

International Parity Condition



Yohanes Jimmy

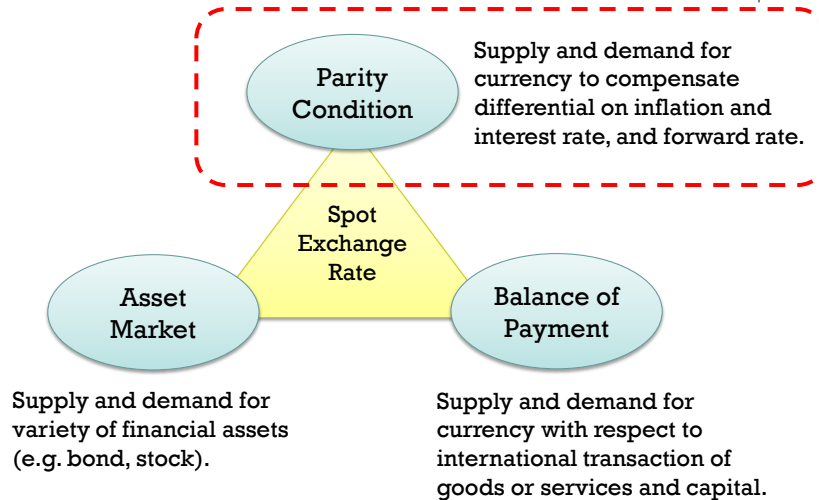


Agenda

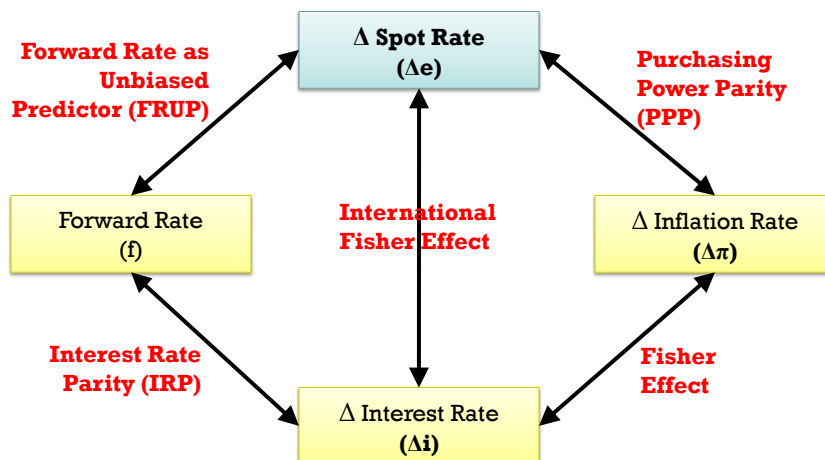
- ◉ Purchasing Power Parity
- ◉ Fisher Effect and International Fisher Effect
- ◉ Forward Rate as Unbiased Predictor
- ◉ Interest Rate Parity
- ◉ International Parity Condition



Determinant of Exchange Rate



IPC Framework





Part-I

Purchasing Power Parity (PPP)



Purchasing Power Parity (PPP)

- ⊙ PPP exists if:
 - currencies of two countries has similar purchasing power in their each country
 - exchange rate is in a equilibrium
- ⊙ Formula for Absolute PPP:

$$e_{f/h} = \frac{P_h}{P_f}$$

Appropriate Conditions:

- ☐ No restrictions (tax, tariff, blocking, etc)
- ☐ No transportation cost (move goods to another place)
- ☐ No transaction cost (cost to carry on a transaction)
- ☐ No market power (perfect competition)



Illustration-1

- ⊙ A tools kit in Jakarta worth IDR 45,000.

USD/IDR = 9,000

- PPP exists if:

$$e_{\$/\text{IDR}} = \frac{P_h}{P_f} \rightarrow 9,000 = \frac{45,000}{P_f} \rightarrow P_f = \text{USD } 5.00$$

- The existence of PPP:

$$\frac{P_h}{P_f} \cdot \frac{1}{e_{\$/\text{IDR}}} = 1 \rightarrow \frac{45,000}{5} \cdot \frac{1}{9,000} = 1$$

Equilibrium
(PPP exists)



Illustration-2

- ⊙ What happen if tool kit's price in Jakarta = IDR 50,000 (exchange rate remains = 9,000)?

- Arbitrage behavior → people buy tool kits in New York, and sell them in Jakarta

- ⊙ What happen next?

- The tool kit's price in New York raise, while in Jakarta falls, and/or
- USD will be appreciated compare to IDR

Illustration-3



- ◉ If both price of tool kits in Jakarta and New York do not change, what should the exchange rate be?

- Actual exchange rate :

$$e_{\text{USD/IDR}} = 9,000$$

- Implied rate: $e_{\text{f/h}} = \frac{50,000}{5}$

$$\rightarrow e_{\text{USD/IDR}} = 10,000$$

- ◉ Recent time, PPP does not exists:

$$\frac{P_h}{P_f} \cdot \frac{1}{e_{\text{f/h}}} = \frac{50,000}{5} \cdot \frac{1}{9,000} = 1.11$$

Recent time, IDR is
overvalued
compare to USD

Conclusion for Absolute PPP

(Price rises → Currency depreciates)



If price in Indonesia rises (compare to US)



IDR is overvalued
compare to USD



In the long-run:

- ◉ IDR will **depreciate**, or
- ◉ USD will **appreciate**

If price in Indonesia falls (compare to US)



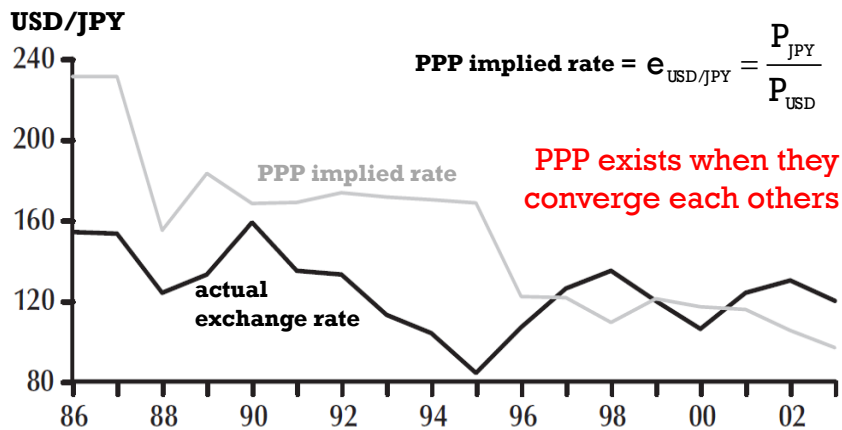
IDR is undervalued
compare to USD



In the long-run:

- ◉ IDR will **appreciate**, or
- ◉ USD will **depreciate**

Example: Absolute PPP



Measuring Absolute PPP



- ◉ The most consideration to measure absolute PPP is the selection the basket of goods and services (not single product)
- ◉ It must be:
 - Products and services are common
 - Sold in every country
- ◉ Indicators used commonly now are PWT and Big Mac Index

PWT and Big Mac Index 2000 (Based on USD)



Country	PWT	Big Mac
Thailand	30	58
Malaysia	41	47
Singapore	80	75
Indonesia	18	73
Hong Kong	86	52
China	23	48
Japan	145	111
Denmark	107	123
Argentina	66	100
Britain	98	120
South Korea	65	108

- ◉ PWT, designed by United Nation, comprises about 150 product and service categories.
- ◉ Big Mac Index introduced in September 1986 by Pam Woodall for semi-humorous illustration.
- ◉ It became famous as its simplicity, and known as informal version of PWT.
- ◉ Big Mac now sold in more than 120 countries.
- ◉ The correlation of PWT and Big Mac Index 2000 is 0.73.

Relative PPP



- ◉ **Relative PPP**: exchange rate will be related to the changes in price level in two countries
 - **Absolute PPP**: exchange rate will be related to the price of a basket of goods in two countries
- ◉ RPPP usually compares changes of CPI (i.e. inflation rate) in each country.

$$\% \Delta e_{th} = \% \Delta P_h - \% \Delta P_f$$

or

$$\% \Delta P_h - \% \Delta P_f - \% \Delta e_{th} = 0$$

Equilibrium
(PPP exists)

Consumer Price Indices (CPI)



- ◉ Food stuff
- ◉ Prepared food, soft drink, cigarette, and tobacco
- ◉ Housing, water, electricity, gas, and fuel
- ◉ Clothing
- ◉ Health
- ◉ Education, recreation, and sport
- ◉ Transportation and communication

Example: Relative PPP



Country	CPI 2006	CPI 2007	Δ CPI	% Δ CPI
Indonesia	100	106	6	6.0%
US	100	104	4	4.0%

- Inflation rate in Indonesia = 6.0%
- Inflation rate in US = 4.0%
- ◉ $\% \Delta e_{\text{USD/IDR}} = 6.0\% - 4.0\% = +2.0\%$
- ◉ In the long-run, **USD will be appreciated by 2% per year** compare to IDR.

Usage of Relative PPP



- The example above is conceptually wrong!
- We used past inflation rate to predict future exchange rate.
- We should use **expected inflation rate**, i.e. inflation rate that is predicted by market participants or regulators
- The relative version of PPP is used more commonly now.

Conclusion: Relative PPP

(Higher inflation → Currency depreciate)



If Indonesia expected
inflation rate is higher
than US



IDR is overvalued
compare to USD



In the long-run:

- **IDR will depreciate**, or
- **USD will appreciate**

If Indonesia expected
inflation rate is lower
than US



IDR is undervalued
compare to USD



In the long-run:

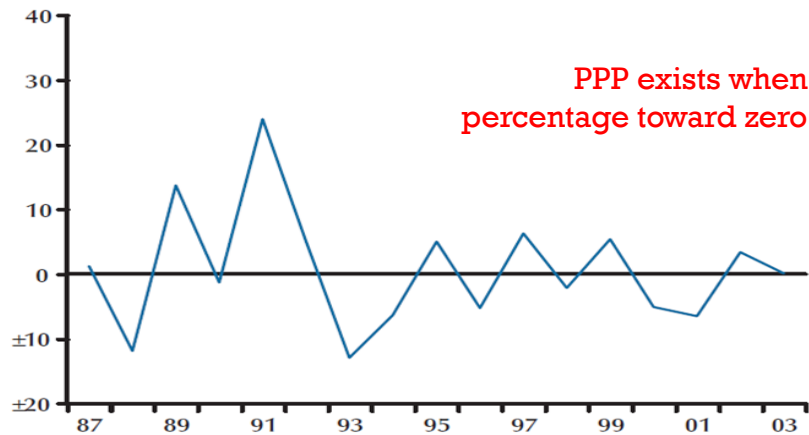
- **IDR will appreciate**, or
- **USD will depreciate**

Example: Relative PPP

GBP/USD



$$\% \Delta P_h - \% \Delta P_f - \% \Delta e_{f/h}$$

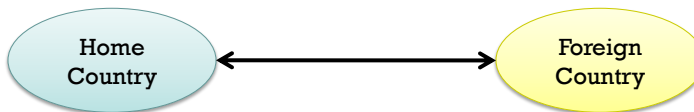


Other Formula of Relative PPP



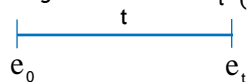
inflation rate = π_h

inflation rate = π_f



Spot exchange rate at the beginning

Spot exchange rate in period "t" (future)



$$e_t = e_0 \cdot \frac{(1 + \pi_h)^t}{(1 + \pi_f)^t} \quad \xrightarrow{\text{If } t = 1} \quad e_1 = e_0 \cdot \frac{1 + \pi_h}{1 + \pi_f}$$

Exercise-1



At the 1990s, Argentina employed the fixed currency system to USD ($\text{USD/ARS} = 1.0000$). At Jan 2002, USD/ARS started to fluctuate, and at the end of year, it became 3.2000. During 2002, inflation in Argentina and US are 20% and 2.2% respectively.

- a. What is the appreciation or depreciation of Argentina Peso (ARS) compare to USD?
- b. If PPP exists, what should the USD/ARS be in the end of 2002?

Exercise-2



Assume US and UK has only one product, i.e. wheat. The price/kg in US and UK are \$3.25 and £2.05, respectively.

- a. What is the PPP implied exchange rate?
- b. One time, US government applies additional tariff of \$0.5/kg for wheat imported from UK. What is the appreciation or depreciation of USD compare to GBP?

Exercise-3



Assume, 2006's composite price index (CPI) in US and Japan are 100. Three years later, the CPI are 104 (US) and 110 (Japan).

