The exchange rate

- The nominal exchange rate e (or, for short, exchange rate) between two currencies is the price of one currency in terms of the other. It allows domestic purchasing power to be spent abroad.
- If $e = 2$ \$/€, one euro can be traded for two dollars: the price in dollars of one euro is two dollars.
- The inverse $e' = \frac{1}{2}$ \$/€ of $e = 2$ \$/€ shows how many euros can be traded for one dollar: the price in euros of one dollar is 0.5 euros. Accordingly, both e and e' express the same information.

1 Xrate

Quoting an exchange rate

- The direct quotation of an exchange rate expresses the exchange rate as
$$\frac{\text{domestic (home) currency units}}{\text{foreign currency units}}.$$
- In indirect quotation, the exchange rate is quoted as
$$\frac{\text{foreign currency units}}{\text{domestic (home) currency units}}.$$
- If the euro is the home currency, $e = 2$ \$/€ expresses the exchange rate using indirect quotation (the quotation chosen determines the units of e).

2 Xrate

Currency appreciation

- A currency X appreciates with respect to another currency Y if the number of units of Y that one unit of X can buy increases.
- When X appreciates with respect to Y, currency X becomes more valuable in terms of Y.
- Using indirect quotation, the home currency appreciates when the exchange rate rises.
- Using direct quotation, the home currency appreciates when the exchange rate falls.

3 Xrate

Examples of appreciation

- In passing from $e = 1$ \$/€ to $e' = 2$ \$/€, the euro appreciates with respect to the dollar. Initially, one euro could be traded for only one dollar; after the jump in the exchange rate, one euro can be traded for two dollars, so the euro has increased its value.
- In passing from $e = 2$ €/¥ to $e' = 1$ €/¥, the euro appreciates with respect to the yen. Initially, two euros were needed to buy one yen; after the fall of the exchange rate, only one euro is required to buy one yen, so the euro has increased its value.

4 Xrate

Currency depreciation

- A currency X depreciates with respect to another currency Y if the number of units of Y that one unit of X can buy diminishes.
- When X depreciates with respect to Y, currency X becomes less valuable in terms of Y.
- Using indirect quotation, the home currency depreciates when the exchange rate falls.
- Using direct quotation, the home currency depreciates when the exchange rate rises.

5 Xrate

Examples of depreciation

- In passing from $e = 2$ \$/€ to $e' = 1$ \$/€, the euro depreciates with respect to the dollar. Initially, one euro could be traded for two dollars; after the rise in the exchange rate, one euro can only be traded for one dollar, so the euro has reduced its value.
- In passing from $e = 1$ €/¥ to $e' = 2$ €/¥, the euro depreciates with respect to the yen. Initially, one euro could buy one yen; after the exchange rate falls, one euro can only buy 0.5 yen, so the euro has lost value.

6 Xrate

	USD	GBP	CAD	EUR	AUD
	1	0.59676	1.10661	0.72389	1.11928
	1.67571	1	1.85436	1.21302	1.87559
	0.90366	0.53927	1	0.65415	1.01145
	1.38143	0.82439	1.52871	1	1.54621
	0.89343	0.53317	0.98868	0.64674	1

Refresh in 0:33 | Feb 28, 2014 17:28 UTC

	USD	GBP	CAD	EUR	AUD
	1	0.59838	1.11317	0.72505	1.11621
	1.67117	1	1.86029	1.21168	1.86538
	0.89834	0.53755	1	0.65134	1.00274
	1.37921	0.82530	1.53529	1	1.53950
	0.89589	0.53608	0.99727	0.64956	1

Refresh in 0:52 | Feb 28, 2014 11:26 UTC

1 € exchanges for 1.38143 $
1 $ exchanges for 0.72389 €

	USD	GBP	CAD	EUR	AUD
	1	0.62990	0.99322	0.75169	0.95072
	1.58756	1	1.57680	1.19336	1.50932
	1.00682	0.63420	1	0.75682	0.95720
	1.33033	0.83797	1.32131	1	1.26476
	1.05184	0.66255	1.04471	0.79066	1

