

# Prices and Exchange Rates: Purchasing Power Parity

*These slides draw on Husted/Melvin: International Economics; and Krugman/Obstfeld/Melitz: International Economics; adapted by Guido Baldi.*

# Preview

- Law of one price
- Purchasing power parity
- Shortcomings of purchasing power parity
- Long-run model of exchange rates: monetary approach
- Real exchange rates

# Law of One Price

- The **law of one price** simply says that the *same* good in different competitive markets must sell for the same price, when transportation costs and barriers between those markets are not important.
  - Why? Suppose the price of pizza at one restaurant is \$20, while the price of the *same* pizza at an identical restaurant across the street is \$40.
  - What do you predict will happen? Many people will buy the \$20 pizza, few will buy the \$40 one.

# Law of One Price (cont.)

- Due to the price difference, entrepreneurs would have an incentive to buy pizza at the cheap location and sell it at the expensive location for an easy profit.
- Due to strong demand and decreased supply, the price of the \$20 pizza would tend to increase.
- Due to weak demand and increased supply, the price of the \$40 pizza would tend to decrease.
- People would have an incentive to adjust their behavior and prices would tend to adjust until one price is achieved across markets (across restaurants).

# Law of One Price (cont.)

- Consider a pizza restaurant in Seattle and one across the border in Vancouver.
- The law of one price says that the price of the same pizza (using a common currency to measure the price) in the two cities must be the same if markets are competitive and transportation costs and barriers between markets are not important.

$$P^{pizza}_{US} = (E_{US\$/C\$}) \times (P^{pizza}_{Canada})$$

$P^{pizza}_{US}$  = price of pizza in Seattle

$P^{pizza}_{Canada}$  = price of pizza in Vancouver

$E_{US\$/C\$}$  = U.S. dollar/Canadian dollar exchange rate

# Problems with Law of One Price

- The more homogeneous goods are, the more the law of one price is expected to hold.
- There are obstacles to equalization of product prices across countries, including differentiated products, different tastes, distance, costly information and costly shipping.

# Purchasing Power Parity

- **Purchasing power parity** is the application of the law of one price across countries for *all* goods and services, or for representative groups (“baskets”) of goods and services.

$$P_{US} = (E_{US\$/C\$}) \times (P_{Canada})$$

$P_{US}$  = level of average prices in the U.S.

$P_{Canada}$  = level of average prices in Canada

$E_{US\$/C\$}$  = U.S. dollar/Canadian dollar exchange rate

# Purchasing Power Parity (cont.)

- Purchasing power parity (PPP) implies that the exchange rate is determined by levels of average prices

$$E_{\text{US}\$/\text{C}\$} = P_{\text{US}}/P_{\text{Canada}}$$

- If the price level in the U.S. is US\$200 per basket, while the price level in Canada is C\$400 per basket, PPP implies that the C\$/US\$ exchange rate should be C\$400/US\$200 = C\$2/US\$1.
- Predicts that people in all countries have the same purchasing power with their currencies: 2 Canadian dollars buy the same amount of goods as 1 U.S. dollar, since prices in Canada are twice as high.



# Purchasing Power Parity (cont.)

- Purchasing power parity (PPP) comes in 2 forms:
- **Absolute PPP:** purchasing power parity that has already been discussed. Exchange rates equal the *level* of relative average prices across countries.

$$E_{\$/\epsilon} = P_{US}/P_{EU}$$

- **Relative PPP:** *changes* in exchange rates equal *changes* in prices (inflation) between two periods:

$$(E_{\$/\epsilon,t} - E_{\$/\epsilon,t-1})/E_{\$/\epsilon,t-1} = \pi_{US,t} - \pi_{EU,t}$$

where  $\pi_t$  = inflation rate from period  $t - 1$  to  $t$

# “Overvalued” vs. “Undervalued” Currency

- **Overvalued currency**—a currency worth more than the PPP value.
- **Undervalued currency**—a currency worth less than the PPP value.

