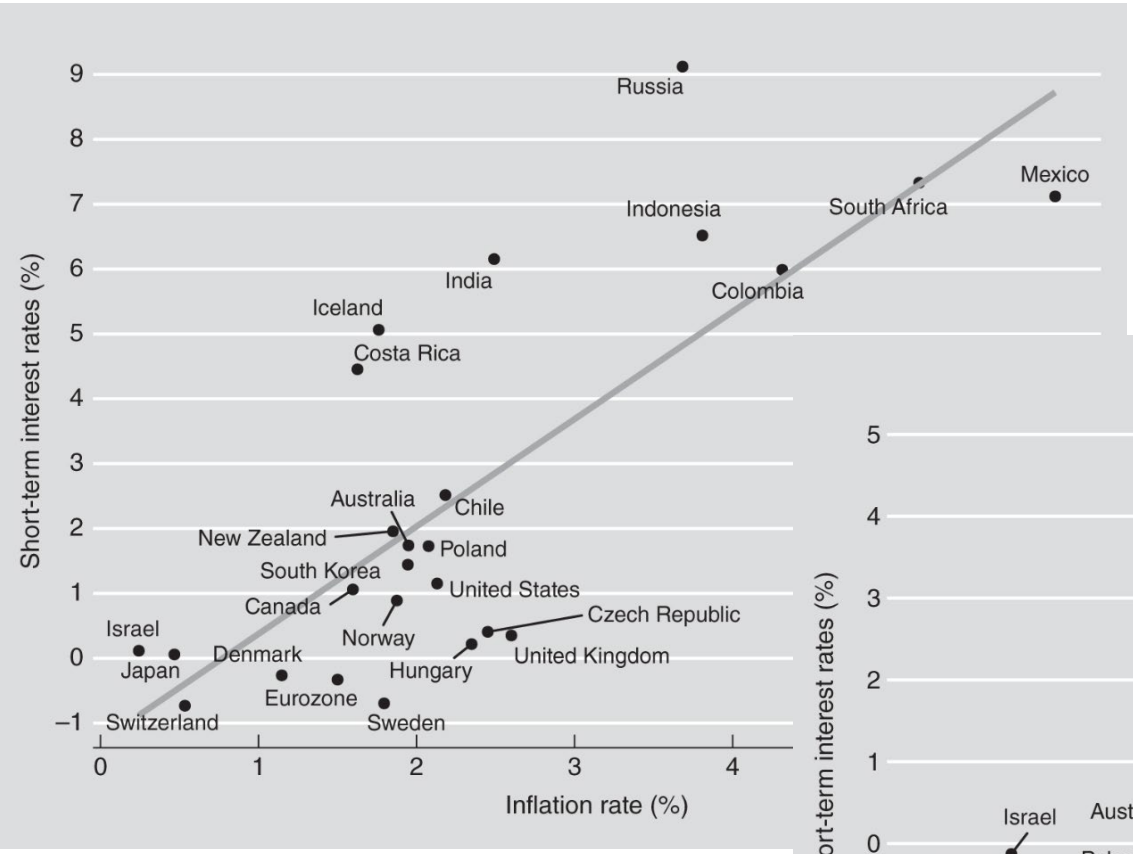
3.3 Empirical Evidence

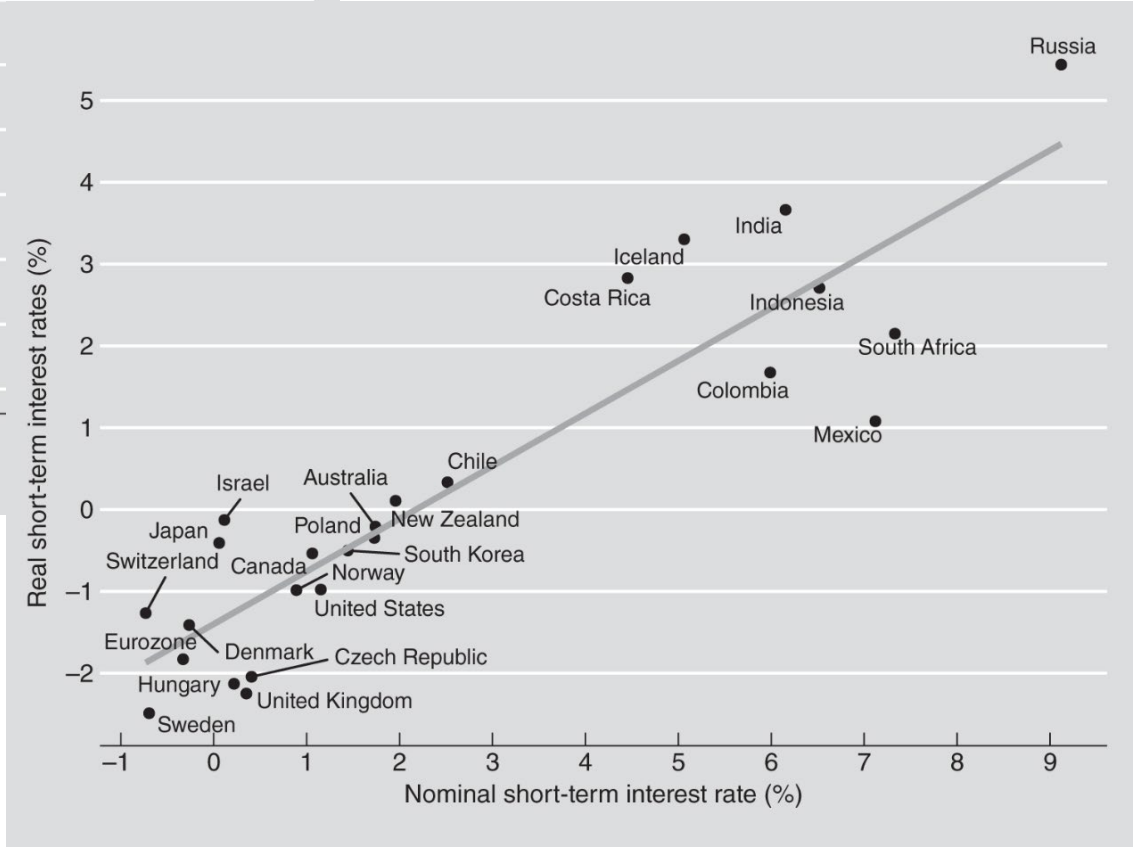
- If capital markets are fully integrated, real interest rates are determined by the global demand and supply of funds. Hence, assets denominated in different currencies, but carry similar risks, will have the same real interest rate.
- Real interest rates differentials, which imply capital market segmentation could exist without arbitrage due to:
  - Risk aversion (for example, due to currency risk, investors may prefer one currency to the others, even when its real interest is lower)
  - Political risk (such as capital control risk)
  - Transaction costs (such as taxes)

