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Lessons V and VI: Overview

1. FX parity conditions
2. Do the PPP and the IRPs (CIRP and UIRP) hold in practice?

FX parity conditions

FX parity conditions

1. The Law of One Price and the Purchasing Power Parity
2. The Covered Interest Rate Parity (Lesson III)
3. The Uncovered Interest Rate Parity
4. The Fisher-open condition
5. The Forward Rate Unbiased

The usefulness of parity conditions

Parity conditions should be thought of as "**break- even values**", where the decision-maker is indifferent between two available strategies

Parity conditions rely heavily on the "no free lunch " principle→ violations of parities may give rise to arbitrage opportunities, that would be exploited and reabsorbed in a very short span of time.

The Law of One Price I

Ceteris paribus, the price of a product, when converted into a common currency using the spot exchange rate, is the same in every country.

$$P_{iD} = S_{(D/F)} \cdot P_{iF}$$

with i= i^{th} product

Law of One Price II

Delving with the *ceteris paribus* condition

There must be no frictions for the LOP to hold, meaning no legal restrictions on the movement of goods, no transportation costs and no tariffs.

The LOP and the Big Mac I

A feast of burgernomics
The Big Mac index

	Big Mac prices		Implied PPP* of the dollar	Actual dollar exchange rate Jan 31st	Under (-)/over (+) valuation against the dollar, %
	In local currency	in dollars			
United States†	$3.22	3.22			
Argentina	Peso 8.25	2.65	2.56	3.11	-18
Australia	A$3.45	2.67	1.07	1.29	-17
Brazil	Real 6.4	3.01	1.99	2.13	-6
Britain	£1.99	3.90	1.62‡	1.96‡	+21
Canada	C$3.63	3.08	1.13	1.18	-4
Chile	Peso 1,670	3.07	519	544	-5
China	Yuan 11.0	1.41	3.42	7.77	-56
Colombia	Peso 6,900	3.06	2,143	2,254	-5
Costa Rica	Colones 1,130	2.18	351	519	-32
Czech Republic	Koruna 52.1	2.41	16.2	21.6	-25
Denmark	DKr27.75	4.84	8.62	5.74	+50
Egypt	Pound 9.09	1.60	2.82	5.70	-50
Estonia	Kroon 30	2.49	9.32	12.0	-23
Euro area§	€2.94	3.82	1.10**	1.30**	+19
Hong Kong	HK$12.0	1.54	3.73	7.81	-52
Hungary	Forint 590	3.00	183	197	-7
Iceland	Kronur 509	7.44	158	68.4	+131
Indonesia	Rupiah 15,900	1.75	4,938	9,100	-46
Japan	¥280	2.31	87.0	121	-28
Latvia	Lats 1.35	2.52	0.42	0.54	-22
Lithuania	Litas 6.50	2.45	2.02	2.66	-24
Malaysia	Ringgit 5.50	1.57	1.71	3.50	-51
Mexico	Peso 29.0	2.66	9.01	10.9	-17
New Zealand	NZ$4.60	3.16	1.43	1.45	-2
Norway	Kroner 41.5	6.63	12.9	6.26	+106
Pakistan	Rupee 140	2.31	43.5	60.7	-28
Paraguay	Guarani 10,000	1.90	3,106	5,250	-41
Peru	New Sol 9.50	2.97	2.95	3.20	-8
Philippines	Peso 85.0	1.74	26.4	48.9	-46
Poland	Zloty 6.90	2.29	2.14	3.01	-29
Russia	Rouble 49.0	1.85	15.2	26.5	-43
Saudi Arabia	Riyal 9.00	2.40	2.80	3.75	-25
Singapore	S$ 3.60	2.34	1.12	1.54	-27
Slovakia	Crown 57.98	2.13	18.0	27.2	-34
South Africa	Rand 15.5	2.14	4.81	7.25	-34
South Korea	Won 2,900	3.08	901	942	-4
Sri Lanka	Rupee 190	1.75	59.0	109	-46
Sweden	SKr32.0	4.59	9.94	6.97	+43
Switzerland	SFr6.30	5.05	1.96	1.25	+57
Taiwan	NT$75.0	2.28	23.3	32.9	-29
Thailand	Baht 62.0	1.78	19.3	34.7	-45
Turkey	Lire 4.55	3.22	1.41	1.41	nil
UAE	Dirhams 10.0	2.72	3.11	3.67	-15
Ukraine	Hryvnia 9.00	1.71	2.80	5.27	-47
Uruguay	Peso 55.0	2.17	17.1	25.3	-33
Venezuela	Bolivar 6,800	1.58	2,112	4,307	-51

