

14	<h2>EXCHANGE RATES I: PPP and THE MONETARY APPROACH IN THE LONG RUN</h2>
1 Exchange Rates and Prices in the Long Run 2 Money, Prices, and Exchange Rates in the Long Run 3 The Monetary Approach 4 Money, Interest, and Prices in the Long Run 5 Monetary Regimes and Exchange Rate Regimes 6 Conclusions	

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Introduction to Exchange Rates and Prices
<ul style="list-style-type: none"> <li>• Consider some hypothetical data on prices and exchange rates in the U.S. and U.K.:             <ul style="list-style-type: none"> <li>♦ Prices of U.S. and U.K. CPI baskets                 <ul style="list-style-type: none"> <li>▪ 1970 <math>P_{UK}=\text{£}100</math>                      1990 <math>P_{UK}=\text{£}110</math></li> <li>▪ 1970 <math>P_{US}=\text{\\$}175</math>                      1990 <math>P_{US}=\text{\\$}175</math></li> </ul> </li> <li>♦ Exchange rates (£/\$)                 <ul style="list-style-type: none"> <li>▪ 1970 <math>E_{\text{£}/\text{\\$}}=0.57</math>                      1990 <math>E_{\text{£}/\text{\\$}}=0.63</math></li> </ul> </li> <li>♦ Prices of baskets in common currency (U.S. \$)                 <ul style="list-style-type: none"> <li>▪ UK    1970    <math>\text{\\$}175 (= \text{£}100/0.57)</math></li> <li>          1990    <math>\text{\\$}175 (= \text{£}110/0.63)</math></li> <li>▪ US    <math>\text{\\$}175</math> in both years</li> </ul> </li> </ul> </li> <li>• Relative purchasing power of the two currencies has remained the same</li> <li>• Is it coincidence that the exchange rate and price levels adjusted in this way?</li> </ul>
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Introduction to Exchange Rates and Prices
<ul style="list-style-type: none"> <li>• The ideas of arbitrage             <ul style="list-style-type: none"> <li>♦ Chapter 13: applied here to currencies and interest rates</li> <li>♦ Chapter 14: applied here to the goods market</li> </ul> </li> <li>• The prices of goods and services in different countries are related to the exchange rate.             <ul style="list-style-type: none"> <li>♦ When the relative prices of goods changes, the exchange rate adjusts to reflect this change (but this may take time).</li> </ul> </li> <li>• The monetary approach to exchange rates is the result.             <ul style="list-style-type: none"> <li>♦ A long run theory linking money, exchange rates, prices, and interest rates.</li> </ul> </li> <li>• The foundation of this theory is the fundamental arbitrage principle known as the <i>law of one price</i>.</li> </ul>
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### The Law of One Price

- Key assumption – frictionless trade
  - No transaction costs
  - No barriers to trade
  - Identical goods in each location
  - No barriers to price adjustment
  
- General idea:
  - Prices must be equal in all locations for any good when expressed in a common currency.
  - Otherwise, there would be a profit opportunity from buying low and selling high.

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### The Law of One Price

- Consider a single good,  $g$ , in 2 different markets.
- The **law of one price** (LOOP) states that the price of the good in each market must be the same.
- This is a microeconomic concept, applied to a single good,  $g$ .
- Relative price ratio for  $g$ :
 

$$q_{E/US}^g = (E_{\$/\epsilon} P_E^g) / P_{US}^g$$

relative price of good $g$ in Europe versus U.S.	European price of good $g$ expressed in \$	U.S. price of good $g$ expressed in \$
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### The Law of One Price

- If LOOP holds then (for each good  $g$ ):
 

$$q_{E/US}^g = 1 \quad \leftrightarrow \quad E_{\$/\epsilon} P_E^g = P_{US}^g$$

This means the price of good  $g$  is the same in Europe and in the U.S.
  