# The Euro/CHF exchange rate and purchasing power parity



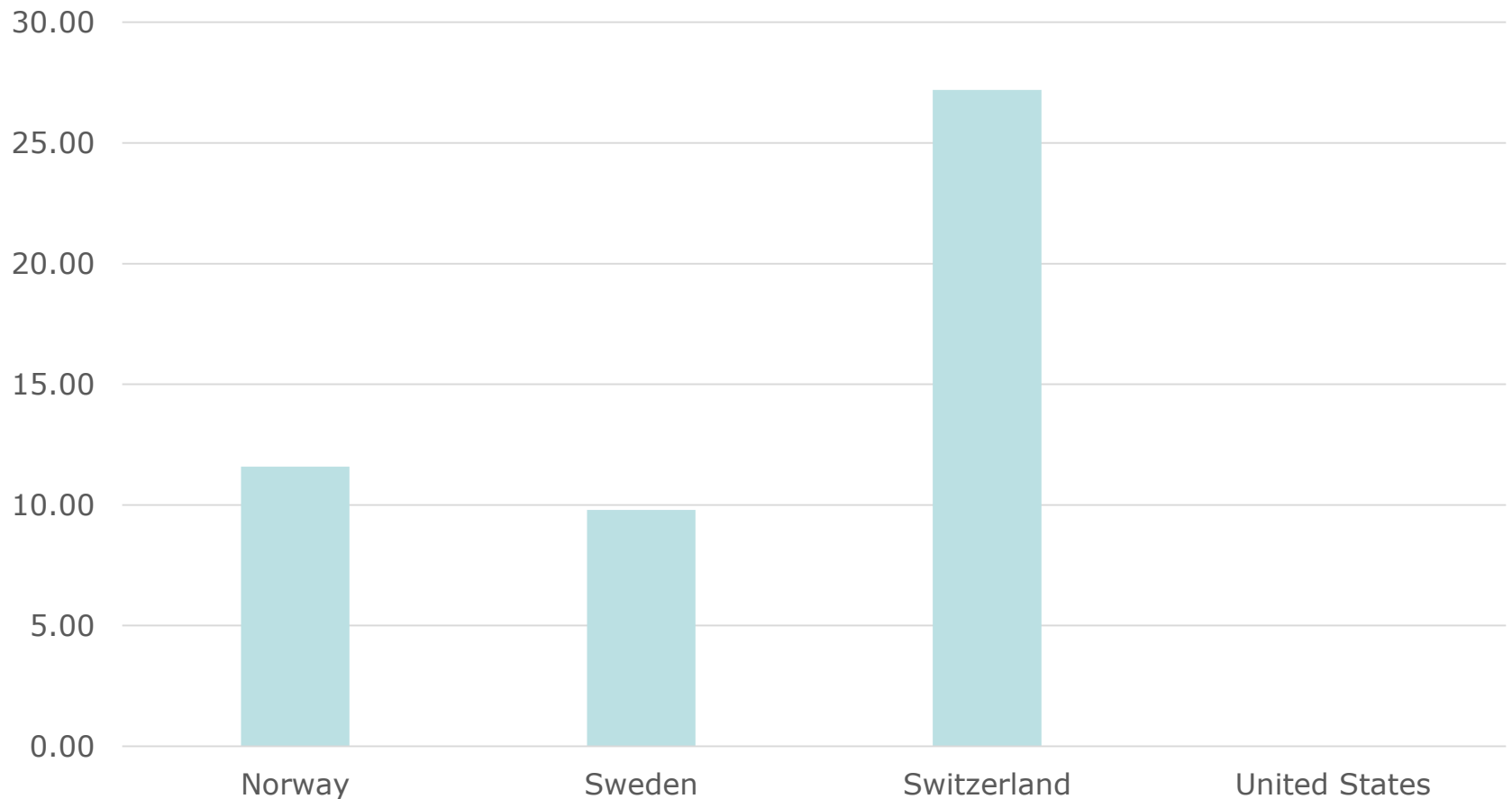
# Law of One Price for Hamburgers?

The hamburger standard					
	Big Mac prices		Implied PPP* of the dollar	Actual exchange rate: Jan 30 <sup>th</sup>	Under (-)/over(+) Valuation against the dollar, %
	in local currency	in dollars			
United States <sup>†</sup>	\$3.54	3.54	-	-	
Argentina	Peso 11.50	3.30	3.25	3.49	-7
Australia	A\$3.45	2.19	0.97	1.57	-38
Brazil	Real 8.02	3.45	2.27	2.32	-2
Britain	£2.29	3.30	1.55 <sup>‡</sup>	1.44 <sup>‡</sup>	-7
Canada	C\$4.16	3.36	1.18	1.24	-5
Chile	Peso 1.550	2.51	438	617	-29
China	Yuan 12.5	1.83	3.53	6.84	-48
Czech Republic	Koruna 65.94	3.02	18.6	21.9	-15
Denmark	DK 29.5	5.07	8.33	5.82	43
Egypt	Pound 13.0	2.34	3.67	5.57	-34
Euro areas <sup>§</sup>	€3.42	4.38	1.04 <sup>**</sup>	1.28 <sup>**</sup>	24
Hong Kong	HK\$13.3	1.72	3.76	7.75	-52
Hungary	Forint 680	2.92	192	233	-18
Indonesia	Rupiah 19.800	1.74	5,593	11,380	-51
Israel	Shekel 15.0	3.69	4.24	4.07	4
Japan	¥290	3.23	81.9	89.8	-9
Malaysia	Ringgit 5.50	1.52	1.55	3.61	-57
Mexico	Peso 33.0	2.30	9.32	14.4	-35
New Zealand	NZ\$4.90	2.48	1.38	1.97	-30
Norway	Kroner 40.0	5.79	11.3	6.61	63
Peru	Sol 8.06	2.54	2.28	3.18	-28
Philippines	Peso 98.0	2.07	27.7	47.4	-42
Poland	Zloty 7.00	2.01	1.98	3.48	-43
Russia	Ruble 62.0	1.73	17.5	35.7	-51
Saudi Arabia	Riyal 10.0	2.66	2.82	3.75	-25
Singapore	S\$3.95	2.61	1.12	1.51	-26
South Africa	Rand 16.95	1.66	4.79	10.2	-53
South Korea	Won 3,300	2.39	932	1,380	-32
Sweden	SKR 38.0	4.58	10.7	8.30	29
Switzerland	CHF 6.50	5.60	1.84	1.16	58
Taiwan	NT\$75.0	2.23	21.2	33.6	-37
Thailand	Baht 62.0	1.77	17.5	35.0	-50
Turkey	Lire 5.15	3.13	1.45	1.64	-12