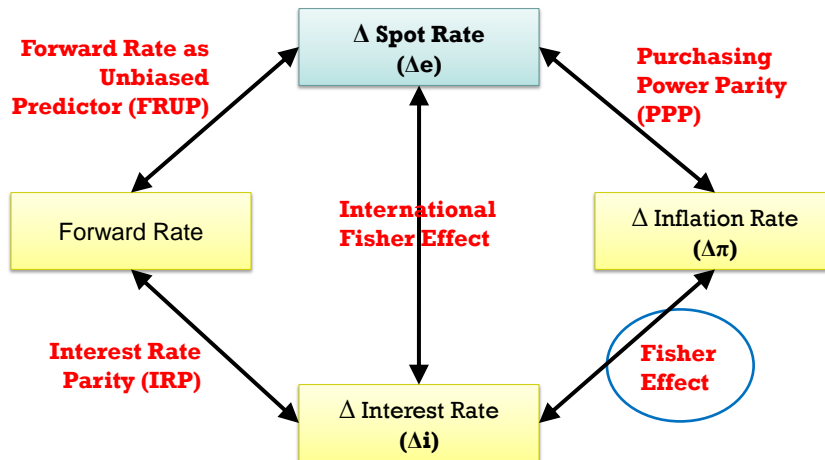
- a. If in 2006 the JPY/USD = 0.008431, what is the spot rate in 2009? Use two kinds of formula, and compare the results.
- b. The actual JPY/USD in 2009 is 0.09125. Is JPY overvalued or undervalued according PPP?
- c. Calculate, how much (in %) is JPY undervalued or overvalued compare to USD?

Part-II

Fisher Effect and International Fisher Effect



IPC Framework



Fisher Effect



- ◉ Fisher Effect (Fischer Hypothesis) states that nominal interest rate (i) in each country are equal to the required real rate of return (r) plus compensation for expected inflation (π)

$$i = r + \pi + r \cdot \pi \quad \text{or} \quad i \approx r + \pi$$

- ◉ In other word, we can say: $r \approx i - \pi$
 - **Investment:** our real return is equal to nominal interest rate that is adjusted by inflation
 - **Borrowing:** our real cost of borrowing is equal to nominal interest rate that is adjusted by inflation
- ◉ Real interest rate relates to our purchasing power

Illustration: Investment



We have IDR 1,000,000

- ⊙ Now
 - Goods price @ IDR 100 → if we buy them, we get 10,000 pieces
 - Now we invest that money at 10% p.a.
- ⊙ One year later
 - We get our money + interest → we get IDR 1,100,000
 - Inflation rate = 6% → goods price = @IDR 106
 - Buy products @ IDR 106 → we get 10,377 pieces
- ⊙ We get 10,377 pieces instead of 11,000 pieces. The reduction of 623 pieces is called **Fisher Effect**.

Illustration: Borrowing



We borrow IDR 1,000,000 at interest rate of 10% p.a.

- ⊙ Now:
 - Buy products now @ IDR 100 → we get 10,000 pieces
- ⊙ One year later:
 - Inflation rate = 6% → goods price = @ IDR 106
 - Sell 10,000 pieces at IDR 106 → we get IDR 1,060,000
 - We have to pay loan + interest → we pay IDR 1,100,000
- ⊙ The real cost of borrowing is 4% (IDR 40,000) instead of 10% (IDR 100,000). The reduction of IDR 60,000 is called **Fisher Effect**.

FE and GFE



- ◉ **FE in a country**: increasing of inflation rate in a country will be accompanied by increasing of its nominal interest rate (or vice versa), and thus **maintain relatively similar real interest rate** (during certain period)
- ◉ **FE across countries (GFE)**: capital will flow from country with lower real interest rate to country with higher real interest rate, thus **real interest rate between two countries are equalized** (during certain period)

$$\Delta i = \Delta \pi$$

FE in Indonesia

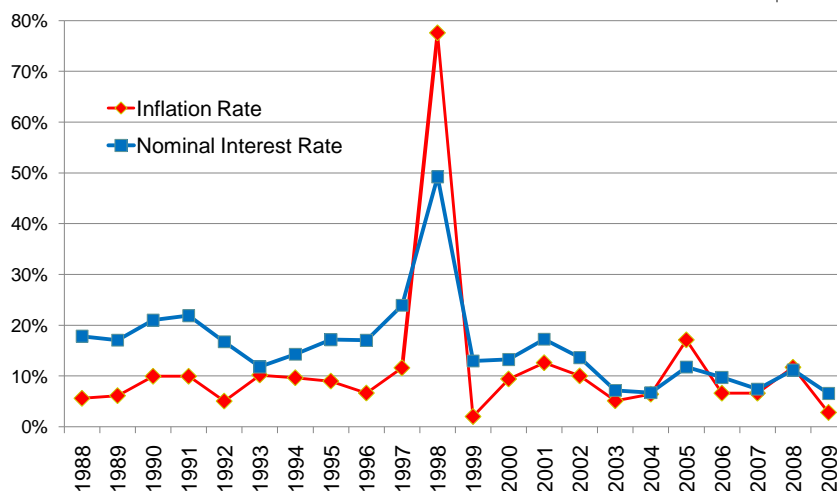


Illustration: GFE

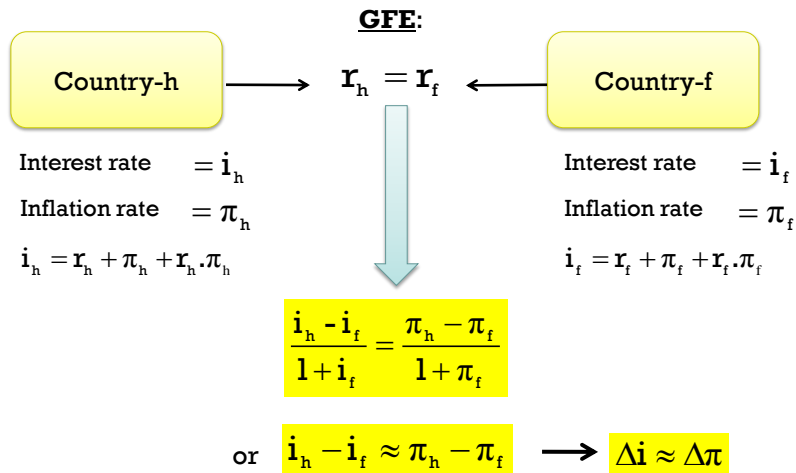


Illustration: Reaching Equilibrium



Country-h			Capital	Country-f		
i_h	π_h	r_h	GFE:	i_f	π_f	r_f
8.0%	5.0%	3.0%	$r_h > r_f$	4.0%	2.5%	1.5%
7.0%	5.0%	2.0%	$r_h > r_f$	4.0%	2.5%	1.5%
7.0%	5.2%	1.8%	$r_h = r_f$	4.3%	2.5%	1.8%

FE and GFE Comparison



FE

$\Delta i = \Delta \pi$ → In one country

Changes in nominal interest rate will be accompanied by changes in inflation rate, so that:

Real interest rate relatively unchanged

Nominal interest rate should be higher than inflation rate

GFE

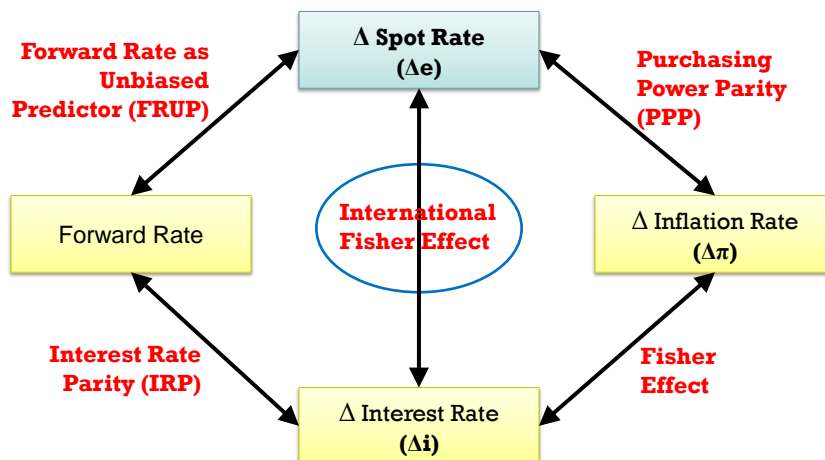
$\Delta i = \Delta \pi$ → Across countries

Difference of nominal interest rate across countries will be equal with difference of their inflation rate, so that:

Real interest rate across countries are equalized

Country with higher interest rate has higher inflation rate

IPC Framework



International Fisher Effect



GFE:	$i_h - i_f \approx \pi_h - \pi_f$	Difference of interest rate will be equal with difference of inflation rate.
Relative PPP:	$\% \Delta e_{f/h} = \pi_h - \pi_f$	Currency with lower inflation rate will be appreciated
IFE:	$\% \Delta e_{f/h} \approx i_h - i_f$	Currency with lower interest rate will be appreciated
Full formula	$\% \Delta e_{f/h} = \frac{e_t - e_0}{e_0} = \frac{i_h - i_f}{1 + i_f}$	Spot exchange rate should change in an equal amount to the difference in interest rate between two countries

Exercise-4



- Explain the fundamental differences between:
 - (a) GFE and IFE, (b) IFE and PPP
- Give example of Fisher Effect in practice.
- Your salary at the end of 2008 was IDR 5 million, while at the end of 2009 was IDR 5.2 million. If Indonesia inflation rate in 2009 was 3.8%. What is the increasing or decreasing of your purchasing power?
- In financial crisis 2008, Indonesia inflation rate was 12%. This condition made your business suffered a stable revenue growth. If you expected to increase your real wealth by 3% in 2008, how much cost efficiency should you make in that current business?

Exercise-5



In the beginning of 2009, interest rate in Indonesia and Australia are 9% and 5% respectively. The expected inflation rate during 2009 are 6% in Indonesia and 4% in Australia.

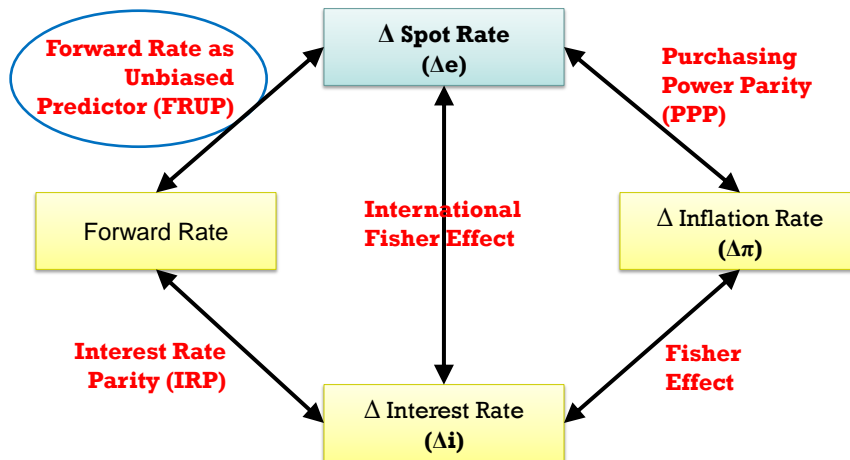
- a. What is the movement of Indonesia interest rate in the end of 2009?
- b. If $\text{AUD/IDR} = 9,500$ in the beginning of 2009, can you predict what is the AUD/IDR going to be in the end of year?



Part-III

Forward Rate as Unbiased Predictor (FRUP)

IPC Framework



FRUP (Unbiased Predictor)

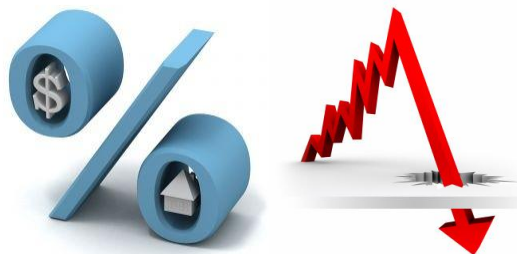


- In efficient market and no intervention, today forward rate will reflect the future spot rate.
- Actually, it is less likely to happen.
- What is the meaning of **UNBIASED PREDICTOR**?
 - It doesn't mean no deviation (100% accurate) between today forward rate and future spot rate.
 - Actual future spot rate may deviate around the forward rate. It is up or down with the same probability.
 - If any deviations in one period, forward rate will be corrected (adjusted) in the next period.
- Theoretically, forward rate is an expectation of market participants about how spot rate in the future will be.

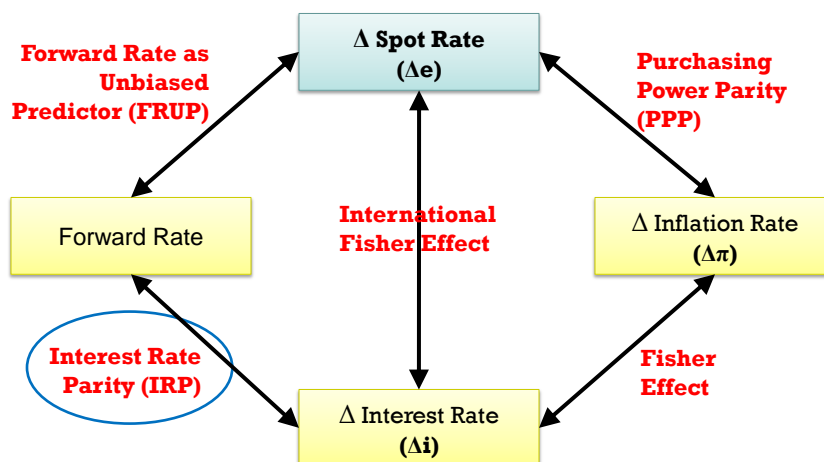


Part-IV

Interest Rate Parity (IRP)



