

Lessons IV and V: FX Parity Conditions

Friday 16th March, 2018

An Overview of Parity Conditions

Getting Started

The Law of One Price
and the Purchasing
Power Parity

The Uncovered
Interest Rate Parity

The Fisher-open
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The Forward Rate
Unbiased

Focus on the Empirical Evidence

Does the PPP Hold in
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Does the CIRP Hold
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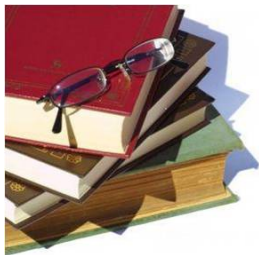
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Parity conditions should be thought of as **break-even values**, where the decision-maker is indifferent between two available strategies.

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



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The LoP: an Overview

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

$$P_{iD} = S_{\frac{D}{F}} \cdot P_{iF}$$

with $i=i^{th}$ product



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Ceteris Paribus...

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.



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From the LoP to the PPP

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**):

$$P_D = S_{\frac{D}{F}} \cdot P_F$$

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

In intuitive terms, the **CIRP** applies to **financial markets**: the **PPP** can be conceived as a parallel parity condition referring to the **products market**.



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Rearranging the Terms...

$$S_{\frac{D}{F}}^{PPP} = \frac{P_D}{P_F}$$

- ▶ Whenever $S_{\frac{D}{F}} > S^{PPP} \Rightarrow$ the **domestic** currency (D) is **undervalued** or, equivalently, the **foreign** currency (F) is **overvalued**
- ▶ Whenever $S_{\frac{D}{F}} < S^{PPP} \Rightarrow$ the **domestic** currency (D) is **overvalued** or, equivalently, the **foreign** currency (F) is **undervalued**



From Theory to Practice

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.

Price levels could be substituted with inflation rates \Rightarrow PPP in **relative or dynamic terms**



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From Static to Dynamic PPP I

Suppose that at time t_0 :

$$P_D = S_{\frac{D}{F}} \cdot P_F$$

In 1 year time it will be:

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

Divide the latter by the former and get:

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

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From Static to Dynamic PPP II

Rearranging the terms:

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

Or, equivalently:

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

When inflation is relatively low, the above relationship simplifies to:

$$\Delta S_{\frac{D}{F}} \simeq (\Delta P_D - \Delta P_F)$$

The exchange rate **offsets inflation differentials** between countries.

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From the CIRP to the URIP

Based on the CIRP (Lesson III)

$$(1 + r_D)^n = \frac{F_{n\frac{D}{F}}}{S_{\frac{D}{F}}} (1 + r_F)^n$$

Assuming **risk neutrality** and zero transaction costs, it should be that

$$F_{n\frac{D}{F}} = S_{\frac{D}{F}}^E$$

Substituting:

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

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

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Digging a Little Bit Deeper

By definition, it must be that:

$$S_{\frac{D}{F}}^E = S_{\frac{D}{F}} \cdot (1 + \Delta S^E)^n$$

Substituting

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

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

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Combining the PPP and the UIRP

If we now combine

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

and

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

we get

$$r_D - \Delta P_D = r_F - \Delta P_F$$

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

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Stated in simpler terms...

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



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The Fwd Rate Unbiased

If we assume that

$$F_{n\frac{D}{F}} = S^E\frac{D}{F}$$

we could infer that

$$\frac{F_{n\frac{D}{F}} - S_{\frac{D}{F}}}{n \cdot S_{\frac{D}{F}}} = \frac{S_{\frac{D}{F}}^E - S_{\frac{D}{F}}}{n \cdot S_{\frac{D}{F}}}$$

Fwd Rate Unbiased: Today's fwd premium/discount equals the expected percentage change in the spot rate



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Does PPP hold in practice?