3.3 Empirical Evidence

- In general, countries with higher inflations tend to have higher nominal interest rates.
- However, cross-country differences in real interest rates do exist.
- The following figure shows that real interest rates tend to be high developing countries. From the perspective of firms, real interest rates reflect real costs of capital.

Inflation and ST Nominal and Real Interest Rates (Dec 2017)



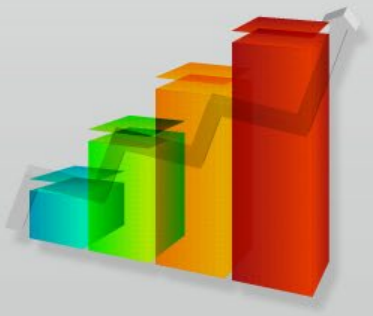


4. International Fisher Effect

4.1 International Fisher Effect

4.2 Empirical Evidence

4.3 Applications



4.1 International Fisher Effect

- The IFE is also known as Uncovered Interest Parity (UIP).
- The IFE states that two investments of identical risk should provide the same expected nominal return when converted into a common currency. Applying the statement to interest rates on 2 currencies, IFE can be expressed as

1+ rate of change in exchange rate

interest differencial

$$\frac{E[S_t^{HC/FC}]}{S_0^{HC/FC}} = \frac{(1+i_H)^t}{(1+i_F)^t}$$

then $1 <$ if > 1

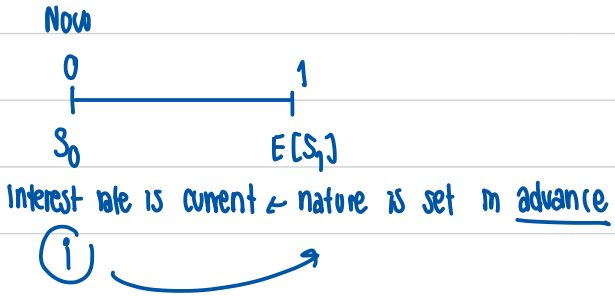
H has higher i_H → mkt expects HC to depreciate over time

everything square off in equilibrium

Change in exchange rate must be equal to change in interest rate

- In other words, "1+E[c] = 1+Current Interest differential"
- If t=1,

$$\frac{E[S_1^{HC/FC}] - S_0^{HC/FC}}{S_0^{HC/FC}} = E[c] \approx i_H - i_F$$



Interest rate is current ← nature is set in advance

(1)

Concept: 2 investments in diff mkt
↳same risk, investors should demand same expected return in equilibrium

4.1 International Fisher Effect

- EX: Consider 2 bank deposits, THB-deposit paying 5% pa interest and USD-deposit paying 8% pa interest. The current exchange rate S_0=B30.0/$ and the expected future exchange rate is $E[S_1]$=B30.0/$. Starting with B1 investment, expected payoff at the end of the year measured in THB are;
  - THB Investment (HC): B1×(1+0.05) = B1.05
  - USD Investment (FC): $1/30×(1+0.08)×30 = B1.08
  - Is this an equilibrium situation?
  - In equilibrium we should expect 2 investments that have identical risk (default risk in this case) to earn the same expected return measured in a common currency.

have to exchange THB → USD first ①
i_{TH}
i_{US}
exchange rate when buy dollar to invest ② 8%
principal + int
return on US investment in $
not in equilibrium
until they're equal
everyone want to buy $
S_0, spot rate today becomes higher

When HC ฿ depreciates Home manufacturers gain price competitiveness
S_0 = ฿30/$
S_1 = ฿40/$ → สามารถถอนเงิน $ ได้

