14

EXCHANGE RATES I: PPP and THE MONETARY APPROACH IN THE LONG RUN

Introduction to Exchange Rates and Prices

- Consider some hypothetical data on prices and exchange rates in the U.S. and U.K.:
  - Prices of U.S. and U.K. CPI baskets
    - 1970 P_{UK}=£100 1990 P_{UK}=£110
    - 1970 P_{US}=$175 1990 P_{US}=$175
  - Exchange rates (£/$)
    - 1970 $E_{£/\$}$=0.57 1990 $E_{£/\$}$=0.63
  - Prices of baskets in common currency (U.S. $)
    - UK 1970 $175 (= £100/ 0.57)
      1990 $175 (= £110/ 0.63)
    - US $175 in both years
- Relative purchasing power of the two currencies has remained the same
- Is it coincidence that the exchange rate and price levels adjusted in this way?

Introduction to Exchange Rates and Prices

- The ideas of arbitrage
  - Chapter 13: applied there to currencies and interest rates
  - Chapter 14: applied here to the goods market
- The prices of goods and services in different countries are related to the exchange rate.
  - When the relative prices of goods changes, the exchange rate adjusts to reflect this change (but this may take time).
- The monetary approach to exchange rates is the result.
  - A long run theory linking money, exchange rates, prices, and interest rates.
- The foundation of this theory is the fundamental arbitrage principle known as the *law of one price*.

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.

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*:

$$\underbrace{q^{g}_{E/US}}_{\substack{\text{relative price}\\ \text{of good } g\\ \text{in Europe}\\ \text{versus U.S.}}} = \underbrace{(E_{\$/€} P^{g}_{E})}_{\substack{\text{European price}\\ \text{of good } g\\ \text{expressed}\\ \text{in \$}}} / \underbrace{P^{g}_{US}}_{\substack{\text{U.S. price}\\ \text{of good } g\\ \text{expressed}\\ \text{in \$}}}$$

The Law of One Price

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

$$q^g_{E/US} = 1 \quad \leftrightarrow \quad E_{\$/€} P^g_E = P^g_{US}$$

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.

$$q^g_{E/US} > 1 \quad \leftrightarrow \quad E_{\$/€} P^g_E > P^g_{US}$$

  - Goods less expensive in Europe

$$q^g_{E/US} < 1 \quad \leftrightarrow \quad E_{\$/€} P^g_E < P^g_{US}$$

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:

$$\underbrace{q_{E/US}}_{\text{relative price of basket in Europe versus U.S.}} = \underbrace{(E_{\$/€} P_E)}_{\text{European price of basket expressed in \$}} / \underbrace{P_{US}}_{\text{U.S. price of basket expressed in \$}}$$

The Real Exchange Rate

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

$$\underbrace{q_{E/US}}_{\substack{\text{relative price}\\ \text{of basket}\\ \text{in Europe}\\ \text{versus U.S.}}} = \underbrace{(E_{\$/€} P_E)}_{\substack{\text{European price}\\ \text{of basket}\\ \text{expressed}\\ \text{in \$}}} / \underbrace{P_{US}}_{\substack{\text{U.S. price}\\ \text{of basket}\\ \text{expressed}\\ \text{in \$}}}$$

- 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…

Real Appreciation and Depreciation

$$\underbrace{q_{E/US}}_{\substack{\text{relative price}\\ \text{of basket}\\ \text{in Europe}\\ \text{versus U.S.}}} = \underbrace{(E_{\$/€} P_E)}_{\substack{\text{European price}\\ \text{of basket}\\ \text{expressed}\\ \text{in \$}}} / \underbrace{P_{US}}_{\substack{\text{U.S. price}\\ \text{of basket}\\ \text{expressed}\\ \text{in \$}}}$$

- 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**.

Overvaluation and Undervaluation

- **Absolute PPP** holds if and only if the real exchange rate equals 1:

$$E_{\$/€} P_E = P_{US}, \text{ or } q_{E/US} = 1.$$

- 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.

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:

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

    - 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.