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

- ▶ **Different baskets of goods** underlying the price index
- ▶ **Non tradable** goods
- ▶ **Transaction costs** (quotas, tariffs, duties)
- ▶ **Different** consumers' preferences = **Different** price indexes' weighting schemes
- ▶ **Oligopolistic** markets



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Emerging Empirical Evidence

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



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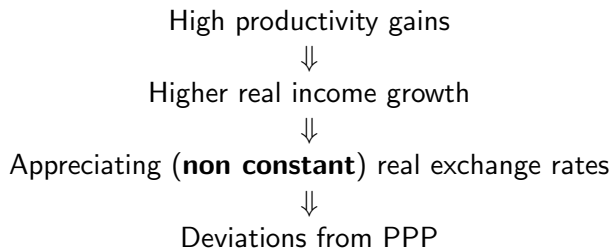
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Persistent Deviations from the PPP



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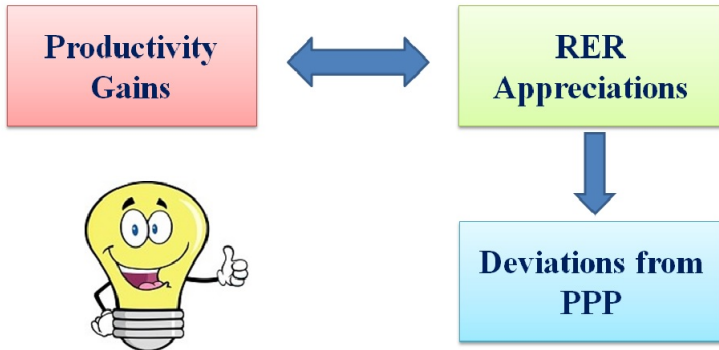
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The Balassa-Samuelson Effect I

The Balassa-Samuelson effect focuses on the relationship among



The Balassa-Samuelson Effect II

Would you be able to explain why productivity gains generally go hand in hand with RER appreciations?
Can you explain why richer countries tend to exhibit relatively higher price levels?



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Does the CIRP Hold in Practice?

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

- ▶ **Execution** risk
- ▶ **Transaction costs** (Is it really so? Step back to Lesson III...)
- ▶ **Political** risk
- ▶ **Tax** advantages
- ▶ **Liquidity** risk



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CIRP and Execution Risk

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

This tends to create a **band around the CIRP line**.



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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)



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CIRP and Political Risk

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 **inconvertible** into other currencies.

Investors typically require a **risk premium** from foreign investments versus domestic investments: Political risk creates a **band** around the CIRP line.

Watch out: 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.



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

- ▶ **Withholding** taxes
- ▶ **Differences** between the tax rate on income (τ_I) and the tax rate on capital gains (τ_K)



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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 **if** the rate of withholding \leq 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.

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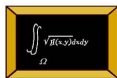
Income vs K gains taxation I

$$r_D - r_F = \frac{1 - \tau_K}{1 - \tau_I} \cdot n \cdot \frac{F \frac{1}{n} \frac{D}{F} - S \frac{D}{F}}{S \frac{D}{F}}$$

As long as $\tau_K < \tau_I$,

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

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



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Income vs K gains taxation II

If $\tau_K \neq \tau_I$, 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** $(1 - \tau_I)$ of the interest and $(1 - \tau_K)$ of the gain from the forward premium (considered as a K gain).



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CIRP and Liquidity Preferences

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

Suppose the funds put in a covered foreign investment are needed **earlier** \Rightarrow The investor might incur in **potential losses** when monetizing the original investment \Rightarrow 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



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Empirical Evidence

Empirically, the CIRP seems to hold:

- ▶ in the eurocurrency market
- ▶ for short term lending/borrowing



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Emerging Empirical Evidence

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



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Carry Trade in practice (Q₂-2012) I

Intensifying worries about PIIGS ⇒ Increasing
Government bond yields



Source: Bloomberg, 10YR Govt Bond Yields

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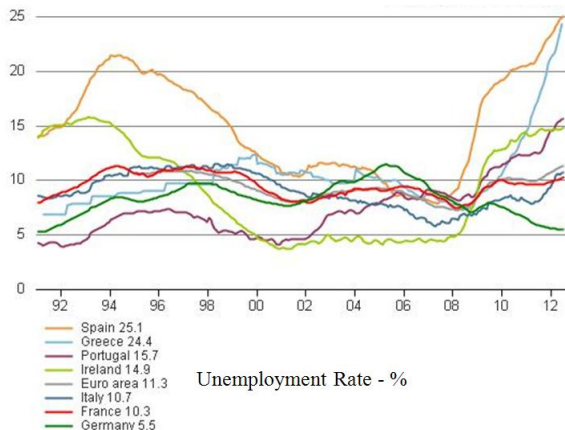
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Carry Trade in practice (Q₂-2012) II