IPC Framework



Introduction



IFE	$\% \Delta e_{t/h} = \frac{e_t - e_0}{e_0} = \frac{i_h - i_f}{1 + i_f}$	Spot exchange rate should change in an equal amount to the difference in interest rate between two countries
FRUP	$\text{Forward rate} = E(e_t)$	Forward rate is an unbiased predictor of spot rate in the future
IRP	$\% f_{t/h} = \frac{f - e_0}{e_0} = \frac{i_h - i_f}{1 + i_f}$	Forward rate in percentage quotation
IRP	$f_{t/h} = e_0 \frac{1 + i_h}{1 + i_f}$	Forward rate in outright quotation
IRP	$f_{t/h} = e_0 \frac{1 + \left[i_h \cdot \frac{n}{360} \right]}{1 + \left[i_f \cdot \frac{n}{360} \right]}$	Forward rate for n-days in outright quotation

Interest Rate Parity (IRP)



- Forward rate is formed by the difference of interest rate between two countries.

$$\% f_{t/h} = \frac{i_h - i_f}{1 + i_f} \quad \longrightarrow \quad \% f_{t/h} \approx i_h - i_f$$

Simplification

- Example:

- Indonesia interest rate = 6% p.a.
 - Singapore interest rate = 4% p.a.
- } $\% f_{\text{SGD/IDR}} = 6\% - 4\% = +2\%$

- IRP:** currency with lower interest rate should be traded at premium in forward market

IRP Illustration: Investment



- Interest rate in USD and CHF money market are 8% p.a. and 4% p.a. respectively. If we have CHF 1 million and spot rate USD/CHF = 1.4800, where is the **preferable money market to invest** for the next 3 months?

$$\begin{aligned} i_{\text{CHF}} &= 4.00\% \text{ p.a.} \\ i_{\text{USD}} &= 8.00\% \text{ p.a.} \end{aligned}$$

$$i_{\text{CHF}} - i_{\text{USD}} = -4.00\% \text{ p.a.}$$

$$f_{\text{USD/CHF}} = 1.4800 \times \frac{1 + 1.00\%}{1 + 2.00\%} = 1.4655$$

$$\%f_{\text{USD/CHF}} = \frac{1.4655 - 1.4800}{1.4800} \times \frac{360}{90} = -3.92\% \text{ p.a.}$$

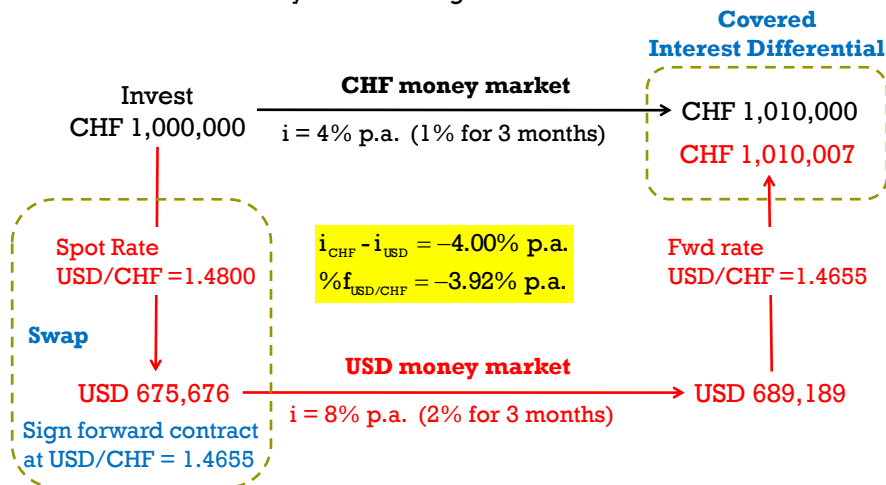
**Covered
interest
differential**

IRP Illustration: Investment



CHOICE:

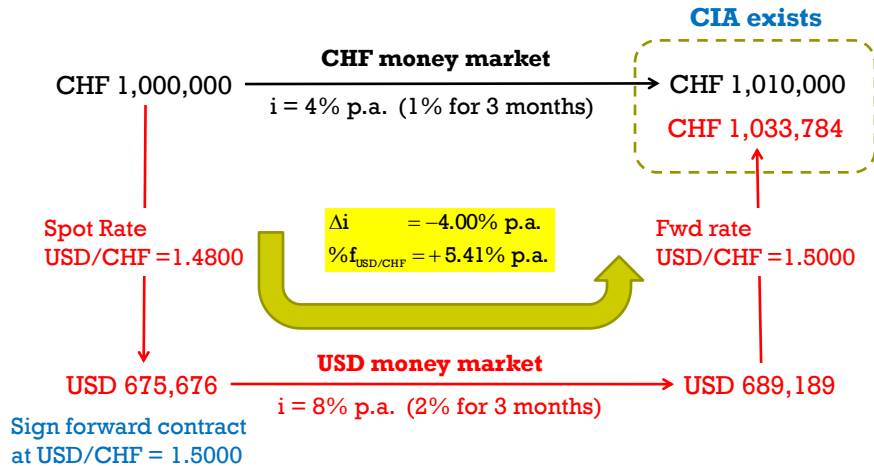
- Invest in CHF money market, or
- Invest in USD money market + sign forward



Covered Interest Arbitrage (CIA)



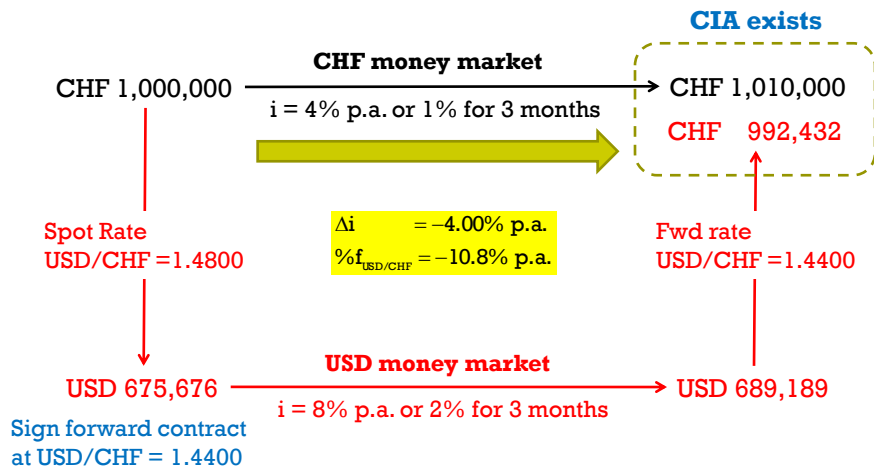
If 3-months forward USD/CHF = 1.5000



Covered Interest Arbitrage (CIA)