Relative PPP, Inflation, and Exchange Rate Depreciation

- The **absolute PPP** equation:

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

- 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. $):

$$\frac{\Delta E_{\$/€,t}}{E_{\$/€,t}} = \underbrace{\frac{E_{\$/€,t+1} - E_{\$/€,t}}{E_{\$/€,t}}}_{\substack{\text{rate of depreciation} \\ \text{of the nominal exchange rate}}}$$

Relative PPP, Inflation, and Exchange Rate Depreciation

- The rate of change in relative prices (P_{US}/P_E) is the home-foreign inflation differential:

$$\frac{\Delta P_{US,t}}{P_{US,t}} - \frac{\Delta P_{E,t}}{P_{E,t}} = \underbrace{\left(\frac{P_{US,t+1} - P_{US,t}}{P_{US,t}}\right)}_{\text{rate of inflation in U.S. } \pi_{US,t}} - \underbrace{\left(\frac{P_{E,t+1} - P_{E,t}}{P_{E,t}}\right)}_{\text{rate of inflation in Europe } \pi_{E,t}}$$

- Result is **Relative PPP**

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

  - Relative PPP implies that the rate of depreciation of the nominal exchange rate equals the inflation differential.

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.*

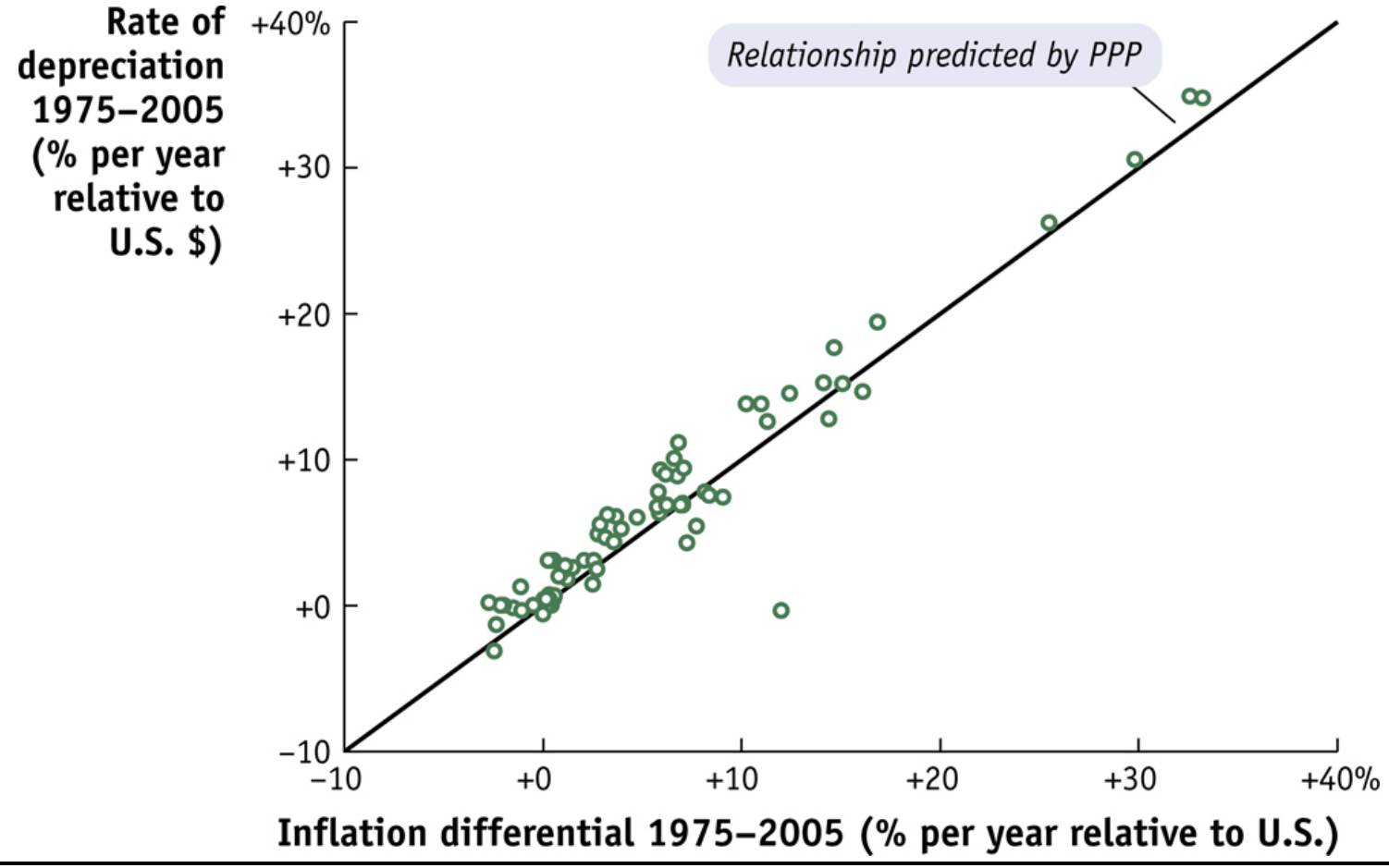
Where Are We Now?