Sources: McDonald's; *The Economist*

*Purchasing-power parity: local price divided by price in United States
†Average of New York, Atlanta, Chicago and San Francisco ‡Dollars per pound
§Weighted average of prices in euro area **Dollars per euro

Source: The Economist, 2007

The LOP and the Big Mac II

1. Which is the most overvalued currency? Why?
2. Which is the most undervalued currency? Why?

The Purchasing Power Parity I

If the LOP were to hold for a certain basket of goods and services, we get the **Purchasing Power Parity** relation (in **absolute** or **static form**):

$$P_D = S(D/F) \cdot P_F$$

with P = price index of the underlying basket of goods/services

The CIRP applies to financial markets: the PPP can be conceived as a parallel parity condition referring to the products market.

The Purchasing Power Parity II

Based on the PPP condition, it must be that:

$$S_{PPP} = \frac{P_D}{P_F}$$

1. Whenever $\mathbf{S_{D/F} > S_{PPP}}$ → the **domestic currency** (D) is **undervalued/** the **foreign currency** (F) is **overvalued**;
2. Whenever $\mathbf{S_{D/F} < S_{PPP}}$ → the **domestic currency** (D) is **overvalued/** the **foreign currency** (F) is **undervalued**

The Purchasing Power Parity III

In practice, however, it is difficult to test the validity of PPP in absolute form.

Different baskets of goods are used in different countries to compute price indexes, given that tastes and needs differ on an international scale, affecting what people buy.

The Purchasing Power Parity IV

Price levels could be substituted with inflations rates

PPP in **relative** or **dynamic terms**

Dealing with algebra I

Suppose that at t_0:

$$P_D = S(D/F) \cdot P_F$$

In 1 year's time, it will be:

$$P_D(1+\Delta P_D) = S(D/F)(1+\Delta S_{D/F}) \cdot P_F(1+\Delta P_F)$$

Divide the latter by the former and get:

$$(1+\Delta P_D) = (1+\Delta S_{D/F}) \cdot (1+\Delta P_F)$$

Dealing with algebra II

Rearranging the terms:

$$\Delta S_{D/F} = \frac{(1+\Delta P_D)}{(1+\Delta P_F)} - 1$$

Or, equivalently:

$$\Delta S_{D/F} = \frac{(\Delta P_D - \Delta P_F)}{(1+\Delta P_F)}$$

Dealing with algebra III

When inflation is low:

$$\Delta S_{D/F} \cong (\Delta P_D - \Delta P_F)$$

The exchange rate offsets inflation differentials between countries.

Terminology

From the PPP to the real FX rate

The real interest rate can be defined as:

$$q_{(D/F)} = \frac{S_{(D/F)} \cdot P_F}{P_D}$$

$q_{(D/F)}$ is a broad summary measure of the prices of one country's goods and services relative to the prices of another's.

The real exchange rate I

Consider the $/€ real FX rate

$$q_{(\$/€)} = \frac{S_{(\$/€)} \cdot P_{€}}{P_{\$}}$$

$q_{\$/€}$ can be conceived as the USD price of European products (goods and services) in terms of American products.

- Whenever $q_{\$/€}$ increases/decreases→ **real depreciation/appreciation of the USD against the EUR** (i.e. fall/increase of the purchasing power of a $ within Europe's borders)

The real exchange rate II

$$q_{(\$/€)} = \frac{S_{(\$/€)} \cdot P_{€}}{P_{\$}}$$

If PPP holds, the real exchange rate is perfectly constant.

From the CIRP to the UIRP

$$(1+r_D)^n = \frac{F(_nD/F)}{S(D/F)}(1+r_F)^n$$

As long as $F(_nD/F) = S^E(D/F)$ (assuming, as usual, risk neutrality and zero transaction costs)…

The UIRP

$$(1+r_D)^n = \frac{S^E({}_nD/F)}{S(D/F)}(1+r_F)^n$$

Uncovered interest rate parity: the mathematical expression is almost analogous to the one used for CIRP, apart from the fact that foreign exchange exposure is **not** covered with a forward exchange contract.