1 € exchanges for 1.33033 $
1 $ exchanges for 0.75169 €

Refresh in 0:52 | Jan 21, 2013 11:29 UTC

http://www.x-rates.com/

	USD	GBP	CAD	EUR	AUD
	1	1.58437	0.99672	1.33879	1.0683
	0.631162	1	0.629092	0.844999	0.674273
	1.00329	1.58959	1	1.3432	1.07182
	0.746938	1.18343	0.744488	1	0.797957
	0.936062	1.48307	0.932992	1.25319	1

Monday, February 27, 2012

1 € exchanges for 1.33879 $
1 $ exchanges for 0.746938 €

7 Xrate

Alphabetical order Euro ▲	Jan 21, 2013 11:10 UTC 1.00 EUR ▲▼	inv. 1.00 EUR ▲▼	Alphabetical order Euro ▲	Feb 28, 2014 17:08 UTC 1.00 EUR ▲▼	inv. 1.00 EUR ▲▼
Argentine Peso	6.584374	0.151875	Argentine Peso	10.891473	0.091815
Australian Dollar	1.264280	0.790964	Australian Dollar	1.545866	0.646887
Bahraini Dinar	0.501556	1.993795	Bahraini Dinar	0.520752	1.920300
Botswana Pula	10.641423	0.093972	Botswana Pula	12.220769	0.081828
Brazilian Real	2.714622	0.368375	Brazilian Real	3.223470	0.310225
British Pound	0.838164	1.193083	British Pound	0.824268	1.213197
Bruneian Dollar	1.635636	0.611383	Bruneian Dollar	1.749708	0.571524
Bulgarian Lev	1.955129	0.511475	Bulgarian Lev	1.955889	0.511276
Canadian Dollar	1.321215	0.756879	Canadian Dollar	1.529190	0.653941
Chilean Peso	628.034927	0.001592	Chilean Peso	771.531557	0.001296
Chinese Yuan Renminbi	8.279226	0.120784	Chinese Yuan Renminbi	8.485542	0.117848
Colombian Peso	2356.124402	0.000424	Colombian Peso	2826.785773	0.000354
Croatian Kuna	7.578196	0.131958	Croatian Kuna	7.648890	0.130738
Czech Koruna	25.579354	0.039094	Czech Koruna	27.326648	0.036594
Danish Krone	7.463196	0.133991	Danish Krone	7.462659	0.134000
Emirati Dirham	4.885744	0.204677	Emirati Dirham	5.072475	0.197142
Hong Kong Dollar	10.313085	0.096964	Hong Kong Dollar	10.717523	0.093305
Hungarian Forint	292.753917	0.003416	Hungarian Forint	309.803248	0.003228
Icelandic Krona	170.967649	0.005849	Icelandic Krona	156.533756	0.006388
Indian Rupee	71.727447	0.013942	Indian Rupee	85.313901	0.011721
Indonesian Rupiah	12800.301851	0.000078	Indonesian Rupiah	15985.908788	0.000063
Iranian Rial	16324.564494	0.000061	Iranian Rial	34523.519976	0.000029
Israeli Shekel	4.977133	0.200919	Israeli Shekel	4.817120	0.207593
Japanese Yen	119.046752	0.008400	Japanese Yen	140.970921	0.007094