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

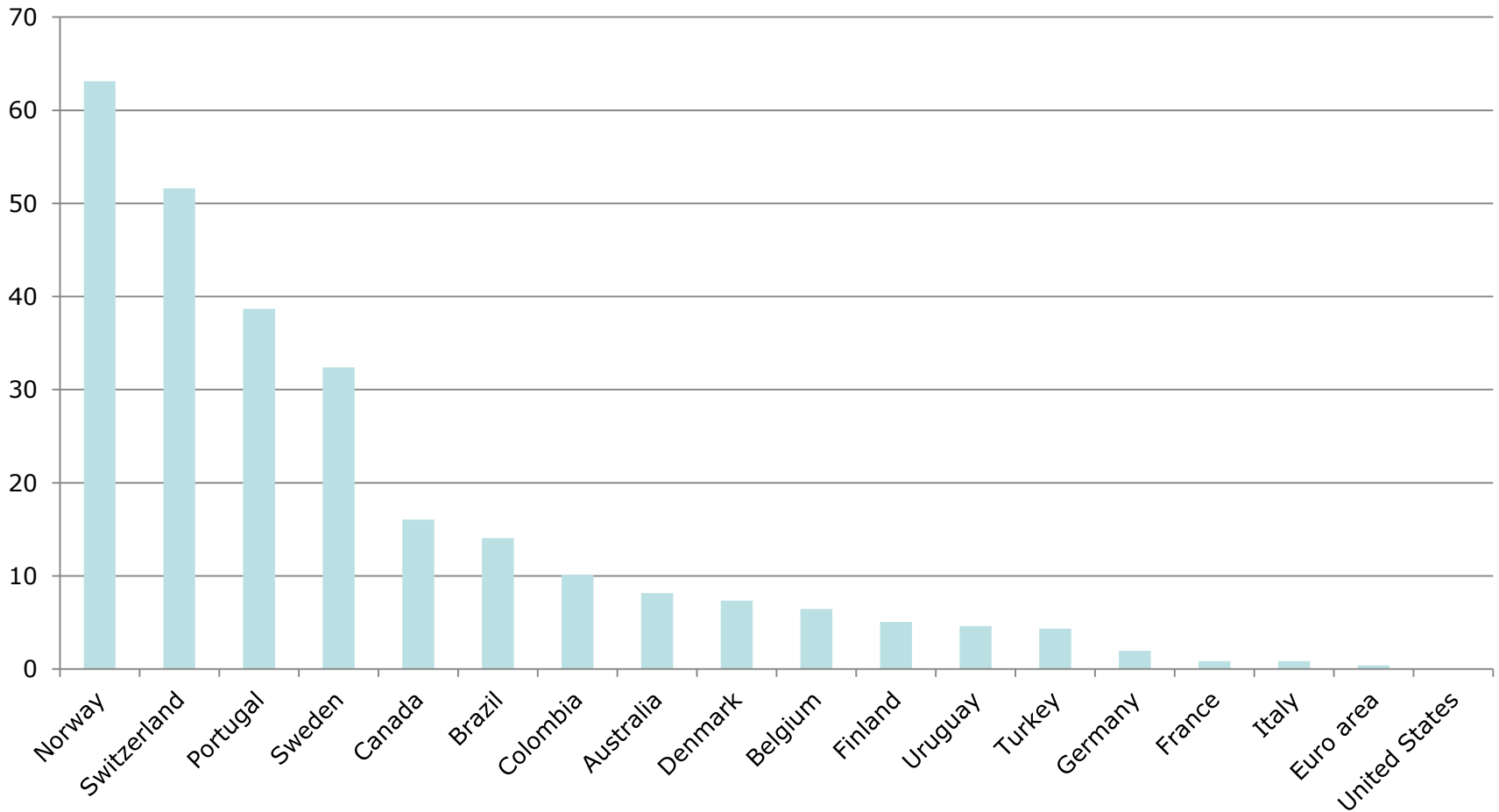
Sources: McDonald's; the *Economist*, February 4, 2010. Exchange rates are local currency per dollar, except where noted.