If 3-months forward USD/CHF = 1.4400



IRP Illustration: Borrowing



- Interest rate in USD and CHF money market are 8% p.a. and 4% p.a. respectively. If we need CHF 1 million and spot rate USD/CHF = 1.4800, where is the **preferable money market to borrow** for the next 3 months?

$$\begin{aligned} i_{\text{CHF}} &= 4.00\% \text{ p.a.} \\ i_{\text{USD}} &= 8.00\% \text{ p.a.} \end{aligned}$$

$$i_{\text{CHF}} - i_{\text{USD}} = -4.00\% \text{ p.a.}$$

$$f_{\text{USD/CHF}} = 1.4800 \times \frac{1 + 1.00\%}{1 + 2.00\%} = 1.4655$$

$$\%f_{\text{USD/CHF}} = \frac{1.4655 - 1.4800}{1.4800} \times \frac{360}{90} = -3.92\% \text{ p.a.}$$

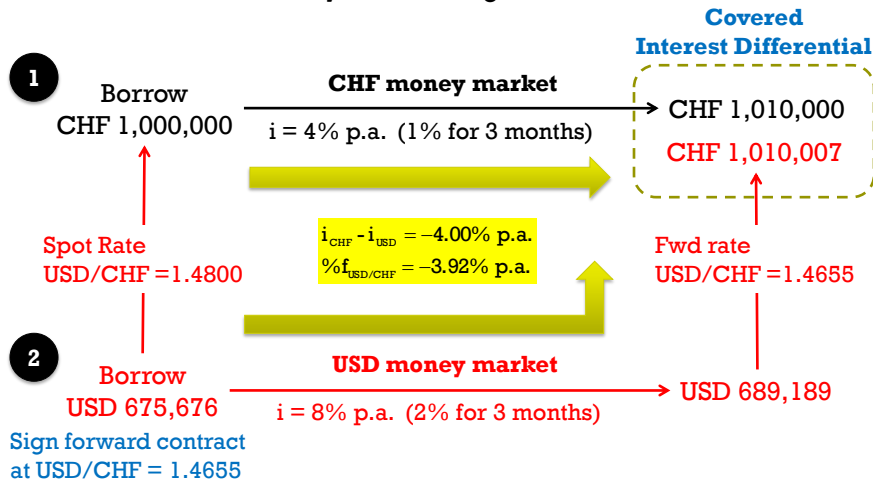
**Covered
interest
differential**

IRP Illustration: Borrowing



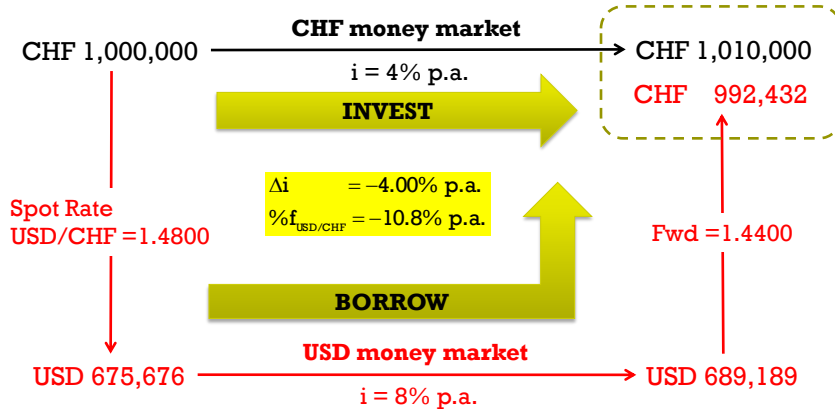
CHOICE:

- Borrow in CHF money market, or
- Borrow in USD money market + sign forward

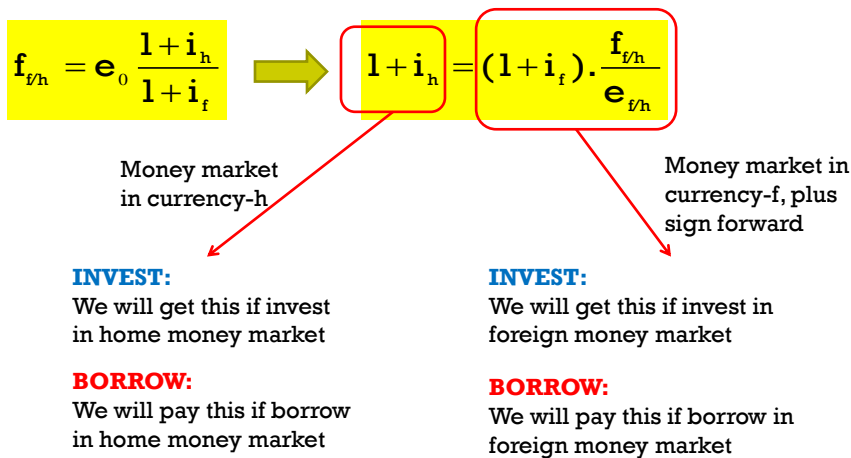


Investing and Borrowing

Spot rate USD/CHF = 1.4800 $i_{CHF} = 4\%$ p.a.
 3-months forward USD/CHF = 1.4400 $i_{USD} = 8\%$ p.a.