- What if LOOP doesn't hold?
  - Goods less expensive in U.S.
 

$$q_{E/US}^g > 1 \quad \leftrightarrow \quad E_{\$/\epsilon} P_E^g > P_{US}^g$$
  
  - Goods less expensive in Europe
 

$$q_{E/US}^g < 1 \quad \leftrightarrow \quad E_{\$/\epsilon} P_E^g < P_{US}^g$$

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### Purchasing Power Parity

- Macroeconomic counterpart to LOOP.
  - If LOOP holds for every good in CPI basket, then the prices of the entire baskets must be the same in each locations.
- The **purchasing power parity (PPP)** theory states that these overall price levels in each market must be the same.
- Relative price level ratio:

$$q_{E/US} = (E_{\$/\text{€}} P_E) / P_{US}$$

relative price of basket in Europe versus U.S.
European price of basket expressed in \$
U.S. price of basket expressed in \$

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### The Real Exchange Rate

- The relative price level ratio  $q$  is an important concept. It is called the **real exchange rate**

$$q_{E/US} = (E_{\$/\text{€}} P_E) / P_{US}$$

relative price of basket in Europe versus U.S.
European price of basket expressed in \$
U.S. price of basket expressed in \$

- Remember the key difference to avoid confusion.
  - *Nominal exchange rate  $E$  is the ratio at which currencies trade.*
  - *Real exchange rate  $q$  is ratio at which goods baskets trade.*
- However, the real exchange rate has some terminology in common with the nominal exchange rate...

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### Real Appreciation and Depreciation

$$q_{E/US} = (E_{\$/\text{€}} P_E) / P_{US}$$

relative price of basket in Europe versus U.S.
European price of basket expressed in \$
U.S. price of basket expressed in \$

- Changes in the real exchange rate:
  - If the real exchange rate rises
    - more home goods needed in exchange for foreign goods
    - intuitively called a **real depreciation**.
  - If the real exchange rate falls
    - fewer home goods needed in exchange for foreign goods
    - Intuitively called a **real appreciation**.

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### Overvaluation and Undervaluation

- **Absolute PPP** holds if and only if the real exchange rate equals 1:
 
$$E_{\$/\epsilon} P_E = P_{US}, \text{ or } q_{E/US} = 1.$$
- What if absolute PPP does not hold?
  - If the real exchange rate is above one (by x %)
    - foreign (European) goods are relatively expensive
    - foreign currency (euro) is said to be **overvalued** (by x %).
      - why? euros are x% dearer than they would have to be to satisfy PPP.
  - If the real exchange rate is below one (by x %)
    - foreign (European) goods are relatively cheap
    - foreign currency (euro) is said to be **undervalued** (by x %).
      - why? euros are x% cheaper than they would have to be to satisfy PPP.

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### Absolute PPP, Prices, and the Nominal Exchange Rate

- We can now see that PPP supplies a reference level for the exchange rate.
  - Rearrange the PPP equation:
 
$$\underbrace{E_{\$/\epsilon}}_{\text{exchange rate}} = \underbrace{P_{US} / P_E}_{\text{ratio of price levels}}$$
  - PPP implies that the exchange rate at which two currencies trade is equal to the relative price levels of the two countries.
  - PPP theory can be used to predict exchange rate movements – these simply reflect relative prices, so all we need to do is predict prices.

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### Relative PPP, Inflation, and Exchange Rate Depreciation

- The **absolute PPP** equation:
 
$$\underbrace{E_{\$/\epsilon}}_{\text{exchange rate}} = \underbrace{P_{US} / P_E}_{\text{ratio of price levels}}$$
- If this is true in *levels* of exchange rates and prices, then it is also true in *rates of change*.
  - The rate of change in the exchange rate is the rate of depreciation in the home currency (U.S. \$):
 
$$\frac{\Delta E_{\$/\epsilon, t}}{E_{\$/\epsilon, t}} = \frac{E_{\$/\epsilon, t+1} - E_{\$/\epsilon, t}}{\underbrace{E_{\$/\epsilon, t}}_{\text{rate of depreciation of the nominal exchange rate}}}$$

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**Relative PPP, Inflation, and Exchange Rate Depreciation**

- The rate of change in relative prices ( $P_{US}/P_E$ ) is the home-foreign inflation differential:
 
$$\frac{\frac{\Delta P_{US,t}}{P_{US,t}} - \frac{\Delta P_{E,t}}{P_{E,t}}}{1} = \underbrace{\left( \frac{P_{US,t+1} - P_{US,t}}{P_{US,t}} \right)}_{\text{rate of inflation in U.S. } \pi_{US,t}} - \underbrace{\left( \frac{P_{E,t+1} - P_{E,t}}{P_{E,t}} \right)}_{\text{rate of inflation in Europe } \pi_{E,t}}$$
- Result is **Relative PPP**

$$\underbrace{\frac{\Delta E_{\$/\text{€},t}}{E_{\$/\text{€},t}}}_{\text{rate of depreciation of the nominal exchange rate}} = \underbrace{\pi_{US,t} - \pi_{E,t}}_{\text{inflation differential}}$$
  - Relative PPP implies that the rate of depreciation of the nominal exchange rate equals the inflation differential.