# Big-Mac Index 2017 – overvalued currencies



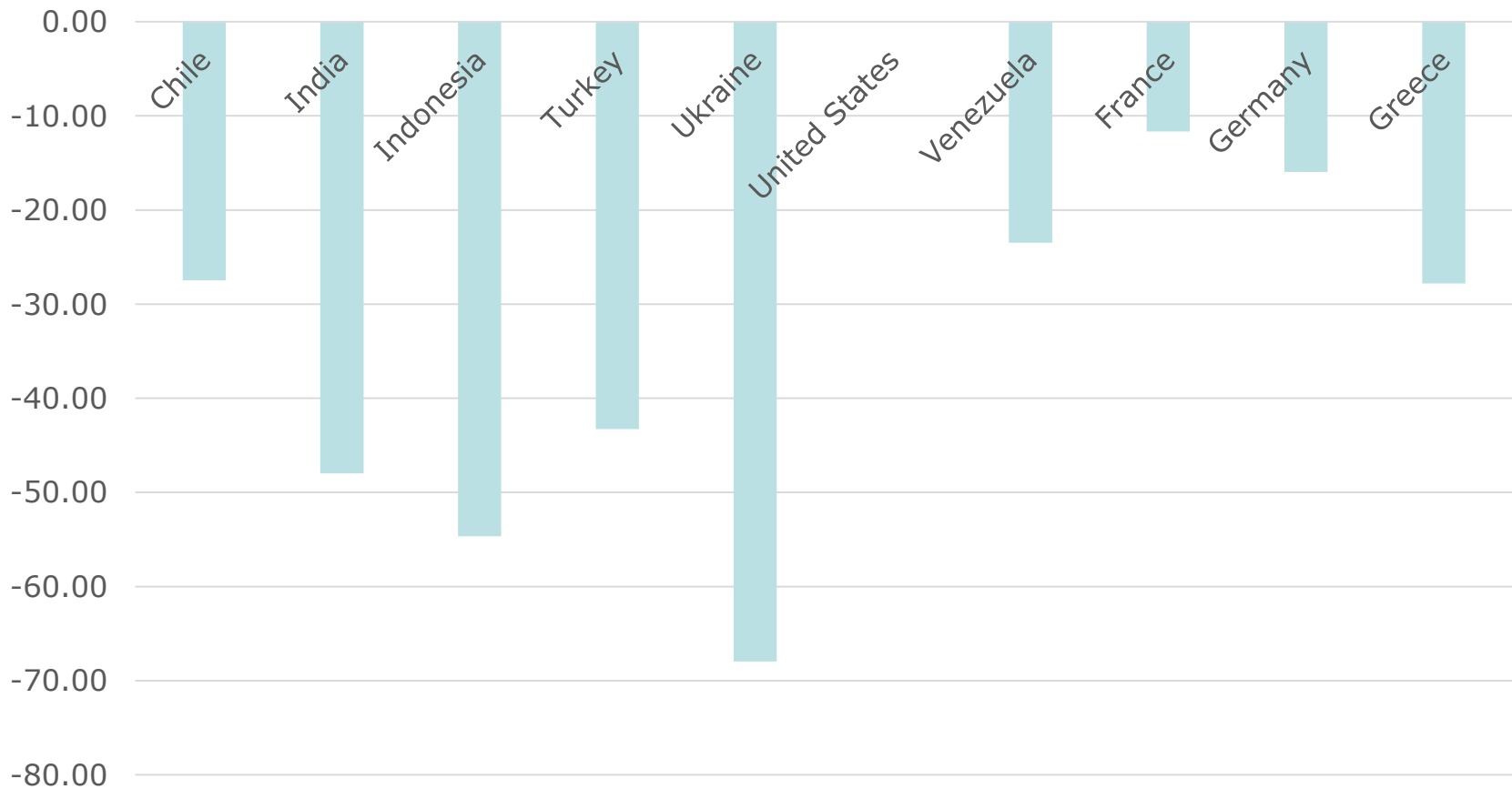
Source: Economist

# Big-Mac Index 2012 – overvalued currencies



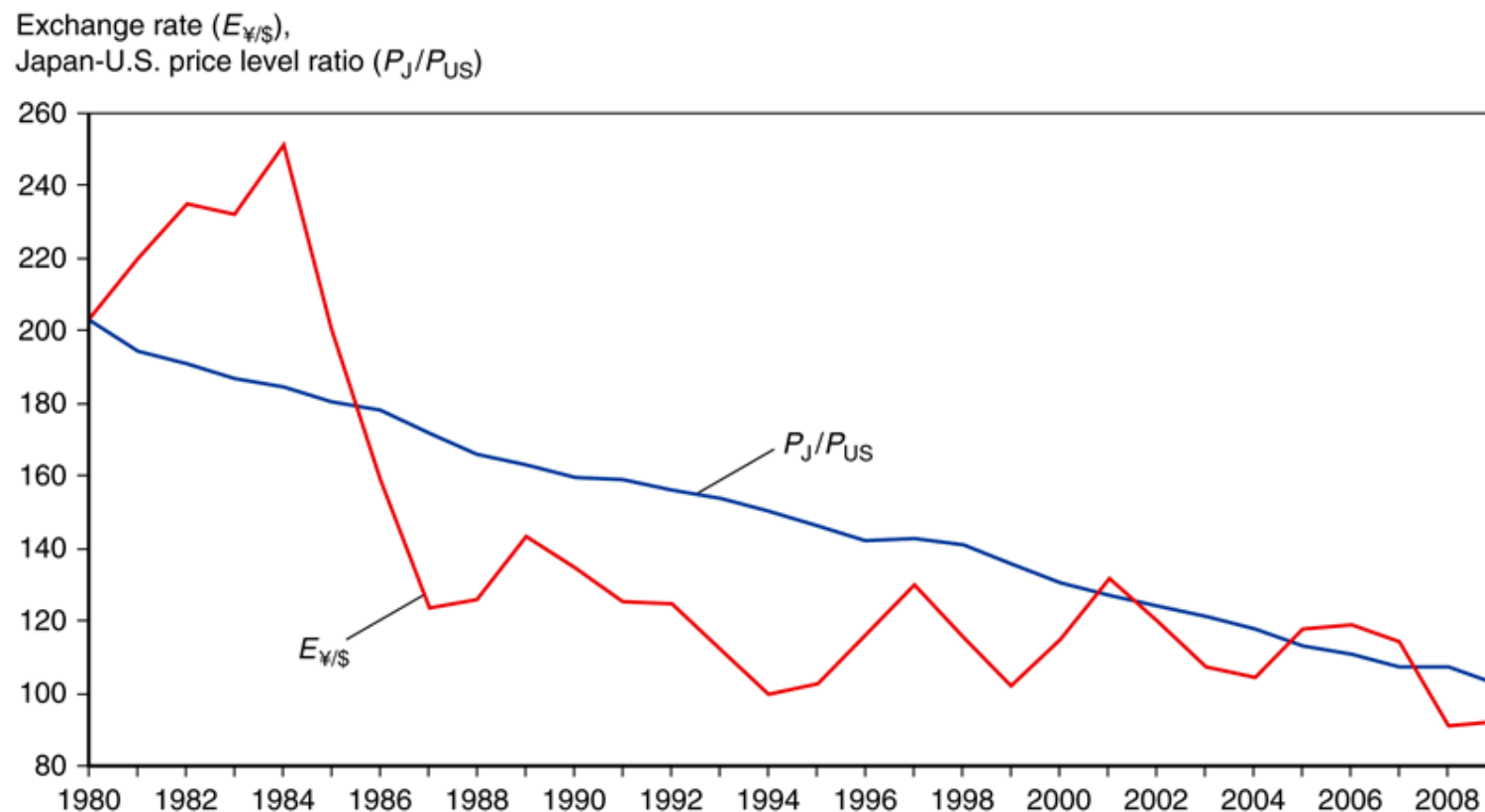
Source: Economist

# Big-Mac Index 2017 – undervalued currencies (selection)



Source: Economist