Guidance



Guidance



CONDITION	INVEST	BORROW
$1 + i_h > (1 + i_f) \cdot \frac{f_{t/h}}{e_{t/h}}$	Home Money Market	Foreign Money Market (plus forward)
$1 + i_h < (1 + i_f) \cdot \frac{f_{t/h}}{e_{t/h}}$	Foreign Money Market (plus forward)	Home Money Market
$1 + i_h = (1 + i_f) \cdot \frac{f_{t/h}}{e_{t/h}}$	INTEREST RATE PARITY HOLDS	

Example-1



$$i_{\text{USD}} = 8.00\% \text{ p.a.} \Rightarrow i_{\text{USD}} = 8.00\% \times \frac{90}{360} = 2.00\% \text{ for 3 months}$$

$$i_{\text{CHF}} = 4.00\% \text{ p.a.} \Rightarrow i_{\text{CHF}} = 4.00\% \times \frac{90}{360} = 1.00\% \text{ for 3 months}$$

Spot exchange rate USD/CHF = 1.4800

3-months forward USD/CHF = 1.4400

$$(1 + i_{\text{CHF}}) = 1 + 1\% = 1.01$$

$$(1 + i_{\text{USD}}) \cdot \frac{f_{\text{USD/CHF}}}{e_{\text{USD/CHF}}} = (1 + 2\%) \cdot \frac{1.4400}{1.4800} = 0.9924$$

→ Invest : in CHF money market (we get 1.01)

→ Borrow : in USD money market (we pay 0.9924)

Example-2

AR = USD 100,000 in the next 6 months



Forward market			Money market		
	Bid	Ask	Interest Rate	IDR	USD
Spot USD/IDR	9,300	9,600	Loan rate	10%	4.0%
180-day forward	3.0%	6.0%	Deposit rate	6.0%	2.0%

$$f_{\text{USD/IDR}} = 3\%$$

$$i_{\text{IDR}} - i_{\text{USD}} = 6\% - 4\% = 2\%$$

- Which instrument is more preferable to hedge our AR ?
- What is USD loan rate so that IRP holds?

Example-3

AP = USD 100,000 in the next 6 months



Forward market			Money market		
	Bid	Ask	Interest Rate	IDR	USD
Spot USD/IDR	9,300	9,600	Loan rate	10%	4.0%
180-day forward	3.0%	6.0%	Deposit rate	6.0%	2.0%

$$f_{\text{USD/IDR}} = 6\%$$

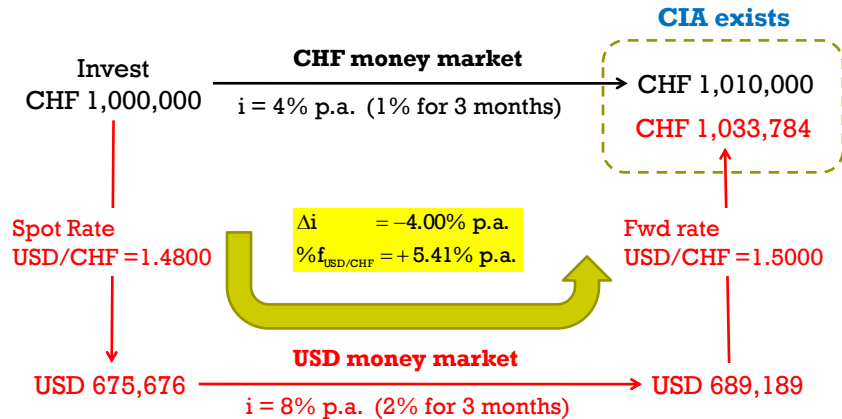
$$i_{\text{IDR}} - i_{\text{USD}} = 10\% - 2\% = 8\%$$

- Which instrument is more preferable to hedge our AR ?
- What is IDR loan rate so that IRP holds?

Covered Interest Arbitrage



If 3-months forward USD/CHF = 1.5000

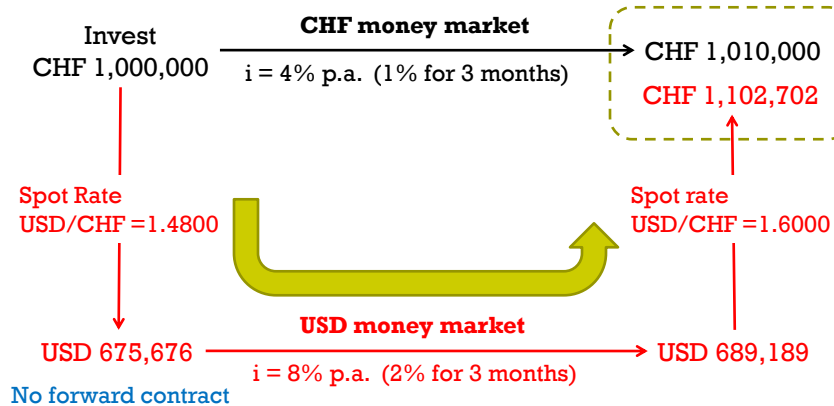


Uncovered Interest Arbitrage



3-months forward USD/CHF = 1.5000

3-months expected spot USD/CHF = 1.6000



Uncovered Interest Arbitrage



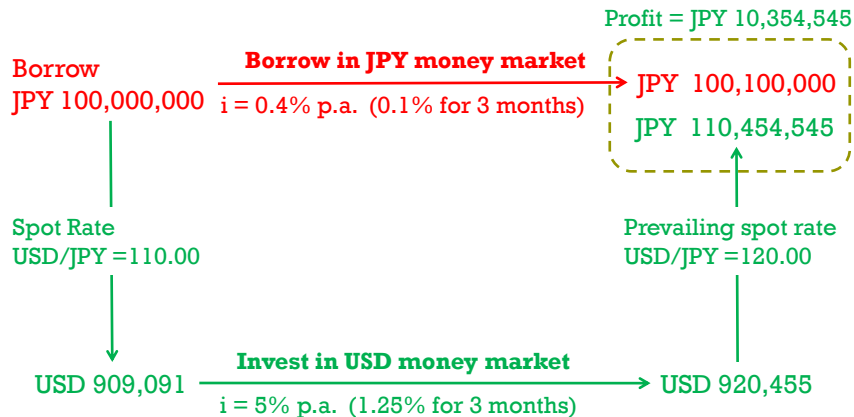
- UIA = CIA with no hedge at the end of period
- CIA = riskless transaction, UIA = high risk transaction
- One of popular UIA is carry trade strategy:
 - Borrow currency with lower interest rate (e.g. JPY)
 - Invest in currency with higher rate (e.g. USD)
 - short JPY, long USD
 - Convert back to currency with lower interest rate
 - sell USD to get back JPY, and pay JPY loans
- Example:
 - USD interest rate = 5.0% p.a.
 - JPY interest rate = 0.4% p.a.

USD/JPY in 2005



Example: Yen Carry-Trade

Spot rate USD/JPY (Sept 1, 2005) = 110.00 $i(\text{USD}) = 5\% \text{ p.a.}$
 3-months forward USD/JPY = 115.00 $i(\text{JPY}) = 0.4\% \text{ p.a.}$
 3-months expected spot USD/JPY = 120.00



Exercise-6



An US investor plans to invest USD 1,000,000 to exploit interest arbitrage. Current spot rate of EUR/USD = 1.5500, while 6-month forward EUR/USD = 1.5478. Interest rate in EUR and USD are 6% and 3% p.a., respectively.