HC vs. FC Investments of Identical Risk

as result of transaction you entered

Transactions	Cash flows t_0	Cash flows t_1
(A) THB or HC Investment		
1. Inv B @ i_{TH} pa.	$-B1$	$+B1\times(1+i_{TH})$
(B) USD or FC Investment		
1. Convert B to \$ @ $S_0^{B/\$}$	$-B\ 1$	
	$+\$\ 1/S_0^{B/\$}$	
2. Inv. \$ @ i_{US} pa.	$-\$\ 1/S_0^{B/\$}$	$+\$\ (1/S_0^{B/\$})(1+i_{US})$
3. Expect to sell \$ @ $E[S_t^{B/\$}]$ at t_t		$-\$\ (1/S_0^{B/\$})(1+i_{US})$
		$+B\ (1/S_0^{B/\$})(1+i_{US})E[S_t^{B/\$}]$
	$-B1$	$+B1\times(E[S_t^{B/\$}]/S_0^{B/\$})(1+i_{US})$

investment outcome from THB account

sell THB to buy USD

put in bank account

principal + int

expectation from now regarding exchange rate in future

denominate THB

in equilibrium, must be equal

4.1 International Fisher Effect

- According to the IFE, nominal return measured in the same currency must be identical across the two investments with the same risk. Therefore,

$$(1+i_{TH}) = (E[S_1^{B/\$}]/S_0^{B/\$})\times(1+i_{US})$$

- or

$$E[S_1^{B/\$}]/S_0^{B/\$} = (1+ i_{TH})/(1+i_{US})$$

- If $(1+i_{TH}) < (E[S_1^{B/\$}]/S_0^{B/\$})\times(1+i_{US})$, funds will flow out from THB-account to the USD-account causing $i_{TH}\uparrow$, $i_{US}\downarrow$ and $S_0^{B/\$}\uparrow$. This continues until IFE holds.

4.1 International Fisher Effect

diff in nominal int rate exist
expect Fr to appreciate against USD by 9%
FC
HC
$i_{SW} = 4\%$
$i_{USD} = 13\%$
same risk

- EX: In July, one year interest rates are 4% and 13% on SFr- and USD-deposits in the Eurocurrency market, respectively.
  - If S_0 is \$0.63/SFr, what is $E[S_1]$ in 1 year's time?
    - $E[S_1]$ = \$0.68/SFr
  - If a change in expectation on π_{US} causes $E[S_1]$ to rise to \$0.70/SFr, what should happen to i_{US}?
    - i_{US} should increase relative to i_{SW}.

current spot exchange rate
mkt expects SFr to appreciate ~9%

$$E[S_1^{\$/SFr}] = \frac{1 + i_{US}}{1 + i_{SW}} \times S_0^{\$/SFr}$$

4.1 International Fisher Effect

- The difference in nominal returns between two countries should exactly compensates investors for expected changes in the value of the currency of their investment. Higher nominal return is required from currency whose value is expected to depreciate.

, expects THB to depreciate

- Assume i_{TH} is 5% higher than i_{US}. Investors will be indifferent between investment in $- and B-denominated financial assets if and only if they expect USD to appreciate by approximately 5% against THB in the future when the investment is due.

eg. S = ฿30/$ → $31.5/$

i_{TH} = 8%, i_{US} = 3%

IFE says it doesn't matter whether invest / borrow TH or US

borrow in USD → pay less int rate @ 3%
but lose out in exchange rate

invest in US → invest ฿30/$ → $31.5/$ gain 5%
offset the low int rate i_{US}

4.2 Empirical Evidence

- Summary of findings
  - IFE does not hold very well in the short-run. One explanation is that, for example, an increase in i_{US} could come either from (1) an increase in r_{US} and/or (2) an increase in $E[\pi_{US}]$. The former will cause USD to appreciate, while the latter will cause USD to depreciate.
  - Over an extended period, it appears that interest differential tends to provide an offset to the realized exchange rate change. That is high interest rates currencies tend to depreciate, while low interest rates currency tend to appreciate.

4.3 Application

- Comparing costs of fund denominated in different currencies.
  - A Thai firm is offered one year USD-loan at i_{US} = 5% pa and one year THB-loan at i_{TH} = 9% pa.
    - Which loan is cheaper? Assuming S_0 = B30.0/$ and the firm expects $E[S_1]$ = B30.9/$
    - Apart from minimizing E[i] when borrow money, what else should be taken into consideration?
- Carry Trade
  - Borrow from a currency whose interest rate is low and invest in a currency whose interest rate is higher
    - Assume i_{JP} = 2% pa and i_{AU} = 7% pa.

borrow USD → loss 3% → dollar cost = 8% (still lower)

THB appreciates by C = +3%

will indifferent if C = +4%

$i^{฿}_{US} = \left(\frac{E[S_1^{฿/\$}]}{S_0^{฿/\$}} \times (1+0.05)\right) - 1 = \frac{30.90}{30.00} \times (1.05) - 1 = 8.15\%$