# Fig. 16-2: The Yen/Dollar Exchange Rate and Relative Japan-U.S. Price Levels, 1980–2009



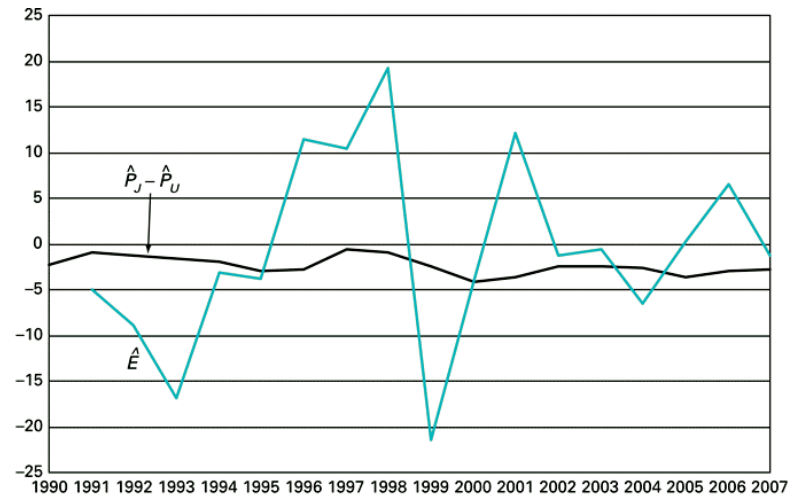
Source: IMF, *International Financial Statistics*. Exchange rates and price levels are end-of-year data.