Playing with UIRP I

By definition, it must be that:

$$S^E(D/F) = S(D/F)(1+\Delta S^E)^n$$

Substituting

$$(1+r_D)^n = (1+\Delta S^E)^n \cdot (1+r_F)^n$$

Playing with UIRP II

Taking the nth-root and multiplying yield

$$1 + r_D = 1 + \Delta S^E + \Delta S^E \cdot r_F + r_F$$

If we ignore interaction terms, we will get

$$\Delta S^E = r_D - r_F$$

Higher-yield currencies are expected to depreciate

Combining PPP and UIRP

If we combine

$$\Delta S^E = r_D - r_F$$

and

$$\Delta S^E = \Delta P^E{}_D - \Delta P^E{}_F$$

we get

$$r_D - \Delta P^E{}_D = r_F - \Delta P^E{}_F$$

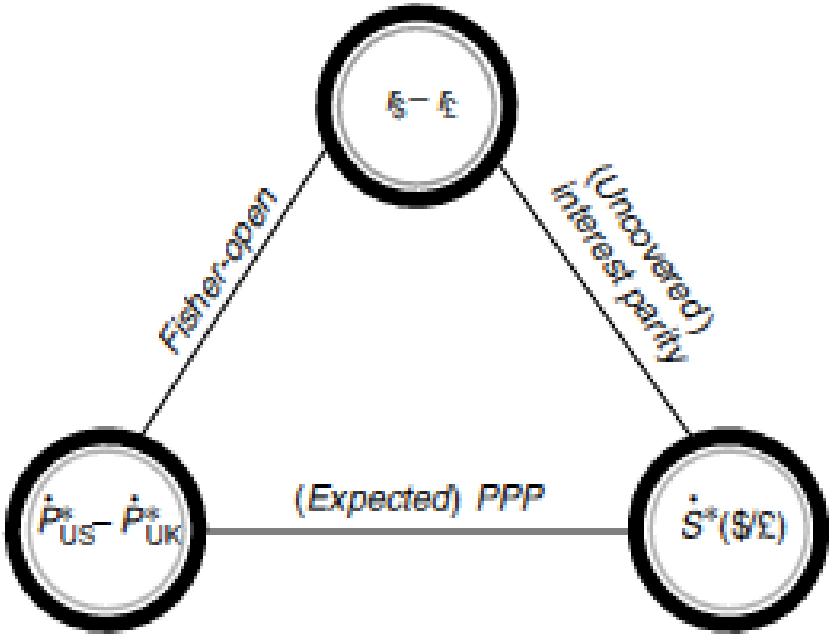
The Fisher-open condition

$$r_D - \Delta P^E{}_D = r_F - \Delta P^E{}_F$$

Fisher-open condition: real interest rates are equal in different countries.

High-yield currencies carry more inflation risk and tend to depreciate over time

The UIRP, the PPP and the Fisher-open condition



The Fwd Rate Unbiased

If $F_{(nD/F)} = S^{E}_{(D/F)}$ we could infer that

$$\frac{F_{(nD/F)} - S_t}{S_t} = \frac{S^{E}_{(D/F)} - S_t}{S_t}$$

Today's fwd premium/discount equals…

…the expected percentage change in the spot rate

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Do the PPP and the IRPs (CIRP and UIRP) hold in practice?

Does PPP hold in practice?

Testing the validity of PPP may be troublesome as a consequence of:

1. **Different baskets of goods** underlying the price index;
2. **Non tradable goods**;
3. **Transaction costs** (quotas, tariffs, duties);
4. Different consumers' preferences→ **Different price indexes' weighting schemes**;
5. **Oligopolistic markets**

Testing the validity of PPP: statistical evidence I

Given the following regression model

$$\Delta\%S_t = \alpha + \beta(\Delta\%P_{Dt} - \Delta\%P_{Ft}) + \varepsilon_t$$

If PPP held, it would have to be:

- **α** → (statistically) not significantly different from 0;
- **β** → (statistically) not significantly different from 1;
- **R^2** sufficiently "high"