http://www.x-rates.com/table/?from=EUR&amount=1.00

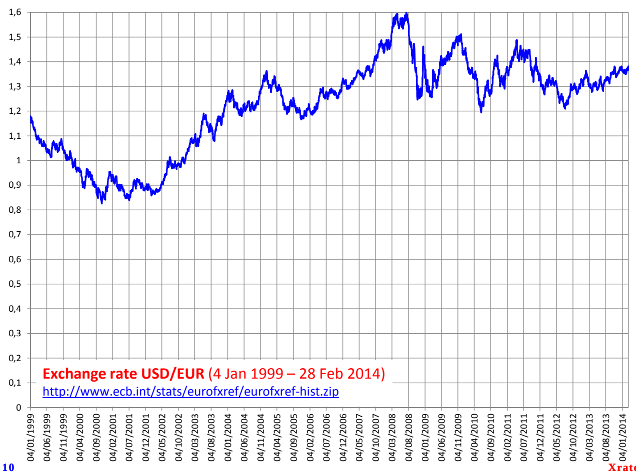
8 Xrate

Jan 21, 2013 11:10 UTC

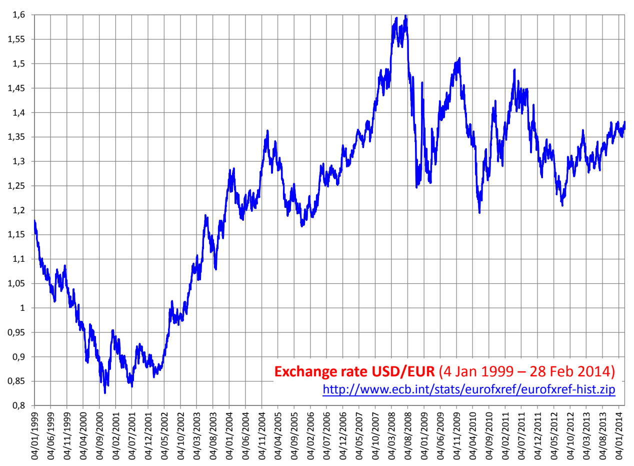
			Feb 28, 2014 17:08 UTC		
Malaysian Ringgit	4.036420	0.247744	Malaysian Ringgit	4.524648	0.221012
Mauritian Rupee	40.875832	0.024464	Mauritian Rupee	41.580128	0.024050
Mexican Peso	16.880615	0.059240	Mexican Peso	18.267719	0.054741
Nepalese Rupee	114.989998	0.008696	Nepalese Rupee	136.957334	0.007302
New Zealand Dollar	1.591461	0.628354	New Zealand Dollar	1.645850	0.607589
Norwegian Krone	7.460848	0.134033	Norwegian Krone	8.278334	0.120797
Omani Rial	0.511919	1.953434	Omani Rial	0.531593	1.881138
Pakistani Rupee	130.008042	0.007692	Pakistani Rupee	144.860690	0.006903
Philippine Peso	53.978611	0.018526	Philippine Peso	61.652102	0.016220
Polish Zloty	4.178300	0.239332	Polish Zloty	4.165675	0.240057
Qatari Riyal	4.842909	0.206487	Qatari Riyal	5.028558	0.198864
Romanian New Leu	4.352993	0.229727	Romanian New Leu	4.504040	0.222023
Russian Ruble	40.285064	0.024823	Russian Ruble	49.531535	0.020189
Saudi Arabian Riyal	4.988599	0.200457	Saudi Arabian Riyal	5.179218	0.193079
Singapore Dollar	1.635636	0.611383	Singapore Dollar	1.749708	0.571524
South African Rand	11.811669	0.084662	South African Rand	14.817695	0.067487
South Korean Won	1415.720836	0.000706	South Korean Won	1477.142470	0.000677
Sri Lankan Rupee	168.433635	0.005937	Sri Lankan Rupee	180.526936	0.005539
Swedish Krona	8.702729	0.114906	Swedish Krona	8.853300	0.112952
Swiss Franc	1.240458	0.806154	Swiss Franc	1.216035	0.822345
Taiwan New Dollar	38.549246	0.025941	Taiwan New Dollar	41.846651	0.023897
Thai Baht	39.554227	0.025282	Thai Baht	44.911722	0.022266
Trinidadian Dollar	8.534559	0.117171	Trinidadian Dollar	8.813850	0.113458
Turkish Lira	2.345200	0.426403	Turkish Lira	3.039791	0.328970
US Dollar	1.330178	0.751779	US Dollar	1.380941	0.724144
Venezuelan Bolivar	5.719765	0.174832	Venezuelan Bolivar	8.699927	0.114943