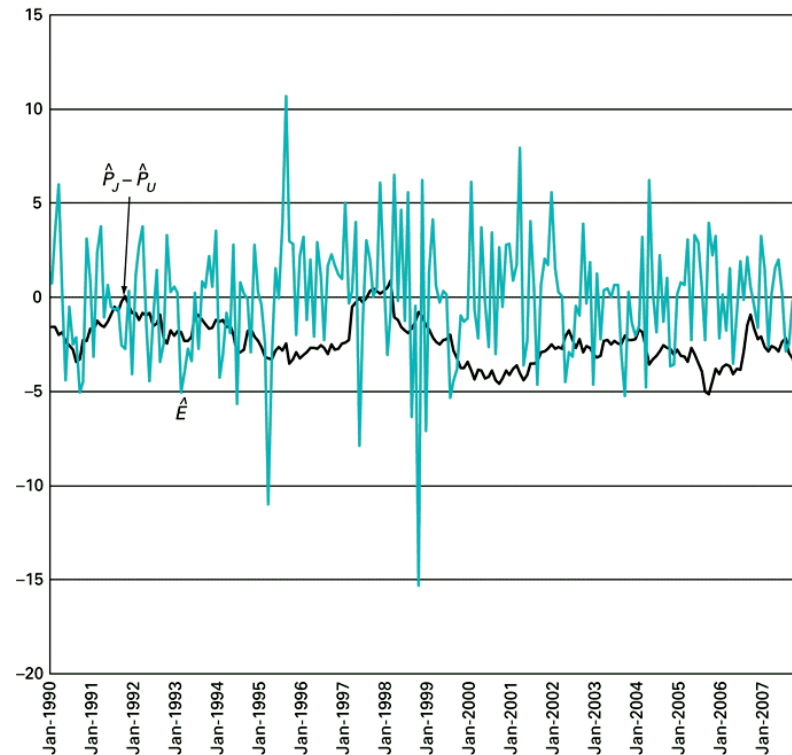
# PPP on a Monthly vs. Annual Basis

- The exchange rates are more variable than the inflation differentials.
- Deviations from PPP are more apparent for monthly than for annual data.

# U.S.–Japan Purchasing Power Parity Monthly vs. Annual



(a) Annual data



(b) Monthly data

# Shortcomings of PPP

- There is little empirical support for absolute purchasing power parity.
  - The prices of identical commodity baskets, when converted to a single currency, differ substantially across countries.
- Relative PPP is more consistent with data, but it also performs poorly to predict exchange rates.

# Shortcomings of PPP (cont.)

Reasons why PPP may not be accurate: the law of one price may not hold because of

1. Trade barriers and nontradable products
2. Imperfect competition
3. Differences in measures of average prices for baskets of goods and services

# Shortcomings of PPP (cont.)

- **Trade barriers and nontradable products**

- Transport costs and governmental trade restrictions make trade expensive and in some cases create nontradable goods or services.
- Services are often not tradable: services are generally offered within a limited geographic region (for example, haircuts).
- The greater the transport costs, the greater the range over which the exchange rate can deviate from its PPP value.
- One price need not hold in two markets.

# Shortcomings of PPP (cont.)

- **Imperfect competition** may result in price discrimination: “pricing to market.”
  - A firm sells the same product for different prices in different markets to maximize profits, based on expectations about what consumers are willing to pay.
  - One price need not hold in two markets.

# Shortcomings of PPP (cont.)

- **Differences in the measure of average prices for goods and services**
  - levels of average prices differ across countries because of differences in how representative groups (“baskets”) of goods and services are measured.
  - Because measures of groups of goods and services are different, the measure of their average prices need not be the same.
  - One price need not hold in two markets.

## Shortcomings of PPP (cont.)

- PPP is not a theory of exchange rate determination. Both prices and exchange rates are **endogenous variables** determined by other given factors such as bad weather or government policy (**exogenous variables**).
- Unexpected information or news (e.g., Federal Reserve monetary policy announcement) may affect both exchange rates and prices.