Testing the validity of PPP: statistical evidence II

Dependent Variable: S$__
Method: Least Squares
Date: 02/03/12 Time: 07:05
Sample: 1997M02 2011M12
Included observations: 179

Variable	Coefficient	Std. Error	t-Statistic	Prob.
US_EU_INFL	-0.383674	0.614007	-0.624869	0.5329
C	0.001007	0.002316	0.434942	0.6641

R-squared	0.002201	Mean dependent var	0.000920
Adjusted R-squared	-0.003436	S.D. dependent var	0.030881
S.E. of regression	0.030934	Akaike info criterion	-4.102822
Sum squared resid	0.169372	Schwarz criterion	-4.067209
Log likelihood	369.2026	F-statistic	0.390461
Durbin-Watson stat	1.901255	Prob(F-statistic)	0.532862

$Y = S_{\$/€}$, $X = \Delta\%P_{\$} - \Delta\%P_{€}$ and $P_{€}$ = EU27 HICP price index

Testing the validity of PPP: statistical evidence III

The emerging empirical evidence suggests that:

- **PPP performs poorly** in the **short run**;
- Prices seem to revert to their PPP levels in the long run→ **mean reverting processes**;
- The **speed of adjustment** towards the PPP level is a **positive function of the size of the deviation**;
- **PPP deviations may be permanent** if a permanent **real shock** affects one country but not the other

Testing the validity of PPP: statistical evidence IV

High productivity gains

↓

Higher real income growth

↓

Appreciating real exchange rates

↓

Non constant real exchange rates

PPP deviations and the Balassa-Samuelson effect I

The PPP states that, when expressed in terms of a single currency, countries' price levels should approximately equate.

The empirical evidence, however, suggests that countries' price levels are positively related to (per capita) real income dynamics (i.e. prices tend to be higher in richer countries)