- The PPP theory, whether in absolute of 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?

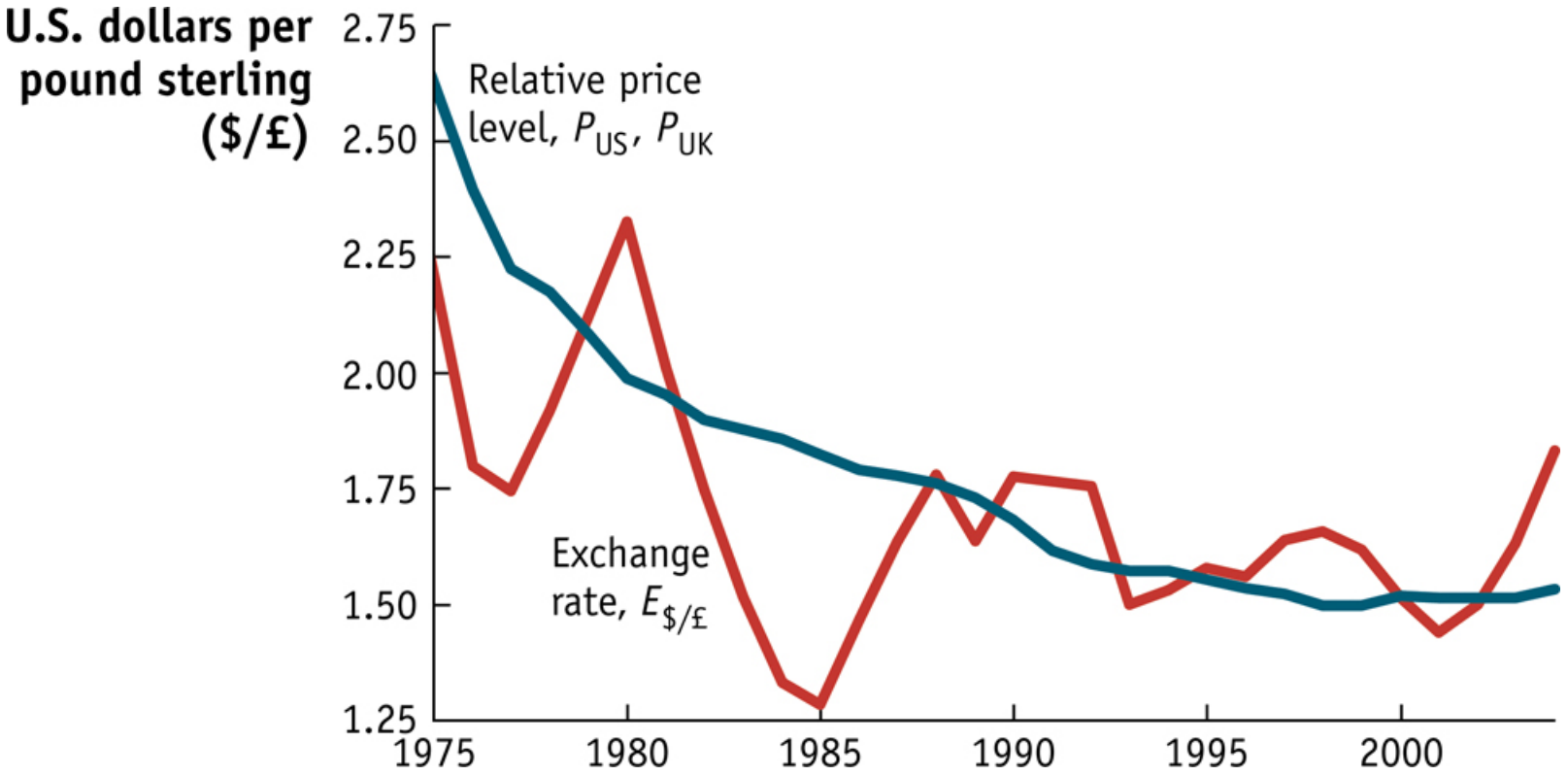
Empirical Evidence on PPP

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



Empirical Evidence on PPP

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



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.