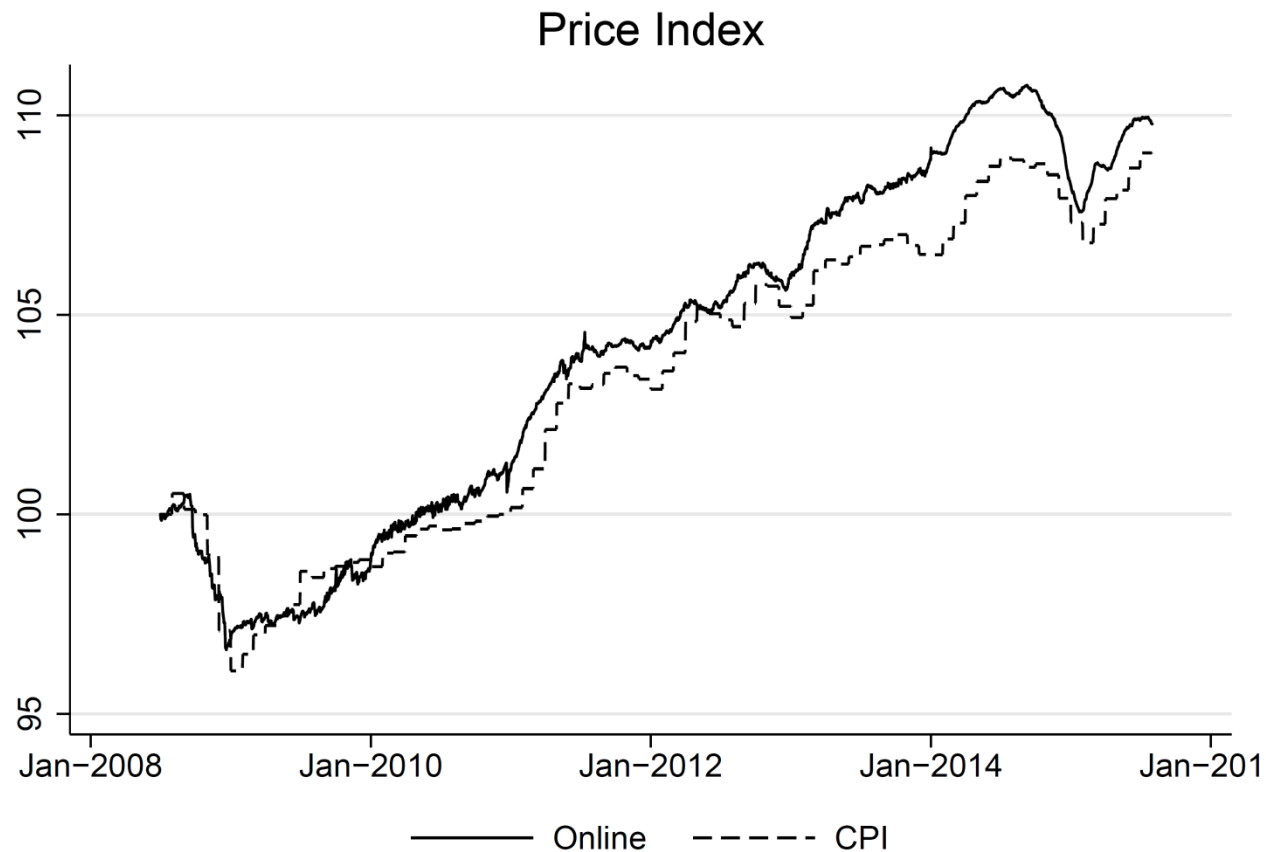
# Recent Research

- Alberto Cavallo, Brent Neiman and Roberto Rigobon: "Currency Unions, Product Introductions, and the Real Exchange Rate" - Quarterly Journal of Economics - May 2014 - Vol. 129 (2).
- They use a novel dataset of online prices of identical goods sold by four large global retailers (Apple, IKEA, H&M, Zara).
- Results:
  - Most deviations from the law of one price reflect differences in prices at the time products are first introduced.
  - The law of one price holds well within currency unions.

# The Billion Prices Project

- <http://bpp.mit.edu/>
- Cavallo, A, and R Rigobon. (2016), "The Billion Prices Project: Using Online Data for Measurement and Research." *Journal of Economic Perspectives*.
- A common basket of ~250 product categories is used and matched across countries including food, electronics and fuel, avoiding biases typically found in single-item calculations or methodologies based on CPIs. The series are updated daily.
- The series can be used to improve measure of (deviations from) PPP.

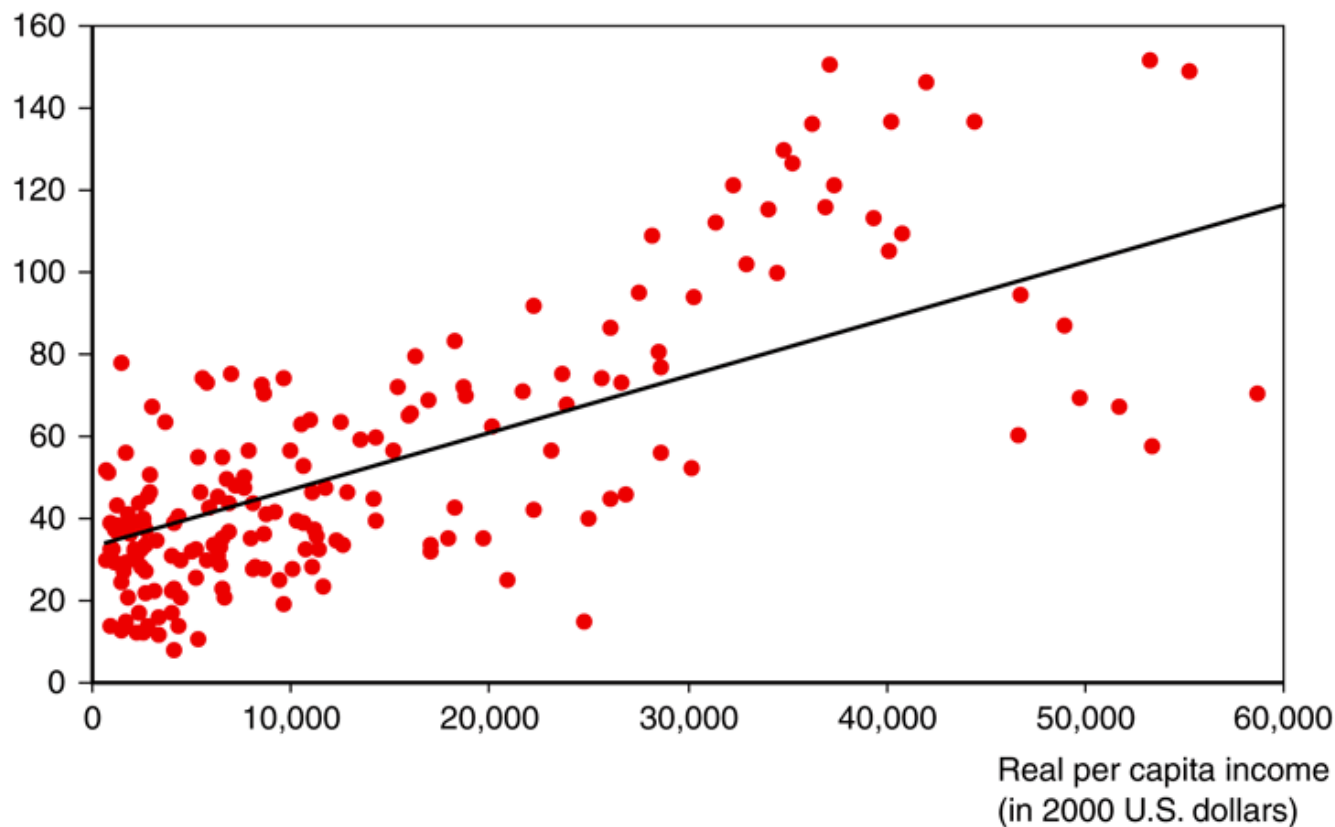
# The Billion Prices Project: United States