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**Relative PPP, Inflation, and Exchange Rate Depreciation**

- Relative PPP is derived from Absolute PPP
  - If Absolute PPP holds then Relative PPP must hold also.
- But the converse need not be true: one could imagine a case where a basket always costs a fixed amount more, say, 10% in common currency terms in one country than the other:
  - In this case Absolute PPP fails, but Relative PPP holds.

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**Where Are We Now?**

- The PPP theory, whether in absolute or relative form, suggests that price levels in different countries and exchange rates are tightly linked, either in levels or in rates of change.
- Stop and ask some questions:
  - Where do price levels come from?
  - Do the data support the theory of purchasing power parity?

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### Empirical Evidence on PPP

- According to relative PPP, the percentage change in the exchange rate should equal the inflation differential.

Rate of depreciation 1975–2005 (% per year relative to U.S. \$)

Inflation differential 1975–2005 (% per year relative to U.S.)

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### Empirical Evidence on PPP

- According to absolute PPP, relative prices should converge over time.

U.S. dollars per pound sterling (\$/£)

Exchange rate,  $E_{\$/\pounds}$

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### How Slow is Convergence to PPP?

- Two measures:
  - ♦ **Speed of convergence:** how quickly deviations from PPP disappear over time (estimated to be 15% per year).
  - ♦ **Half-life:** how long it takes for half of the deviations from PPP to disappear (estimated to be about four years).
- These estimates are useful for forecasting how long exchange rate adjustments will take.

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**Forecasting Real Exchange Rates**

**SIDE BAR**

- If a currency is undervalued or overvalued, then the real exchange rate is not equal to one at all times.
  - We can allow for this by letting q change in the formulas we have derived.
  - From the definition of q:

$$\frac{\Delta E_{\$/\text{€},t}}{E_{\$/\text{€},t}} = \frac{\Delta q_{E/US,t}}{q_{E/US,t}} + (\pi_{US,t} - \pi_{E,t})$$

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**Forecasting Real Exchange Rates**

**SIDE BAR**

$$\frac{\Delta E_{\$/\text{€},t}}{E_{\$/\text{€},t}} = \frac{\Delta q_{E/US,t}}{q_{E/US,t}} + (\pi_{US,t} - \pi_{E,t})$$

- If q=1 is constant (PPP) then the 1<sup>st</sup> term on the right is zero.
  - To forecast the change in E you just need to forecast the inflation differential, as before.
- If q deviates from 1, and we can measure it, then we can use the convergence speed to estimate how quickly q will rise/fall towards 1.
  - This estimate of the rate of change of q can then be factored in, in addition to the inflation differential, to allow for an estimate of nominal depreciation.

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**Forecasting Real Exchange Rates**

**SIDE BAR**

$$\frac{\Delta E_{\$/\text{€},t}}{E_{\$/\text{€},t}} = \frac{\Delta q_{E/US,t}}{q_{E/US,t}} + (\pi_{US,t} - \pi_{E,t})$$

- Example**
  - You find that US inflation is 3%, Eurozone inflation is 2%.
  - Based on the inflation differential you predict a 1% rate of depreciation of the US dollar, or E to rise by 1%.
  - Then you also discover that the US dollar is 10% overvalued against the euro (q=0.90), relative to a PPP value of 1.
  - You expect 15% of that deviation of -0.1 to vanish in one year, so you expect q to rise (real depreciation) by 1.5%.
  - Adding the inflation differential, you now expect E to rise by 2.5%.

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**What Explains Deviations from PPP?**

- Transaction costs
  - ♦ Recent estimates suggest transportation costs may add about 20% to the cost of goods moving internationally.
  - ♦ Tariffs (and other policy barriers) may add another 10%, with variation across goods and across countries.
  - ♦ Further costs arise due to the time taken to ship goods.
- Nontraded goods
  - ♦ Some goods are inherently nontradable;
  - ♦ Most goods fall somewhere in between freely tradable and purely nontradable.
    - For example: a cup of coffee in a café. It includes some highly-traded components (coffee beans, sugar) and some nontraded components (the labor input of the barista).