Growing unemployment rates



Source: Thomson Reuters Datastream, Eurostat

Reuters graphic/Scott Barber 9/20/2012

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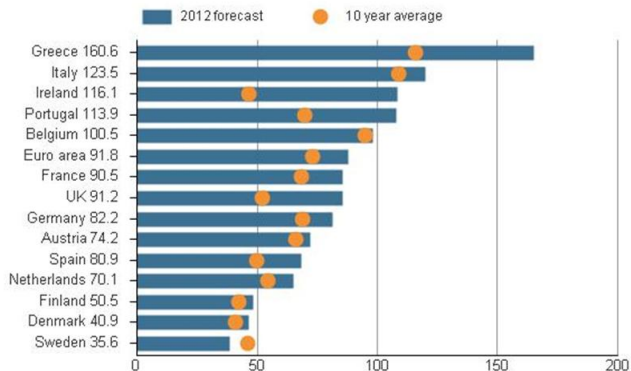
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Carry Trade in practice (Q₂-2012) III

Explosive growth in DEBT/GDP ratios



9/19/2012

Reuters graphic/Scott Barber

Source: Thomson Reuters Datastream, European Commission

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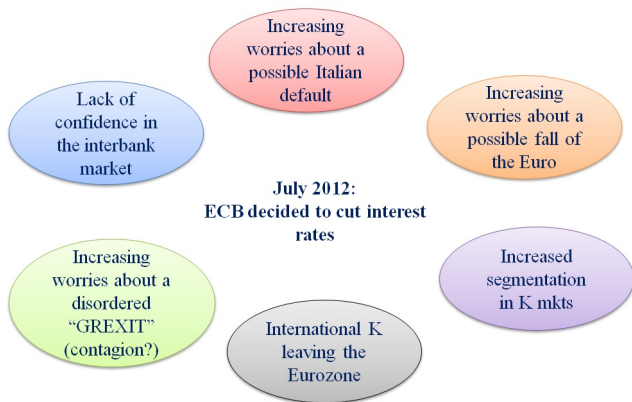
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Carry Trade in practice (Q₂-2012) V

Speculative bet against the Euro

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



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Real Exchange Rate

Real Exchange Rate: broad summary measure of the prices of one country's goods and services **relative** to the prices of another's \Rightarrow useful to **asses the purchasing power** of a currency in a foreign country

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

Watch out: If PPP holds, the real exchange rate is perfectly **constant**.



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Risk Neutrality

Risk Neutrality: investor attitude according to which the value of a **sure** chance of gain or loss is considered to be **equal to an unsure** chance of the same amount of gain or loss (Source: *The Business Dictionary*)



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Carry Trade

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**



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in Practice?

Does the UIRP Hold
in Practice?

Terminology

To Put It into Practice

To Put It into Practice I

5.1: You have been given the following information:

r_{USD}	r_{GBP}	$S_{\frac{USD}{GBP}}$	$F_n_{\frac{USD}{GBP}}$
0.05	0.06	1.5	1.4895

where

- ▶ r_{USD} = annual interest rate on USD short term paper
- ▶ r_{GBP} = annual interest on GBP short term paper

On the basis of the foregoing data:

- ▶ In which paper would you invest?
- ▶ In which currency would you borrow?
- ▶ What is the profit from interest arbitrage?

An Overview of
Parity Conditions

Getting Started

The Law of One Price
and the Purchasing
Power Parity

The Uncovered
Interest Rate Parity

The Fisher-open
condition

The Forward Rate
Unbiased

Focus on the
Empirical Evidence

Does the PPP Hold in
Practice?

Does the CIRP Hold
in Practice?

Does the UIRP Hold
in Practice?