http://www.x-rates.com/table/?from=EUR&amount=1.00

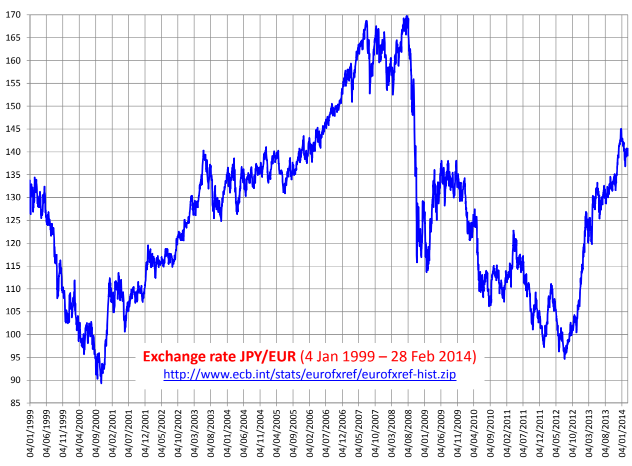
9 Xrate



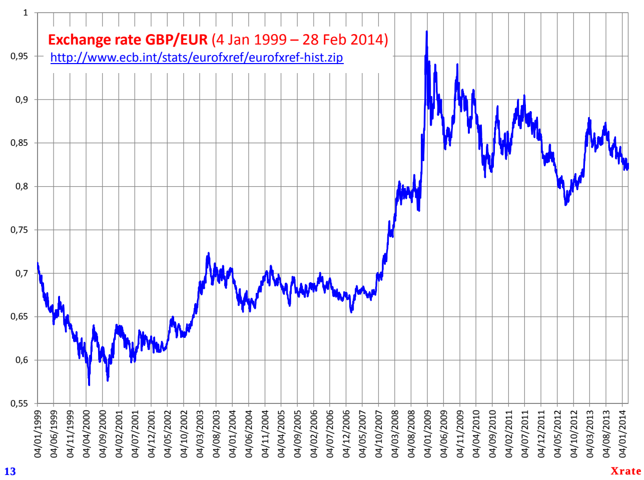
10 Xrate

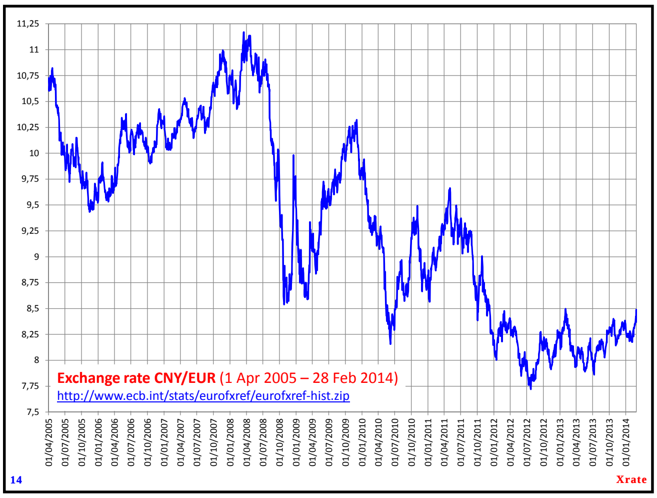


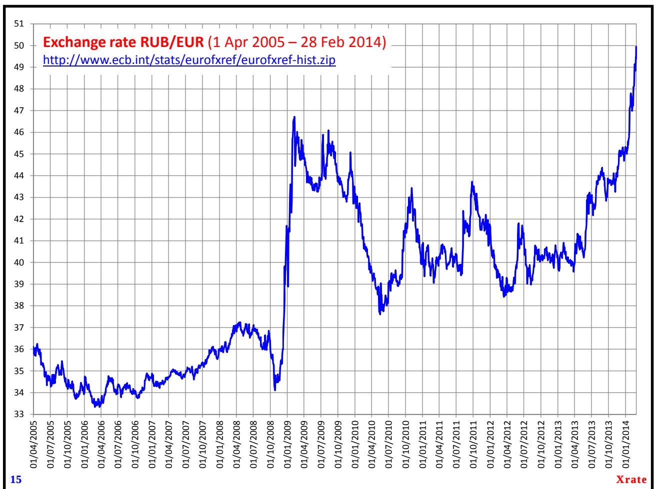
11 Xrate



12 Xrate







The currency (foreign exchange) market

- It is the market for the trading of currencies.
- It is the largest and more liquid financial market in the world.
- Average trading in currency markets in April 2013: $5.3 trillion per day ($4.0 trillion in April 2010; $3.3 trillion in April 2007). It is estimated that about 70% to 90% of all the transactions are speculative.
- The main traders are banks. Interbank trading accounts for more of the 50% of all the transactions.