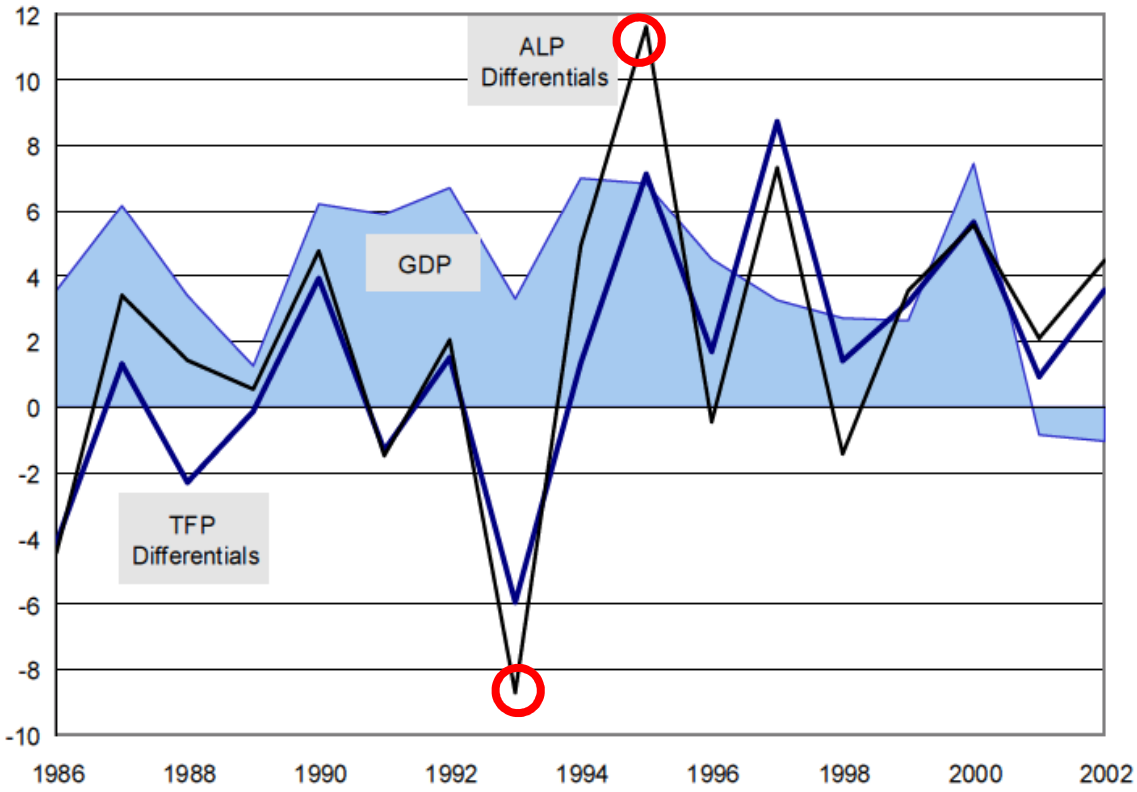
Balassa-Samuelson effect

PPP deviations and the Balassa-Samuelson effect II

Poor countries: the labor force is less productive in the tradables sector (whilst international productivity differences in nontradables are negligible)→ lower productivity implies lower wages, which further imply lower production costs and, consequently, lower price levels.

The Balassa-Samuelson effect can help explain (apparent) persistent deviations from PPP

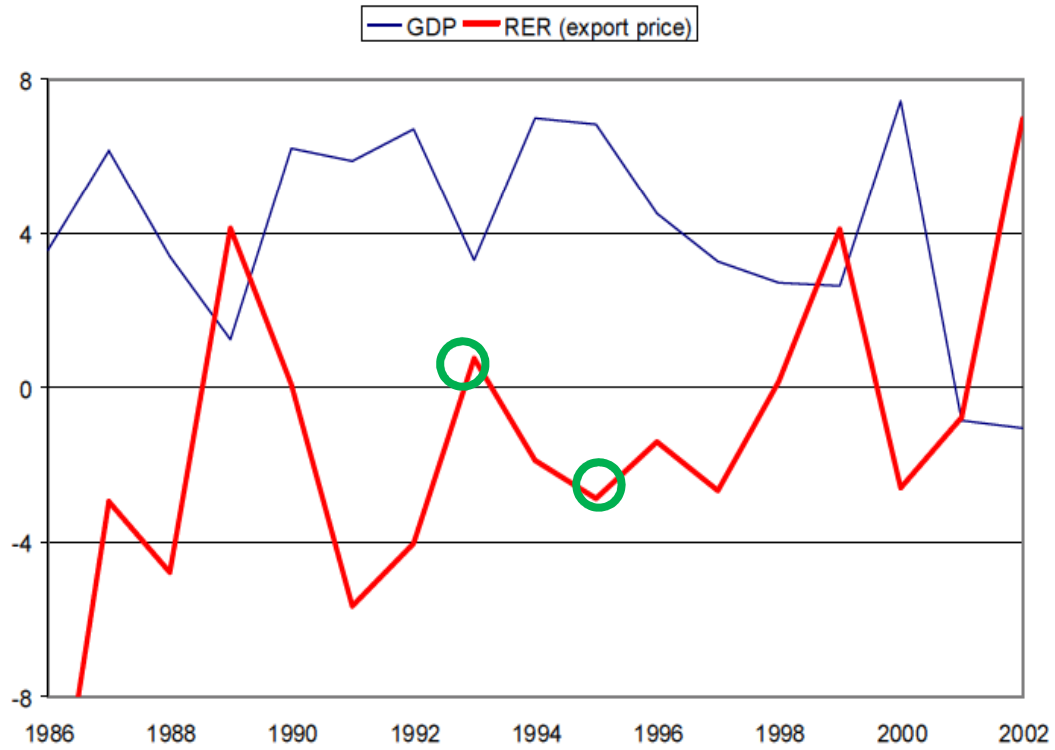
PPP deviations and the Balassa-Samuelson effect III



ALP: Avg labor productivity

TFP: Total factors productivity

PPP deviations and the Balassa-Samuelson's effect IV



RER ₪ /$: Real Exchange Rate

Source: Bank of Israel, B. Romanov, 2003

Does CIRP hold in practice?

Very closely, but **not exactly** as a consequence of:

1. **Execution risk**
2. **Transaction costs** (only in some cases)
3. **Political risk**
4. **Tax advantages**
5. **Liquidity differences**

The CIRP and the execution risk

There might be time lags during execution, thus implying some extra risk→ placing orders takes time and market prices may change

This tends to create a "band" around the CIRP line

The CIRP and the transaction costs

Transaction costs do **not always** contribute to deviations from IRP

Round-trip arbitrages tend to create a "band" around the CIRP line, whilst one-way arbitrages do not (Lesson III)

The CIRP & the political risk I

Political risk involves the uncertainty that while funds are invested in a foreign country, they may be frozen (they cannot be repatriated), confiscated or even made incovertible into other currencies.