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**What Explains Deviations from PPP?**

- Imperfect competition and legal obstacles (see Gandolfo)
  - ♦ Many goods are differentiated products, often with brand names, copyrights, and legal protection.
  - ♦ Firms can engage in price discrimination across countries, using legal protection to prevent arbitrage
    - E.g., if you try to import large quantities of a pharmaceuticals, and resell them, you may hear from the firm's lawyers.
- Price stickiness
  - ♦ One of the most common assumptions of macroeconomics is that prices are "sticky" prices in the short run.
  - ♦ PPP assumes that arbitrage can force prices to adjust, but adjustment will be slowed down by price stickiness.

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**The Big Mac Index**

HEADLINES -----

- For over 20 years *The Economist* newspaper has used PPP to evaluate whether currencies are undervalued or overvalued.
  - ♦ Recall, home currency is x% overvalued/undervalued when the home basket costs x% more/less than the foreign basket.
- The test is really based on Law of One Price because it relies on a basket with one good.
  - ♦ Invented (1986) by economics editor Pam Woodall. She asked correspondents around the world to visit McDonalds and get prices of a Big Mac, then compute price relative to the U.S.

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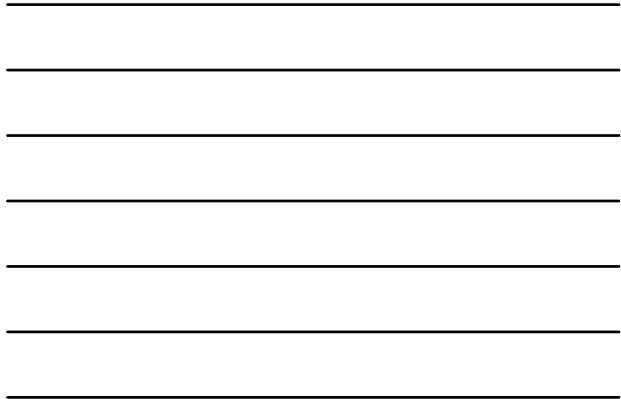


### The Big Mac Index

#### HEADLINES

$$\text{"Big Mac index"} = q^{\text{Big Mac}} - 1 = \frac{E_{\$/\text{local currency}} P_{\text{local}}^{\text{Big Mac}}}{P_{\text{US}}^{\text{Big Mac}}} - 1$$

- ♦ The % deviation (+/-) from the US price measures the over/under valuation of the local currency based on the burger basket.
- ♦ Updated every year: <http://www.economist.com/markets/Bigmac/>
- ♦ In 2004 they tried the same exercise with another global, uniform product: the Starbucks tall latte.

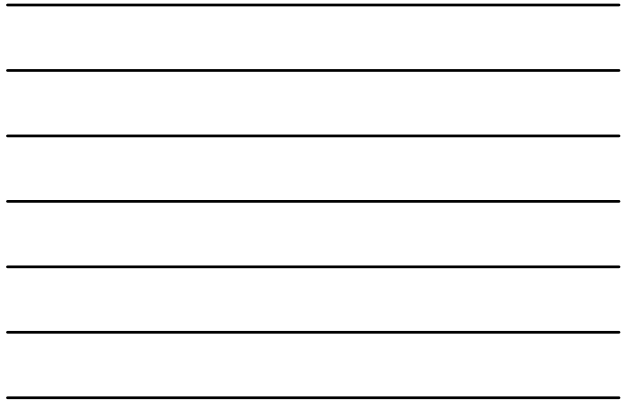


### The Big Mac Index

#### HEADLINES

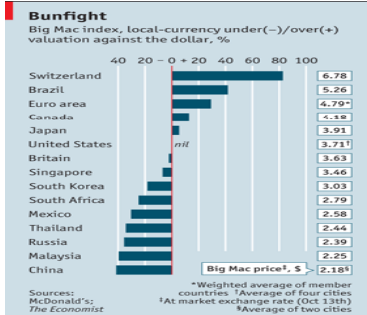
**Big Mac index**  
(based on market exchange rate:  
21 July 2010)