http://en.wikipedia.org/wiki/Currency_market

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Top 10 currency traders (May 2013) http://en.wikipedia.org/wiki/Currency_market

Rank	Name	Market share
1	Deutsche Bank	15.18%
2	Citi	14.90%
3	Barclays Investment Bank	10.24%
4	UBS AG	10.11%
5	HSBC	6.93%
6	JPMorgan	6.07%
7	Royal Bank of Scotland	5.62%
8	Credit Suisse	3.70%
9	Morgan Stanley	3.15%
10	Bank of America Merrill Lynch	3.08%

Top 10 (May 2012)

Rank	Name	Market share
1	Deutsche Bank	14.57%
2	Citi	12.26%
3	Barclays Investment Bank	10.95%
4	UBS AG	10.48%
5	HSBC	6.72%
6	JPMorgan	6.6%
7	Royal Bank of Scotland	5.86%
8	Credit Suisse	4.68%
9	Morgan Stanley	3.52%
10	Goldman Sachs	3.12%

17 Xrate

Most traded currencies by value
% daily share (April 2013)

1	United States dollar	USD ($)	87.0%
2	Euro	EUR (€)	33.4%
3	Japanese yen	JPY (¥)	23.0%
4	Pound sterling	GBP (£)	11.8%
5	Australian dollar	AUD ($)	8.6%
6	Swiss franc	CHF (Fr)	5.2%
7	Canadian dollar	CAD ($)	4.6%
8	Mexican peso	MXN ($)	2.5%
9	Chinese yuan	CNY (¥)	2.2%
10	New Zealand dollar	NZD ($)	2.0%
11	Swedish krona	SEK (kr)	1.8%
12	Russian ruble	RUB (₽)	1.6%
13	Hong Kong dollar	HKD ($)	1.4%
14	Singapore dollar	SGD ($)	1.4%
15	Turkish lira	TRY (₺)	1.3%

% daily share (April 2010)

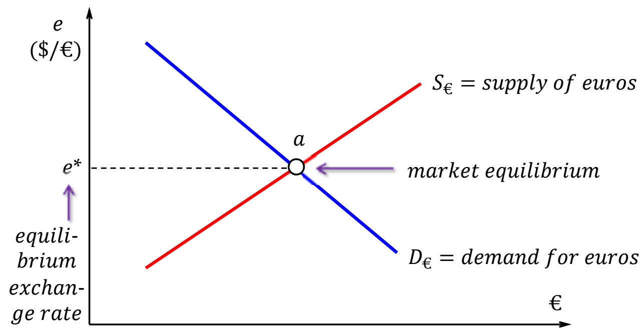
United States dollar	84.9%
Euro	39.1%
Japanese yen	19.0%
Pound sterling	12.9%
Australian dollar	7.6%
Swiss franc	6.4%
Canadian dollar	5.3%
Hong Kong dollar	2.4%
Swedish krona	2.2%
New Zealand dollar	1.6%
South Korean won	1.5%

18 Xrate

The currency market model

- The currency market is modelled as a competitive market.
- In this market, the euro is the home currency and the dollar is the foreign currency.
- Quantity is the quantity of euros. Price is the exchange rate \$/€ quoted indirectly.
- The market demand function $D_€$ is the demand for euros and slopes downward. The upward sloping market supply function $S_€$ is the supply of euros.

Equilibrium exchange rate



Demand for euros

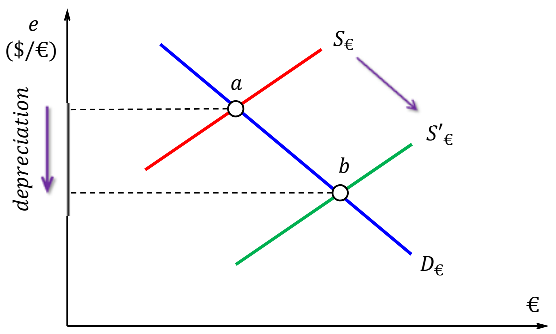
- The demand for euros is, at the same time, supply of dollars.
- The agents demanding euros have dollars but want to buy European goods and/or financial assets.
- The demand function slopes downward because a reduction in e means that fewer dollars are needed to purchase an euro. This makes European goods and financial assets comparatively cheaper. To buy more such goods and assets, more euros are demanded, so $\downarrow e \Rightarrow \uparrow$quantity demanded of euros.