- Is there an coverage interest arbitrage (CIA)? If CIA exists, which money market is more preferable?
- Two scenarios are created by analysts. In scenario-1, they predict that in the next 6 months, EUR/USD will be 1.5790 with probability 60%. While in scenario-2, EUR/USD will be 1.5550. What is the expected profit investor may grasp using UIA?

Answer: Exercise-6a (CIA)



- Is there an coverage interest arbitrage?

Spot EUR/USD	1.5500	}	$\%f_{\text{EUR/USD}} = \frac{1.5478 - 1.5500}{1.5500} \cdot \frac{360}{180} = -0.28\%$
6-month forward	1.5478		
EUR interest rate	6% p.a.	}	$\Delta i = i_{\text{USD}} - i_{\text{EUR}} = 3\% - 6\% = -3\%$
USD interest rate	3% p.a.		

CIA exists

- In which money market should we invest?

$$\Leftrightarrow (1 + i_{\text{USD}}) = 1 + 1.5\% = 1.015$$

$$\Leftrightarrow (1 + i_{\text{EUR}}) \cdot \frac{f_{\text{EUR/USD}}}{e_{\text{EUR/USD}}} = (1 + 3\%) \cdot \frac{1.5478}{1.5500} = 1.0285$$

Invest in EUR
money market
plus sign forward
contract

Answer: Exercise-6b (UIA)



- Scenario-1:** EUR/USD = 1.5790 (p = 60%)

- UIA: $(1 + i_{\text{EUR}}) \cdot \frac{e_t}{e_0} = (1 + 3\%) \cdot \frac{1.5790}{1.5500} = 1.049271 \Rightarrow 4.9271\%$

- Profit = USD 1 million x 4.9271% = USD 49,271

- Scenario-2:** EUR/USD = 1.5550 (p = 40%)

- UIA: $(1 + i_{\text{EUR}}) \cdot \frac{e_t}{e_0} = (1 + 3\%) \cdot \frac{1.5550}{1.5500} = 1.033323 \Rightarrow 3.3323\%$

- Profit = USD 1 million x 3.3323% = USD 33,323

- Expected profit from UIA:

$$= (49,271 \times 60\%) + (33,323 \times 40\%) = \text{USD } 42,892$$

Exercise-7



An investor plan to invest USD 5 billion to grasp profit from interest arbitrage. Information are available as below:

- Spot rate USD/DKK = 6.1720 (Kroner Denmark)
- 3-month forward = 6.2020
- Interest rate = 3% p.a. (US) and 5% p.a. (DKK)

Questions:

- a. Does CIA exist?
- b. If interest rate in USD raises to 4% p.a., how much does profit can get from CIA (if any)?

Exercise-8



Money and foreign exchange in London and New York are very efficient. The following information is available:

- Spot rate EUR/USD = 1.3860
- 1-year treasury bill rate = 3.8% (London) and 4.2% (New York)
- Expected inflation rate in New York = 2.0%

Questions:

- a. What do the financial market suggest for inflation in Europe next year?
- b. Estimate 1-year forward rate between USD and EUR!

Exercise-9



Below are information from financial market:

- Spot rate EUR/USD = 1.4600
- 1-year forward = 1.4900
- Interest rate = 7% p.a. (EUR) and 9% p.a. (USD)

Questions:

- a. Does CIA exist? If any, which money market is more preferable?
- b. If there is fee of 0.25% for every foreign exchange transaction (assume all taxes = 0), does CIA exist? If any, which money market is more preferable?



Part-V

International Parity Condition (IPC)

Summary



	Relation	Description	Prediction
PPP	$\Delta e \sim \Delta \pi$	Changes in price level will be related to changes in spot exchange rate	Higher inflation \rightarrow currency is depreciated
FE	$\Delta i \sim \Delta \pi$	Nominal interest rates equal to the required real rate of return plus compensation for expected inflation rate (π)	Higher inflation \rightarrow higher interest rate \rightarrow real rate of return across countries are equalized
IFE	$\Delta e \sim \Delta i$	The difference of interest rate between two countries should be equal to the changes in spot exchange rate	Lower interest rate \rightarrow currency is appreciated
IRP	$\%f \sim \Delta i$	the difference of interest rate between two countries should be covered by their forward rate	Lower interest rate currency \rightarrow covered by forward discount of higher interest rate currency
FRUP	$\Delta e \sim f$	Spot rate in the future will be around the forward rate that be adjusted continuously.	Forward rate \approx expected spot rate in the future

Formulas



	Formula	Simplification
➤ PPP	$e_1 = e_0 \cdot \frac{1 + \pi_h}{1 + \pi_f}$	$\% \Delta e_{t/h} = \pi_h - \pi_f$
➤ FE	$i = r + \pi + r \cdot \pi$	$i \approx r + \pi$
GFE	$\frac{i_h - i_f}{1 + i_f} = \frac{\pi_h - \pi_f}{1 + \pi_f}$	$i_h - i_f \approx \pi_h - \pi_f$
➤ IFE	$\% \Delta e_{t/h} = \frac{i_h - i_f}{1 + i_f}$	$\% \Delta e_{t/h} \approx i_h - i_f$
➤ IRP	$\% f_{t/h} = \frac{i_h - i_f}{1 + i_f}$	$\% f_{t/h} \approx i_h - i_f$
➤ FRUP	$\frac{e_t - e_0}{e_0} = \frac{f - e_0}{e_0}$	$f_{t/h} = E[e_t]$

Example: IPC



		JAPAN	US
○ Inflation Rate	(π)	1.0%	5.0%
○ Interest Rate	(i)	4.0%	8.0%
○ Spot Rate (USD/JPY)	(e)	104.00	
○ 1-year Fwd Rate	(f)	100.00	

➤ PPP $\% \Delta e_{\text{USD/JPY}} = \pi_{\text{JPY}} - \pi_{\text{USD}} = 1\% - 5\% = -4\%$

➤ FE $r_{\text{JPY}} = i_{\text{JPY}} - \pi_{\text{JPY}} = 4\% - 1\% = 3\%$
 $r_{\text{USD}} = i_{\text{USD}} - \pi_{\text{USD}} = 8\% - 5\% = 3\%$ } Equal real rate of return

➤ IFE $\% \Delta e_{\text{USD/JPY}} = i_{\text{JPY}} - i_{\text{USD}} = 4\% - 8\% = -4\%$

➤ IRP $\Delta i = i_{\text{JPY}} - i_{\text{USD}} = 4\% - 8\% = -4\%$
 $f_{\text{USD/JPY}} = \frac{\text{Fwd} - \text{Spot}}{\text{Spot}} \times \frac{360}{360} = \frac{100.00 - 104.00}{104.00} \approx -4\%$ } Covered Interest Differential