Investors typically require a risk premium from foreign investments versus domestic investments

The CIRP & the political risk II

Political risk creates a "band" around the CIRP line.

The band does not have to be of equal width on the two sides of the CIRP line, if one country is seen as riskier than the other.

The CIRP and tax dynamics

As long as tax rates depend on the country in which funds are borrowed/invested, the interest parity condition will be affected.

Two ways in which taxes can affect the parity condition:

1. Withholding taxes;
2. Differences between the tax rate on income (τ_I) and the tax rate on capital gains (τ_K)

Withholding tax

Withholding tax: tax applied to foreigners at the source of their earnings.

Withholding taxes are unlikely to create any "band" around the parity line **iff** the **rate of withholding** ≤ the tax **rate** that would be **applied to the earnings at home**, since domestic withholding tax credits (purposely designed to avoid double taxation) will offset the tax withheld.

Income vs K gains taxation I

$$r_{\$} - r_{£} = \frac{1-\tau_K}{1-\tau_I}\left[\frac{F_{1\$/£} - S_{\$/£}}{S_{\$/£}}\right](1+r_{£})$$

As long as $\tau_K < \tau_I$,

$$\frac{1-\tau_K}{1-\tau_I} > 1$$

Investors (borrowers) with favorable capital gains treatment will prefer investments denominated in currencies trading at a forward premium (discount)

Income vs K gains taxation II

If $\tau_{\text{Capital Gains}} \neq \tau_{\text{Interest Income}}$, the slope of the CIRP line may be affected.

After taxes, if capital gains taxes are paid on foreign exchange earnings, even when hedged, the investor will receive only (1- $\tau_{\text{Interest Income}}$) of the interest and (1- $\tau_{\text{Capital Gains}}$) of the gain from the forward premium (considered as a K gain)

The CIRP and liquidity differences I

Liquidity refers to how easily, quickly and cheaply an asset can be converted into cash.

Suppose the funds put in a covered foreign investments are needed earlier → the investor might incur in potential losses when monetizing the original investment

The CIRP and liquidity differences II

Liquidity preference is likely to create a band around the covered interest-parity line.

The potential width of the band due to liquidity preference depends on the likelihood that the funds will be needed earlier.

Does the CIRP hold in practice?

Empirically, the CIRP seems to hold:

- in the eurocurrency market;
- for short term lending/borrowing.

Testing the validity of UIRP: statistical evidence I

Given the following regression model

$$\Delta\%S_t = \alpha + \beta(r_{Dt} - r_{Ft}) + \varepsilon_t$$

If UIRP held, it would have to be:

- **α** → (statistically) not significantly different from 0;
- **β** → (statistically) not significantly different from 1;
- **R^2** sufficiently "high"

Testing the validity of UIRP: statistical evidence II

Dependent Variable: EURUSD_CURNCY
Method: Least Squares
Date: 02/03/12 Time: 15:35
Sample: 2000M01 2011M12
Included observations: 144

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IUSA_EU	0.051431	0.067659	0.760148	0.4484
C	0.000762	0.000584	1.306393	0.1935

R-squared	0.004053	Mean dependent var	0.000793
Adjusted R-squared	-0.002961	S.D. dependent var	0.006976
S.E. of regression	0.006986	Akaike info criterion	-7.075999
Sum squared resid	0.006930	Schwarz criterion	-7.034751
Log likelihood	511.4719	F-statistic	0.577825
Durbin-Watson stat	1.550228	Prob(F-statistic)	0.448426

$Y=S_{USD/EUR}$, $X=i_{USA}-i_{EU15}$ and i= avg 3yr Govt Bonds' yields

Testing the validity of UIRP: statistical evidence III

The empirical evidence reveals that the **UIRP holds poorly** in the **short run**.

- Whenever short term interest rates are high, currencies tend to appreciate;
- "Carry trade" strategies are profitable in the short run;
- Basket carry trade strategies perform even better

Terminology

Carry trade

Trading strategy consisting in selling a relatively low interest rate currency and using the funds to purchase another yielding a higher interest rate.