Supply of euros

- The supply of euros is, at the same time, demand for dollars.
- The agents supplying euros want dollars to buy American goods and/or financial assets.
- The supply function slopes upward because a rise in e means that more dollars are given in exchange for one euro, making American goods and financial assets comparatively cheaper. To buy more such goods and assets, more dollars are needed, so more euros are supplied. So $\uparrow e \Rightarrow \uparrow$quantity supplied of euros.

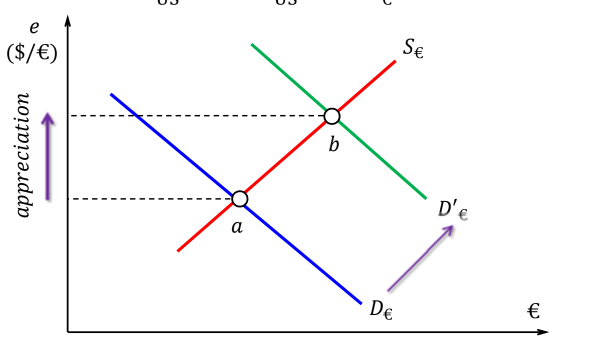
Domestic GDP and exchange rate

$$\uparrow \text{GDP}_{\text{EU}} \Rightarrow \uparrow \text{IM}_{\text{EU}} \Rightarrow \uparrow D_\$ \Rightarrow \uparrow S_€ \Rightarrow \downarrow e$$



Foreign GDP and exchange rate

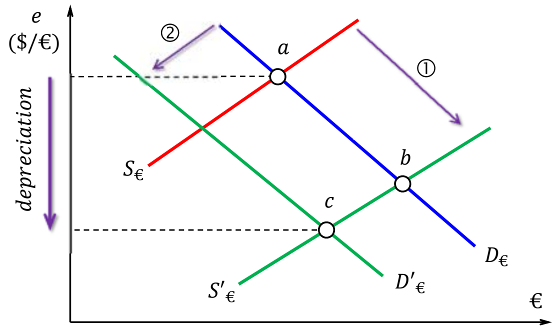
$$\uparrow \text{GDP}_{\text{US}} \Rightarrow \uparrow \text{IM}_{\text{US}} \Rightarrow \uparrow D_€ \Rightarrow \uparrow e$$



Domestic inflation rate and exchange rate

$\uparrow\pi_{EU} \Rightarrow$ ① $\uparrow IM_{EU} \Rightarrow \uparrow D_\$ \Rightarrow \uparrow S_€ \Rightarrow \downarrow e$

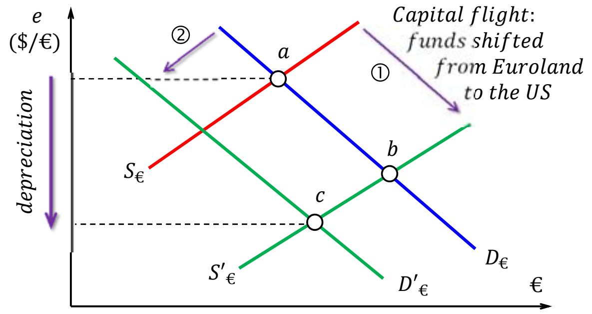
② $\downarrow IM_{US} \Rightarrow \downarrow D_€ \Rightarrow \downarrow e$



Foreing interest rate and exchange rate

$\uparrow i_{US} \Rightarrow$ ① $\uparrow D_{\text{US-securities}}$ (BY EUROPEANS) $\Rightarrow \uparrow D_\$ \Rightarrow \uparrow S_€ \Rightarrow \downarrow e$

② $\downarrow D_{\text{EU-securities}}$ (BY AMERICANS) $\Rightarrow \downarrow D_€ \Rightarrow \downarrow e$



Arbitrage and speculation

- Arbitrage refers to transactions that, taking advantage of price differences, generate a sure profit.
- Speculation is the same as arbitrage with the only difference that transactions do not guarantee a sure profit: whereas a speculator is taking a risk, an arbitrageur obtains a risk-free profit.
- Almost nothing lies outside the scope of arbitration and speculation: commodities, bonds, currencies, shares, options, real estate, derivatives, futures contracts...