# Price Levels and Real Incomes, 2007

- Price level and per capita income are correlated
- Why? Potential explanation: Balassa-Samuelson effect

Price level relative to U.S. (U.S. = 100)



Source: Penn World Table, version 6.3.

# Monetary Approach to Exchange Rates

- **Monetary approach to the exchange rate:** uses monetary factors to predict how exchange rates adjust in the long run, based on the absolute version of PPP.
  - It predicts that levels of average prices across countries adjust so that the quantity of real monetary assets supplied ( $M/P$ ) will equal the quantity of real monetary assets demanded ( $L$ ):

$$P_{US} = M^s_{US}/L (R_{\$}, Y_{US})$$

$$P_{EU} = M^s_{EU}/L (R_{\text{€}}, Y_{EU})$$

# Monetary Approach to Exchange Rates (cont.)

- To the degree that PPP holds and to the degree that prices adjust to equate the quantity of real monetary assets supplied with the quantity of real monetary assets demanded, we have the following prediction:
  - The exchange rate is determined in the long run by prices, which are determined by the relative supply and demand of real monetary assets in money markets across countries.

# Monetary Approach to Exchange Rates (cont.)

- A change in the money supply results in a change in the level of average prices.
- A change in the *growth rate* of the money supply results in a change in the *growth rate* of prices (inflation).
  - A constant growth rate in the money supply results in a persistent growth rate in prices (persistent inflation) at the same constant rate, when other factors are constant.
  - Inflation does not affect the productive capacity of the economy and real income from production in the long run.

# The Role of Inflation and Expectations

- In the monetary approach (with PPP), the rate of inflation increases permanently when the *growth rate* of the money supply increases permanently.
- *Expectations of higher domestic inflation* cause the expected purchasing power of domestic currency to decrease relative to the expected purchasing power of foreign currency, thereby making the domestic currency *depreciate*.



# The Real Exchange Rate Approach to Exchange Rates

- The **real exchange rate** is the *rate of exchange for goods and services* across countries.
  - In other words, it is the relative value/price/cost of goods and services across countries.
  - For example, it is the dollar price of a European group of goods and services relative to the dollar price of an American group of goods and services:

$$q_{US/EU} = (E_{\$/\text{€}} \times P_{EU})/P_{US}$$

# The Real Exchange Rate Approach to Exchange Rates (cont.)

$$q_{US/EU} = (E_{\$/\text{€}} \times P_{EU})/P_{US}$$

- If the EU basket costs €100, the U.S. basket costs \$120, and the nominal exchange rate is \$1.20 per euro, then the real exchange rate is 1 U.S. basket per 1 EU basket.
- A real depreciation of the value of U.S. products means a fall in a dollar's purchasing power of EU products relative to a dollar's purchasing power of U.S. products.
  - This implies that U.S. goods become less expensive and less valuable relative to EU goods.
  - This implies that the value of U.S. goods relative to value of EU goods falls.

# The Real Exchange Rate Approach to Exchange Rates (cont.)

$$q_{US/EU} = (E_{\$/\text{€}} \times P_{EU})/P_{US}$$

- A real appreciation of the value of U.S. products means a rise in a dollar's purchasing power of EU products relative to a dollar's purchasing power of U.S. products.
  - This implies that U.S. goods become more expensive and more valuable relative to EU goods.
  - This implies that the value of U.S. goods relative to value of EU goods rises.