$E[S_1] = 31.2$ ← dollar cost: 9%

~ min ฿30/$ × 1.04

borrow ¥ and pay 2% → convert to AUD → invest in AU and get 7%

* ¥ might appreciate → risk

speculate that ¥ will not appreciate by 5%

bet on JP bond return

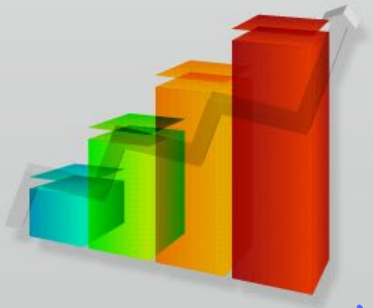
5. Interest Rate Parity

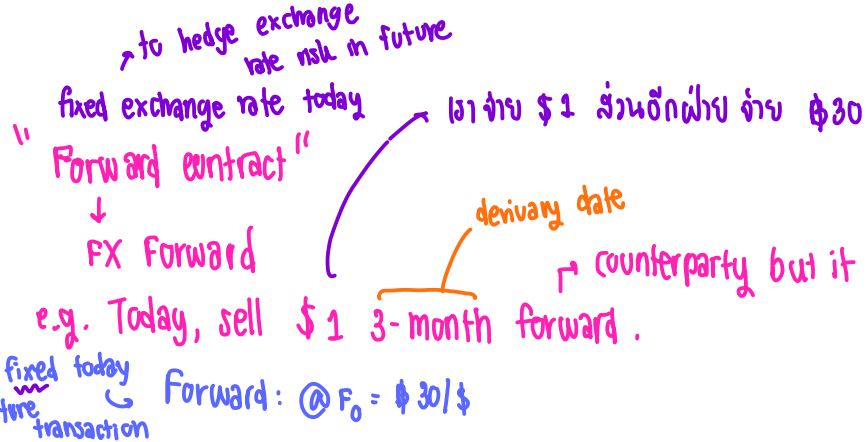
5.1 Interest Rate Parity

5.2 Empirical Evidence

5.3 Forward Rate as an Expected Future Spot Rate

5.4 Applications





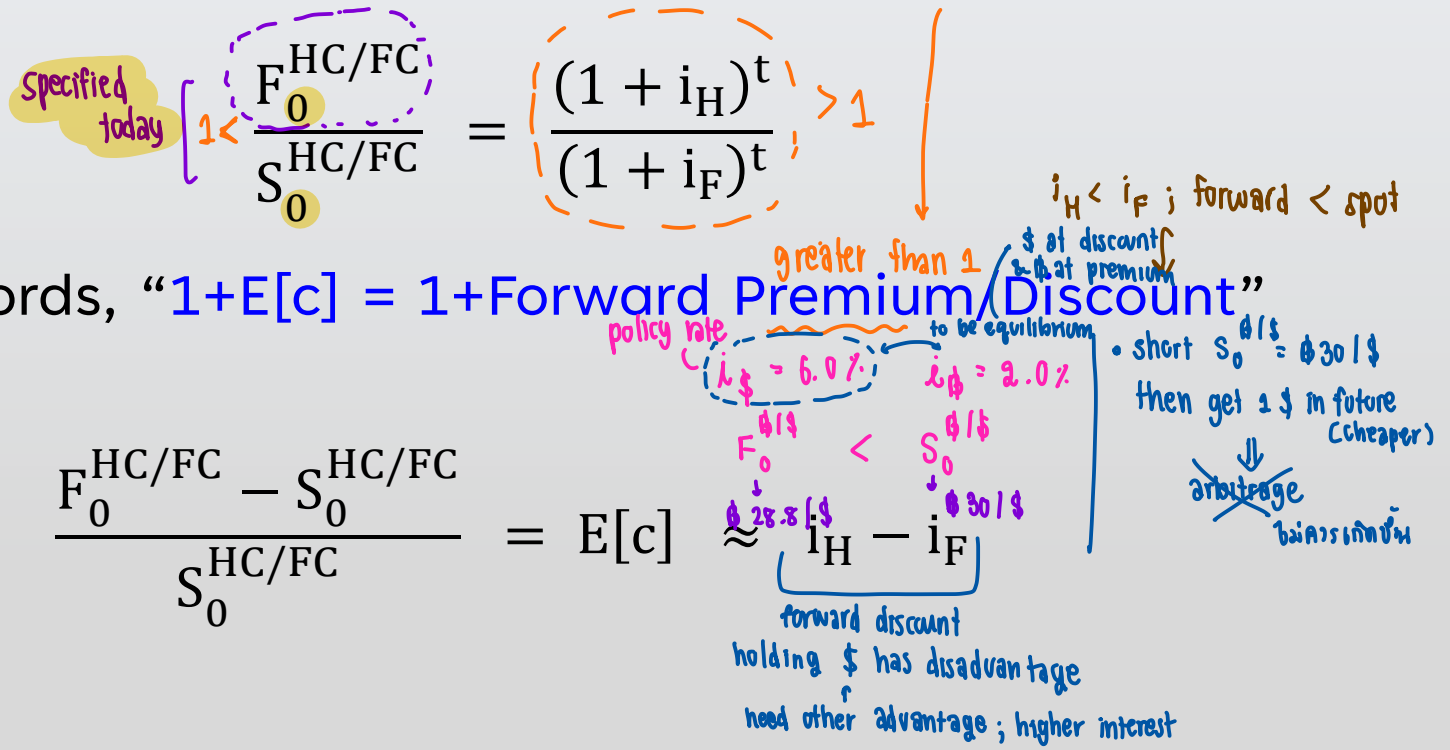
5.1 Interest Rate Parity

- The IRP states that the expected nominal return on a hedged (or covered) foreign investment should be equal to the expected nominal return on domestic investment of identical risk. The IRP is expressed as;