	Big Mac prices* in local currency	in dollars	Implied PPP† of the dollar	Actual dollar exchange rate July 2010	Under(-)/over(+) valuation against the dollar, %
United States†	\$ 3.73	3.73	3.73	3.73	0
Argentina	Price 14.0	3.50	3.75	3.93	-10
Australia	A\$ 4.35	3.84	3.17	3.13	3
Brazil	R\$ 6.71	4.91	2.33	1.77	31
Canada	C\$ 4.07	3.05	3.03	1.025	2
China	¥ 21.17	4.00	1.12	1.05	7
Chile	Price 1,700	3.34	4.08	5.64	-40
China	¥ 21.2	3.95	3.54	6.78	-48
Colombia	Price 8,400	4.39	2.194	1.668	38
Costa Rica	Colones 2,000	3.83	3.36	3.22	3
Czech Republic	Koruna 11.4	2.43	3.01	13.7	-28
Denmark	DKK 28.5	4.30	2.63	5.81	-31
Egypt	Pounds 13.0	2.28	3.68	5.70	-59
Estonia	Kroon 30.0	2.62	6.07	12.2	-30
Euro area**	€ 3.98	4.33	1,101††	1,091††	10
Hong Kong	HK\$ 14.8	3.90	3.98	7.72	-49
Hungary	Forint 740	3.33	3.98	2.22	-13
Indonesia	Rupiah 22,700	2.51	6,102	9,003	-33
Israel	Shekel 14.9	3.88	3.90	3.88	0
Japan	¥ 210	3.62	85.7	87.2	-2
Latvia	Lats 1.55	2.88	0.42	0.55	-26
Lithuania	Litas 2.0	2.73	1.96	2.00	-27
Malaysia	Ringgit 7.05	2.19	1.89	3.01	-41
Mexico	Price 32.0	2.50	6.57	12.8	-33
New Zealand	NZ\$ 5.00	3.50	1.34	1.39	-2
Norway	Krone 45.0	7.20	12.1	8.25	33
Pakistan	Rupay 210	2.48	98.2	86.5	-14
Peru	Sol 10.0	3.54	2.48	2.83	-5
Philippines	Price 100	2.19	27.2	46.5	-43
Poland	Zloty 8.30	2.60	2.22	3.20	-30
Russia	Ruble 21.0	2.33	19.0	30.4	-28
Saudi Arabia	Riyal 10.0	2.67	2.68	3.75	-29
Singapore	S\$ 4.25	3.68	1.13	1.17	-14
South Africa	Rand 18.5	2.05	6.94	7.54	-16
South Korea	Won 3,400	2.82	911	1,004	-26
Sri Lanka	Rupay 210	1.88	94.4	113	-30
Sweden	SKr 48.4	6.96	13.0	7.37	78
Switzerland	CHF 4.50	6.19	1.74	1.05	60
Thailand	฿ 75.0	2.34	20.1	32.1	-37
Turkey	Lira 5.95	1.89	1.59	1.53	4
UK†	£ 3.10	2.96	2.96	3.47	-20
Ukraine	Hryvnia 14.5	1.84	3.88	7.00	-51
Hungary	Forint 74.0	3.74	41.2	21.1	40



#### HEADLINES

**Big Mac index**  
(based on market exchange rate:  
3 October 2010)



## The Big Mac Index

### HEADLINES



**Our hot tips**  
Local currency under (-) / over (+) valuation against the dollar, %, using:

	Starbucks latte-to-latte index	McDonald's Big Mac index
Australia	-4	-17
Britain	+17	+23
Canada	-16	-16
China	-1	-56
Euro area	+33	+24
Hong Kong	+15	-45
Japan	+13	-12
Malaysia	-25	-53
Mexico	-15	-21
New Zealand	-12	-4
Singapore	+2	-31
South Korea	+6	0
Switzerland	+82	+82
Taiwan	-8	-21
Thailand	-31	-46
Turkey	+6	+5




Source: The Economist

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## PPP as a Theory of the Exchange Rate

- In levels we have **Absolute PPP**:

$$\underbrace{E_{\$/\text{€}}}_{\text{exchange rate}} = \underbrace{P_{US} / P_E}_{\text{ratio of price levels}}$$

- In rates of change we have **Relative PPP**

$$\underbrace{\frac{\Delta E_{\$/\text{€},t}}{E_{\$/\text{€},t}}}_{\text{rate of depreciation of the nominal exchange rate}} = \underbrace{\pi_{US,t} - \pi_{E,t}}_{\text{inflation differential}}$$

- Now we need to ask: where do the price levels (and inflation rates) come from?

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