Carry Trade: some insights into the daily practice (Q_2-2012) I

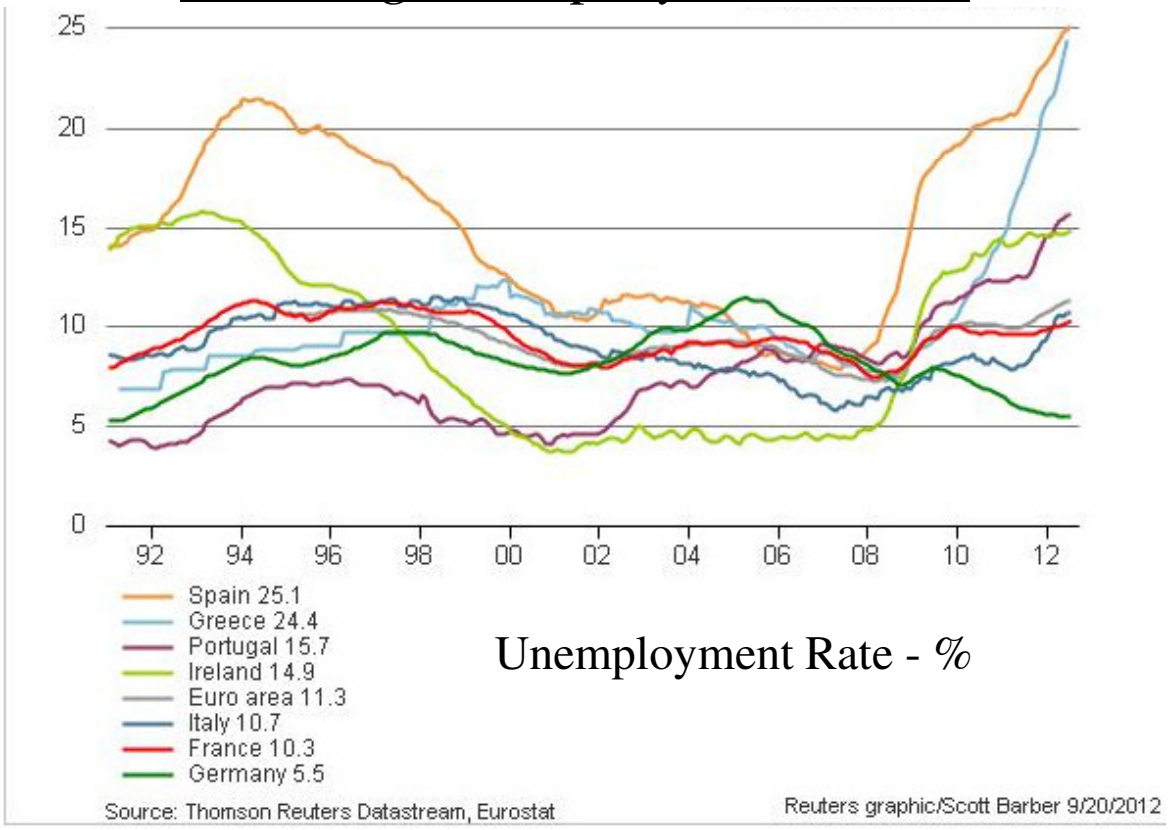
Intensifying worries about **PIIGS**:

Increasing Government bond yields

Source: Bloomberg, 10YR Govt Bond Yields

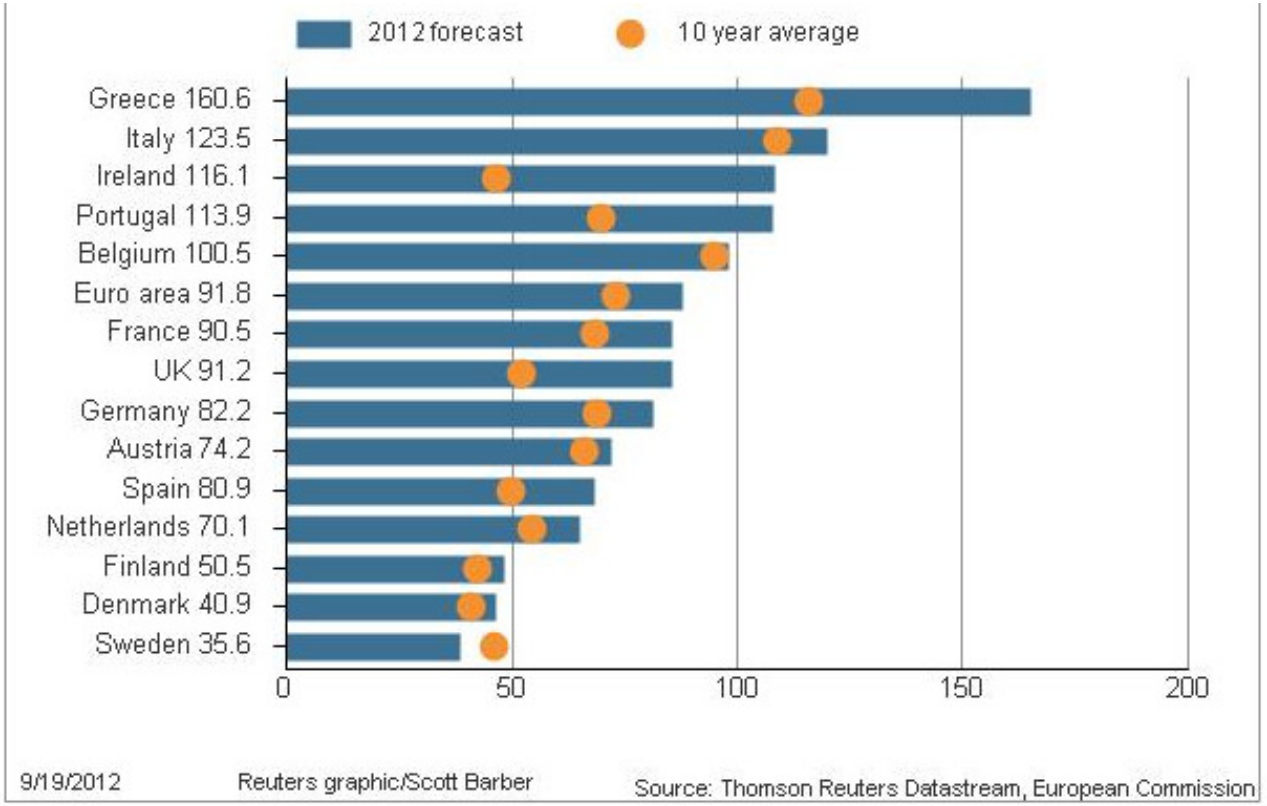
Carry Trade: some insights into the daily practice (Q_2-2012) II

Growing unemployment rates



Carry Trade: some insights into the daily practice (Q_2-2012) III

Explosive growth in DEBT/GDP ratios



Carry Trade: some insights into the daily practice (Q_2-2012) IV

As if it were not enough…

Increasing worries about a possible Italian default

Increasing worries about a possible fall of the Euro

Lack of confidence in the interbank market

July 2012: ECB decided to cut interest rates

Increased segmentation in K mkts

Increasing worries about a disordered "GREXIT" (contagion?)

International K leaving the Eurozone

Carry Trade: some insights into the daily practice (Q_2-2012) V

The **Euro** started to be conceived as a **funding currency**

BORROW
€

INVEST
in higher-yielding assets
(Australian Dollar, New Zealand Dollar, Hungarian Forint, Polish Zloty, South African Rand)

Carry Trade: some insights into the daily practice (Q_2-2012) VI

Speculative bet against the **Euro**

26th July 2012: "*Within our mandate, the ECB is ready to do whatever it takes to preserve the Euro. And believe me, it will be enough*".

To put it into practice

You have been given the following information:

$r_{\$}$	$r_{£}$	$S_{(\$/£)}$	$F_{1/4(\$/£)}$
5%	6%	1.5	1.4895

where

$r_{\$}$ = annual interest rate on 3-month US-dollar commercial paper

$r_{£}$ = annual interest on 3-month British-pound commercial paper

On the basis of the foregoing data:

a. In which commercial paper would you invest?

b. In which currency would you borrow?

c. How would you arbitrage?

d. What is the profit from interest arbitrage per dollar borrowed?