$$\frac{F_0^{HC/FC}}{S_0^{HC/FC}} = \frac{(1+i_H)^t}{(1+i_F)^t}$$

- In other words, "1+E[c] = 1+Forward Premium/Discount"
- If t=1,

$$\frac{F_0^{HC/FC} - S_0^{HC/FC}}{S_0^{HC/FC}} = E[c] \approx i_H - i_F$$



5.1 Interest Rate Parity

- EX: From the example in IFE, now assume the investor could hedge against future exchange rate by selling USD forward at F_0=B29.4/\$. Recall that i_{TH}=5% pa, i_{US}=8% pa, and S_0=B30.0/\$. Starting with B1 investment, expected payoff at the end of the year measured in THB are;
  - THB Investment (HC): B1×(1+0.05) = B1.05
  - USD Investment (FC): \$1/30×(1+0.08)×29.4 = B1.0584
  - This is not an equilibrium situation!!
  - In equilibrium we should expect 2 investments that have identical risk to earn the same expected return measured in a common currency.

HC vs. FC Investments of Identical Risk

Transactions	Cash flows	
	t_0	t_1
THB or HC Investment		
1. Inv B @ i_{TH} pa.	**–B1**	**+B1×(1+i_{TH})**
USD or FC Investment		
1. Convert B to \$ @ $S_0^{B/\$}$	–B 1	
	+\$ $1/S_0^{B/\$}$	
2. Inv. \$ @ i_{US} pa.	–\$ $1/S_0^{B/\$}$	+\$ $(1/S_0^{B/\$})(1+i_{US})$
3. Sell \$ & Buy B Forward @ $F_0^{B/\$}$		–\$ $(1/S_0^{B/\$})(1+i_{US})$
		+B $(1/S_0^{B/\$})(1+i_{US})F_0^{B/\$}$
	–B1	**+B1×($F_0^{B/\$}/S_0^{B/\$}$)(1+$i_{US}$)**

5.1 Interest Rate Parity

- According to the IRP, nominal return measured in the same currency must be identical across the two investments with the same risk. Therefore,

$$(1+i_{TH}) \quad = \quad (F_0^{B/\$}/S_0^{B/\$})\times(1+i_{US})$$

- or

$$F_0^{B/\$}/S_0^{B/\$} \quad = (1+ i_{TH})/(1+i_{US})$$

- If $(1+i_{TH}) < (F_0^{B/\$}/S_0^{B/\$})\times(1+i_{US})$, funds will flow out from THB-account to the USD-account causing $i_{TH}\uparrow$, $i_{US}\downarrow$, $S_0^{B/\$}\uparrow$, and $F_0^{B/\$}\downarrow$. The change in $F_0^{B/\$}$ is due to the hedging demand. This continues until IFE holds.

5.1 Interest Rate Parity

need to convert to period

- EX: If the spot exchange rate is SFr1.4800/$, a 90-day deposit rate for SFr is 4.00% and for $ is 8.00% pa. Find the appropriate 90-day forward rate for SFr/$.

S_0 = SFr 1.4800 / $

i_{SFr} = 4% pa. → 1% per 90 days

$i_{\$}$ = 8% pa. → 2% per n — n

→ holding $ gives interest advantage

↓ must be traded at forward discount

i_{SFr} = 8% pa → 2% per 90-day

$i_{\$}$ = 4% pa → 1% per 90-day

$F_0 = 1.4800 \times \frac{1+0.02}{1+0.01} = 1.4946$

$F_0 = 1.48 \times \frac{1.01}{1.02} = 1.465$ SFr / $

$(1+i_H)^t$ / $(1+i_F)^t$

{ $ is at forward premium

buy $ spot & sell forward

give up 8% pa (SFr rate) to buy $ today → get only 4% pa (US rate)

$: HC

£ : FC

bank use this the most to calculate forward rate

ถ้าต่างจาก IRP customers can make profit against bank

5.1 Interest Rate Parity

- EX: (Covered Interest Arbitrage) $- and £-deposit rates ($i_{US}$ and i_{UK}) are 8.15% and 11.56% pa, respectively. The spot rate (S_0) is \$1.25/£ and the one-year forward rate (F_0) is \$1.20/£. Is there an arbitrage opportunity?

assume 1-yr

check $\frac{F_0^{\$/£}}{S^{\$/£}} = \frac{(1+i_H)^t}{(1+i_F)^t}$

  - IRP condition is violated.

RHS too high relative to $\frac{F_0^{\$/£}}{S_0^{\$/£}}$ (i_{US} ↓ $i_{£}$ ↑)

not equal ⇒ can make arbitrage profit against bank

$$\frac{1+i_{US}}{1+i_{UK}} = \frac{1+0.0815}{1+0.1156} = 0.9694 \quad \textbf{and} \quad \frac{F_0^{\$/£}}{S_0^{\$/£}} = \frac{1.20}{1.25} = 0.9600$$

not absolute high, too low relative to $\frac{F_0}{S_0}$ ↳ this should drop to meet equilibrium; if fix

  - i_{US} is relatively too high compared to i_{UK}. To undertake the arbitrage, (1) borrow £, (2) sell £ for at S_0, (3) invest the proceed in \$-denominated deposit, and (4) hedge the £–value of the \$-deposit by buying £ forward.