Terminology

To Put It into
Practice

To Put It into Practice II

5.2: Focus on the table below

The hamburger standard

	Big Mac price in dollars*	Implied PPP valuation of the dollar	Under (-)/over (+) valuation against the dollar, %		Big Mac price in dollars*	Implied PPP valuation of the dollar	Under (-)/over (+) valuation against the dollar, %
United States ¹	3.06	—	—	Aruba	2.77	1.62	-10
Argentina	1.64	3.55	-46	Bulgaria	1.88	0.98	-39
Australia	2.50	1.06	-18	Colombia	2.79	2124	-9
Brazil	2.39	1.83	-22	Costa Rica	2.38	369	-22
Britain	3.44	1.63 ^h	+12	Croatia	2.50	4.87	-18
Canada	2.63	1.07	-14	Dominican Rep	2.12	19.6	-31
Chile	2.53	.90	-17	Estonia	2.31	9.64	-24
China	1.27	3.43	-59	Fiji	2.50	1.39	-18
Czech Republic	2.30	38.4	-25	Georgia	2.00	1.19	-34
Denmark	4.50	9.07	+50	Guatemala	2.20	5.47	-28
Egypt	1.55	2.94	-49	Honduras	1.91	11.7	-38
Euro area	3.58**	1.05 ¹¹	+17	Iceland	6.67	143	+178
Hong Kong	1.54	3.92	-50	Jamaica	2.70	53.9	-12
Hungary	2.60	173	-15	Jordan	3.66	0.85	+19
Indonesia	1.53	4.771	-50	Latvia	1.92	0.36	-37
Japan	2.34	81.7	-23	Lebanon	2.85	1405	-7
Malaysia	1.38	1.72	-55	Lithuania	2.31	2.12	-24
Mexico	2.58	9.15	-16	Macao	1.40	3.66	-54
New Zealand	3.17	1.45	+4	Macedonia	1.90	31.0	-38
Peru	2.78	2.94	-10	Moldova	1.84	7.52	-40
Philippines	1.47	26.1	-52	Morocco	2.73	8.02	-11
Poland	1.96	2.12	-36	Nicaragua	2.11	11.3	-31
Russia	1.48	13.7	-52	Norway	6.06	12.7	+98
Singapore	2.17	1.18	-29	Pakistan	2.18	42.5	-29
South Africa	2.10	4.56	-31	Paraguay	1.44	2941	-53
South Korea	2.49	817	-19	Qatar	0.68	0.81	-78
Sweden	4.17	10.1	+36	Saudi Arabia	2.40	2.94	-22
Switzerland	5.05	2.06	+65	Serbia & Montenegro	2.08	45.8	-32
Taiwan	2.41	24.5	-21	Slovakia	2.09	21.6	-32
Thailand	1.48	19.6	-52	Slovenia	2.56	163	-16
Turkey	2.92	1.31	-5	Sri Lanka	1.75	57.2	-43
Venezuela	2.13	1,830	-30	Ukraine	1.43	2.37	-53
				UAE	2.45	2.94	-20
				Uruguay	1.82	14.4	-40

*At current exchange rates ^hPurchasing-power parity
¹Average of New York, Chicago, San Francisco and Atlanta
 \$Dollars per pound **Weighted average of member countries
 Sources: McDonald's; The Economist ¹¹Dollars per euro

An Overview of Parity Conditions

Getting Started

- The Law of One Price and the Purchasing Power Parity
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Focus on the Empirical Evidence

- Does the PPP Hold in Practice?
- Does the CIRP Hold in Practice?
- Does the UIP Hold in Practice?

Terminology

To Put It into Practice

To Put It into Practice III

- ▶ Which is the most overvalued currency? Why?
- ▶ Which is the most undervalued currency? Why?



An Overview of Parity Conditions

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Focus on the Empirical Evidence

Does the PPP Hold in
Practice?

Does the CIRP Hold
in Practice?

Does the UIRP Hold
in Practice?

Terminology

To Put It into Practice

To Put It into Practice IV

5.3: Assume that the inflation rate in Brazil is expected to increase substantially. How will this affect Brazil's nominal interest rates and the value of its currency? If the IFE holds, how will the nominal return to U.S. investors who invest in Brazil be affected by the higher inflation in Brazil? **Justify your claims.**



An Overview of Parity Conditions

- Getting Started
- The Law of One Price and the Purchasing Power Parity
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Focus on the Empirical Evidence

- Does the PPP Hold in Practice?
- Does the CIRP Hold in Practice?
- Does the UIRP Hold in Practice?

Terminology

To Put It into Practice

To Put It into Practice V

5.4: Assume the following information is available for US and Europe:

Nominal r_{USD}	0.04
Nominal r_{EUR}	0.06
Expected Inflation $_{USD}$	0.02
Expected Inflation $_{EUR}$	0.05
$S_{\frac{USD}{EUR}}$	1.13
$F_1_{\frac{USD}{EUR}}$	1.13

- ▶ Does the CIRP hold?
- ▶ According to the PPP, what is the expected spot rate of the Euro in one year?
- ▶ According to the UIRP, what is the expected spot rate of the Euro in one year?

An Overview of Parity Conditions

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Focus on the Empirical Evidence

Does the PPP Hold in Practice?
Does the CIRP Hold in Practice?
Does the UIRP Hold in Practice?

Terminology

To Put It into Practice