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:

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

Forecasting Real Exchange Rates

SIDE BAR

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

- If q=1 is constant (PPP) then the 1st 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.

Forecasting Real Exchange Rates

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

- 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%.

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).

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.

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.

The Big Mac Index

HEADLINES

$$\text{“Big Mac index”} = q^{\text{Big Mac}} - 1 = \frac{E_{\$/\text{local currency}} \times P^{\text{Big Mac}}_{\text{local}}}{P^{\text{Big Mac}}_{\text{US}}} - 1$$

- 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.

HEADLINES

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

Last one

The Big Mac index

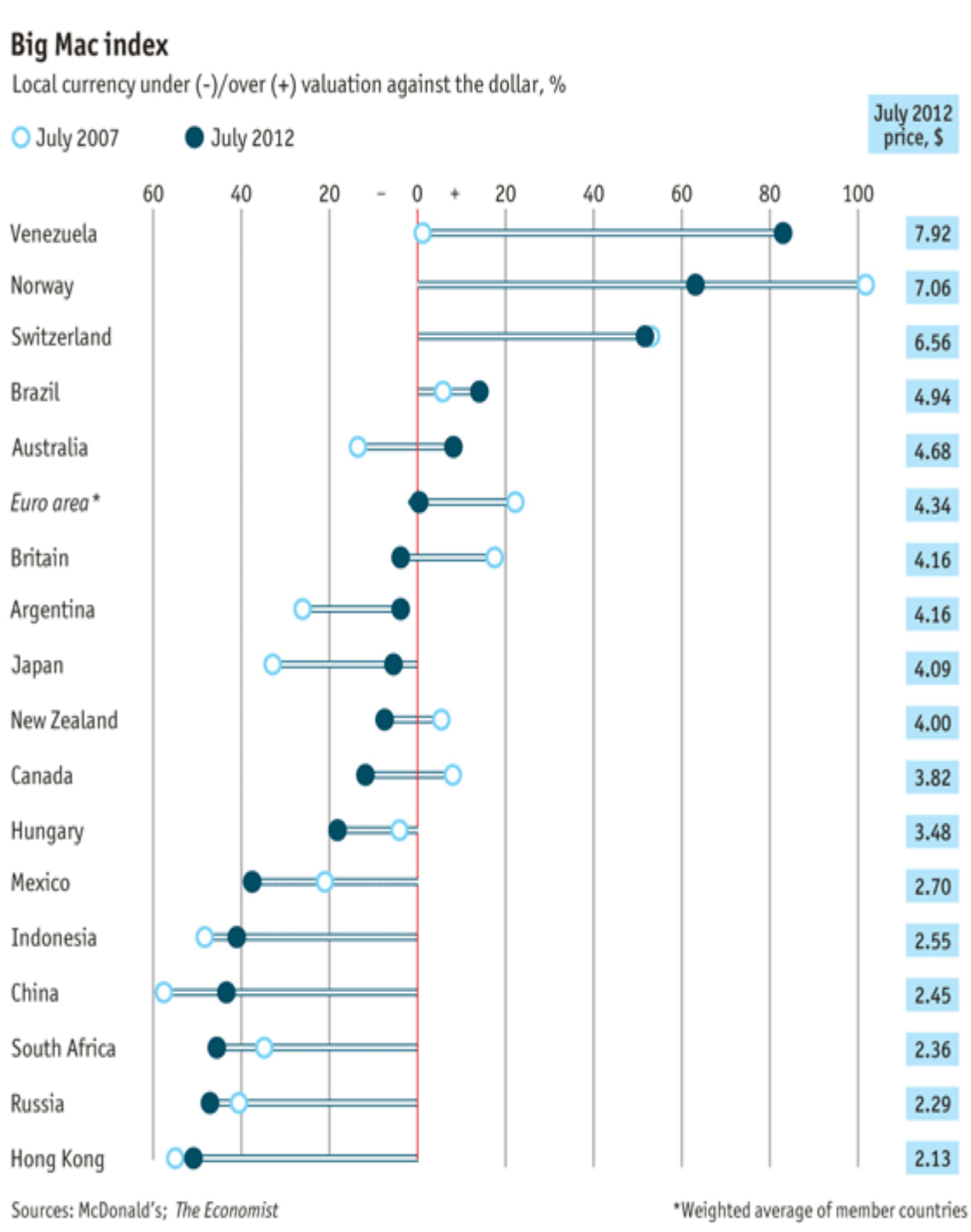
	Big Mac prices* in local currency	Big Mac prices* in dollars	Implied PPP† of the dollar	Actual dollar exchange rate July 21st	Under(-)/over(+) valuation against the dollar, %
United States‡	$ 3.73	3.73			
Argentina	Peso 14.0	3.56	3.75	3.93	-5
Australia	A$ 4.35	3.84	1.17	1.13	3
Brazil	Real 8.71	4.91	2.33	1.77	31
Britain	£ 2.29	3.48	1.63 §	1.52 §	-7
Canada	C$ 4.17	4.00	1.12	1.04	7
Chile	Peso 1,750	3.34	469	524	-10
China	Yuan 13.2	1.95	3.54	6.78	-48
Colombia	Peso 8,200	4.39	2,196	1,868	18
Costa Rica	Colones 2,000	3.83	536	522	3
Czech Republic	Koruna 67.6	3.43	18.1	19.7	-8
Denmark	DK 28.5	4.90	7.63	5.81	31
Egypt	Pound 13.0	2.28	3.48	5.70	-39
Estonia	Kroon 32.0	2.62	8.57	12.2	-30
Euro area**	€ 3.38	4.33	1.10 ††	1.28 ††	16
Hong Kong	HK$ 14.8	1.90	3.96	7.77	-49