↳ borrow at i_{UK} (FC) too low and invest at i_{US} (HC) too high

Covered Interest Arbitrage

Transactions	Cash flows	
	t_0	t_1
1. Borrow £1 @ i_{UK}=11.56%	+£ 1	–£ 1(1+0.1156)
2. Sell £ for \$ at S_0=\$1.25/£	–£ 1	
	+\$ 1×1.25	
3. Invest \$ @ i_{US}=8.15%	–\$ 1.25	+\$ 1.25(1+0.0815)
4. Buy £ & Sell \$ Forward @ F_0=\$1.20/£		–\$ 1.25(1+0.0815)
		+£ 1.25(1+0.0815)/1.20
	–B0	+£ 0.010963

spot transaction

trade at spot! no future obligation

need another ④ forward transaction to hedge risk risk of buying & back in future to payback debt

still need to pay & debt

no transaction now → future obligation <deliver \$ from ③>

don't use your money at all

know at time 0 & is fixed

arbitrage profit

bank will lose out → need to check for IRP

* may happens when do transaction with more than 1 bank

difficult bcs bid-ask spread

institutional who has lowest cost can do this

5.1 Interest Rate Parity

- This covered interest arbitrage strategy creates an arbitrage profit of £0.010963 at t_1 for every £1 borrowed at time 0 (or £10,9625 for every £1m.)
- In $ terms, the arbitrage profit is $0.013155 at time 1 for every £1 borrowed at time 0.

- The arbitrage will drive $i_{US}\downarrow$, $i_{UK}\uparrow$, $S_0^{\$/£}\downarrow$ and $F_0^{\$/£}\uparrow$ until IRP holds.

5.1 Interest Rate Parity

- The forward premium or discount in exchange rate is determined by the nominal return differential between the two currencies.
- A currency with lower interest rate is traded at forward premium relative to a currency with higher interest rate. by 2%
- EX: If interest rate in for $ and ¥ (i_{US} and i_{JP}) are 5% and 3% pa, respectively. What is the one-year forward ¥/$ exchange rate? Assume S = ¥100/$.

$i_{US} > i_{JP}$

trade $ at "forward" discount about 2%.

$$F_0^{¥/\$} = ¥100/\$ \times \frac{(1+3\%)}{(1+5\%)} = ¥98.09/\$$$

discount 2%.

≈ ¥98/$

unlike IFE, need expectation

no expectation at all

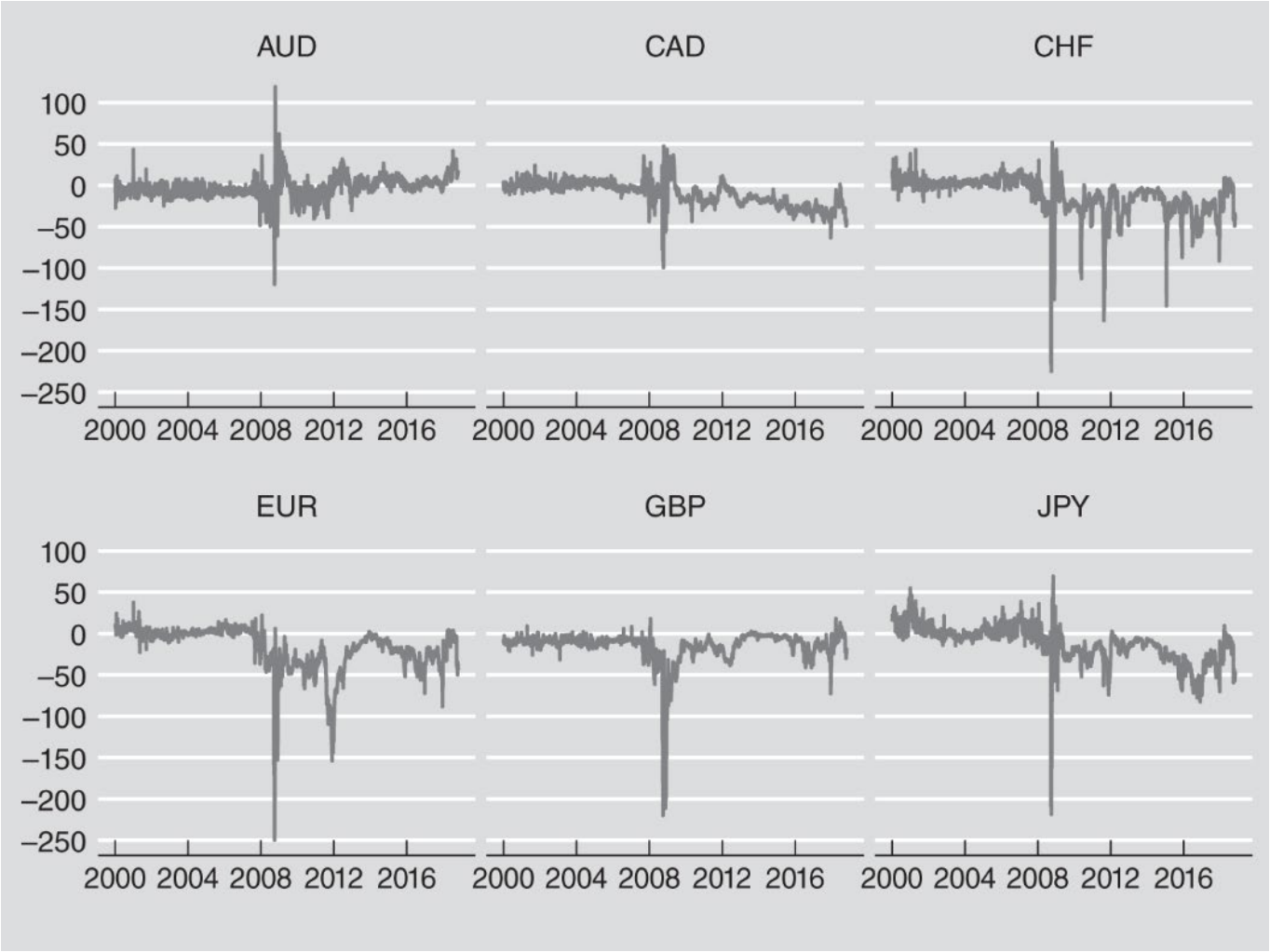
all price of financial assets → low transaction cost