Hungary	Forint 740	3.33	198	222	-11
Indonesia	Rupiah 22,780	2.51	6,102	9,063	-33
Israel	Shekel 14.9	3.86	3.99	3.86	3
Japan	¥ 320	3.67	85.7	87.2	-2
Latvia	Lats 1.55	2.80	0.42	0.55	-25
Lithuania	Litas 7.30	2.71	1.96	2.69	-27
Malaysia	Ringgit 7.05	2.19	1.89	3.21	-41
Mexico	Peso 32.0	2.50	8.57	12.8	-33
New Zealand	NZ$ 5.00	3.59	1.34	1.39	-4
Norway	Kroner 45.0	7.20	12.1	6.25	93
Pakistan	Rupee 210	2.46	56.3	85.5	-34
Peru	Sol 10.0	3.54	2.68	2.83	-5
Philippines	Peso 102	2.19	27.3	46.5	-41
Poland	Zloty 8.30	2.60	2.22	3.20	-30
Russia	Rouble 71.0	2.33	19.0	30.4	-38
Saudi Arabia	Riyal 10.0	2.67	2.68	3.75	-29
Singapore	S$ 4.23	3.08	1.13	1.37	-18
South Africa	Rand 18.5	2.45	4.94	7.54	-34
South Korea	Won 3,400	2.82	911	1,204	-24
Sri Lanka	Rupee 210	1.86	56.3	113	-50
Sweden	SKr 48.4	6.56	13.0	7.37	76
Switzerland	SFr 6.50	6.19	1.74	1.05	66
Taiwan	NT$ 75.0	2.34	20.1	32.1	-37
Thailand	Baht 70.0	2.17	18.8	32.3	-42
Turkey	Lira 5.95	3.89	1.59	1.53	4
UAE	Dirhams 11.0	2.99	2.95	3.67	-20
Ukraine	Hryvnia 14.5	1.84	3.88	7.90	-51
Uruguay	Peso 79.0	3.74	21.2	21.1	*nil*

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

Sources: McDonald's; *The Economist*

HEADLINES

Big Mac index *(based on market exchange rate: July 2012)*



The Big Mac Index

HEADLINES

Our hot tips

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

	Starbucks tall-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	+62	+82
Taiwan	-5	-21
Thailand	-31	-46
Turkey	+6	+5

Source: *The Economist*

PPP as a Theory of the Exchange Rate

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

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

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

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

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