always correct

5.2 Empirical Evidence

- IRP condition has been found to hold relatively well in empirical studies after taking transaction costs into account.
  - The forward rate normally moves within its transaction cost bands. Arbitrage opportunities were rare.
  - For longer-date forwards (i.e., cross currency and interest swap), the no-arbitrage bands are wider and arbitrage opportunities were found more often.
  - IRP may fail to hold because, arbitragers may be uncertain whether they can conduct transactions at the posted prices. Forward position involve default risk.

ST Interbank Rate Deviations from Covered Interest Parity



Based on IRP, the difference between nominal interest differentials and forward premium should be zero. Note the unit on the Y-axis is basis point.

5.3 Forward Rate as an Expected Future Spot Rate

- Does the forward exchange rate reflect market expectation about the future spot rate?
- The idea that the forward exchange rate is an unbiased estimator of the future spot exchange rate can be expressed as;

$$F_0^{HC/FC} = E[S_t^{HC/FC}]$$

  - t is the delivery date of the forward contract.

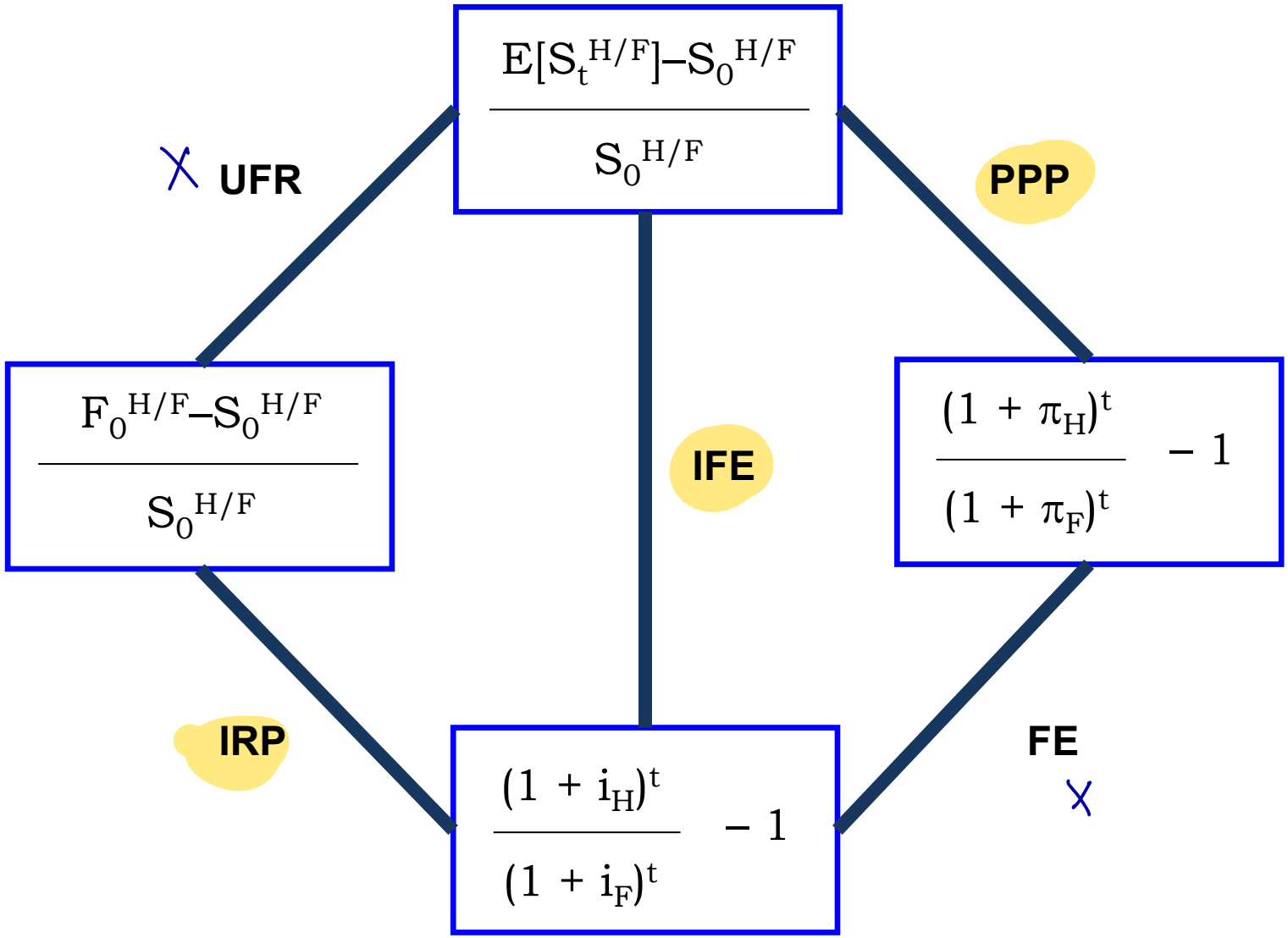
5.3 Forward Rate as an Expected Future Spot Rate

- The drawback of this conclusion is that it relies on the assumption that investors are risk neutral.
- If $F_0^{HC/FC} > E[S_t^{HC/FC}]$, speculators will sell FC forward and wait to buy the FC later in the spot market in the future. This will pressurize $F_0^{HC/FC}\downarrow$.
- If $F_0^{HC/FC} < E[S_t^{HC/FC}]$, speculators will buy FC forward and wait to sell the FC later in the spot market in the future. This will push $F_0^{HC/FC}\uparrow$.
- The equilibrium is achieved when $F_0 = E[S_t]$.
- However, it is found that this condition rarely holds, probably because market participants are risk averse.

5.4 Applications

- IRP has been applied by foreign exchange dealers and banks in determining appropriate forward rated they will quote to their clients.
- Departure from IRP will result in the bank being arbitraged against.

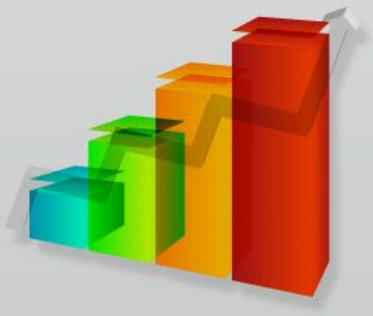
Summary


$\frac{E[S_t^{H/F}] - S_0^{H/F}}{S_0^{H/F}}$
UFR
PPP
$\frac{F_0^{H/F} - S_0^{H/F}}{S_0^{H/F}}$
IFE
$\frac{(1 + \pi_H)^t}{(1 + \pi_F)^t} - 1$
IRP
FE
$\frac{(1 + i_H)^t}{(1 + i_F)^t} - 1$

6. Exchange Rate Forecasting

6.1 Forecasting Approach

6.2 Model Evaluation



6.1 Forecasting Approach

- In a fixed rate system, analysts usually focus on a government's decision-making structure. First, determine whether there is pressure on a currency to devalue or revalue. Then, determine how long the government will persist with this particular level of disequilibrium.
- Forecast approaches
  - Market-based Forecasts assume that the current market prices, i.e., F_0 and i_0, already incorporate market's $E[S_T]$.
  - Model-based Forecasts include 1) Fundamental Analysis, such as PPP or more complicated models and 2)Technical Analysis

6.2 Model Evaluation

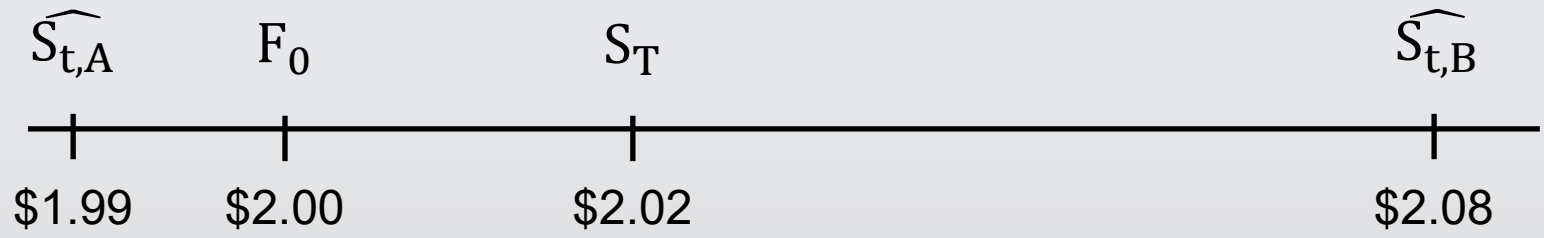
- forecasting performance of a model can be evaluated in 2 aspects: accuracy and usefulness.
- Forecasting accuracy can be measured by examining forecast error (e_t)

$$e_{i,t} = \frac{S_{i,t} - \widehat{S_{i,t}}}{S_{i,t}}$$

  - Where $S_{i,t}$ is the actual spot rate on currency i at time t and $\widehat{S_{i,t}}$ is the forecasted spot rate.
  - Then, mean absolute errors ($\frac{1}{T}\sum_{t=1}^{T}|e_{i,t}|$) or mean square errors ($\frac{1}{T}\sum_{t=1}^{T} e_{i,t}^2$) can be used to summarize the accuracy of a model .

6.2 Model Evaluation

- The follow figure shows the forward rate, spot rates from two alternative forecasts and the actual spot rate realized in the future. HC=USD and FC=GBP.



- Model A is more accurate, but Model B anticipates the direction of exchange rate movement correctly.
- Which model is more useful?