Spatial arbitrage /1

- Spatial arbitrage exploits price differences in different locations.
- Suppose $e_L = 2$ \$/€ in London and $e_N = 3$ \$/€ in New York. An arbitrageur would buy euros where they are "cheap" (in London, where buying €1 just takes \$2) to sell them were they are "expensive" (in NY, where you need \$3 to get €1).
- The sequence €1 $\rightarrow^{\text{sold in NY}}$ \$3 $\rightarrow^{\text{sold in L}}$ €1.5 generates a sure profit of €0.5 per euro (a 50% profit rate). It may be continued: €1 → \$3 → €1.5 → \$4.5 → €2.25 → \$6.75 → €3.375 → …

Spatial arbitrage /2

- Those transactions eventually alter prices. By buying euros in London, $D_€$ shifts to the right and $\uparrow e$ in London: the euro appreciates where it is "cheap".
- By selling euros in NY, arbitrageurs shift $S_€$ to the right in NY, so $\downarrow e$ in NY: the euro depreciates where it is "expensive".
- So $e_L = 2$ \$/€ rises and $e_N = 3$ \$/€. Eventually (may in a matter of minutes), both prices will converge to some value between 2 and 3. Reached that point, spatial arbitrage is no longer possible.

Triangular (or triangle) arbitrage /1

- Based on the idea of taking advantage of price imbalances involving at least three currencies.
- Let exchange rates be 2 \$/€, 3 ¥/\$, and 4 ¥/€. Triangular arbitrage can only occur if the product of two rates is not equal to the third one (in the product one of the currencies should cancel out).
- The 2nd and 3rd cannot be meaningfully multiplied, as no currency cancels out in 3 ¥/\$ · 4 ¥/€. By taking the inverse $\frac{1}{3}$ \$/¥ of 3 ¥/\$ a meaningful product obtains: $\frac{1}{3}$ \$/¥ · 4 ¥/€ = $\frac{4}{3}$ \$/€ ≠ 2 \$/€. This means that there are arbitrage opportunities.

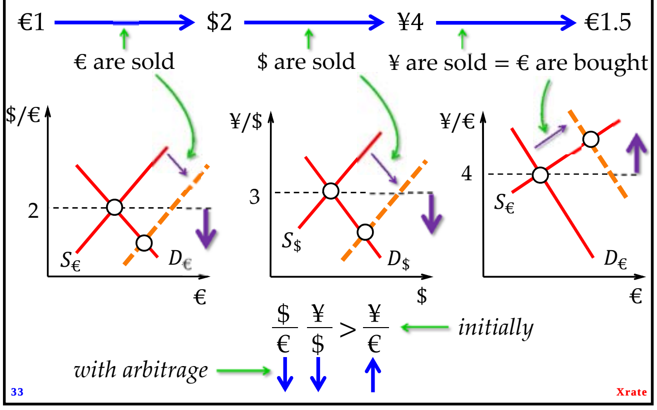
Triangular arbitrage /2

- There are 6 exchange sequences: € → $ → ¥, € → ¥ → $, $ → € → ¥, $ → ¥ → €, ¥ → $ → €, ¥ → € → $.
- But the 1st is equivalent to both the 3rd and the 5th because all generate the same cycle € → $ → ¥ → €.
- And the 2nd, 4th, and 5th are equivalent because all generate the same cycle € → ¥ → $ → €. So there are two ways of trying to exploit price differences, represented by these two exchange cycles.

Triangular arbitrage /3

- One the cycles generates profits; the other, losses. The right-hand cycle yields a loss: €1 → ¥4 → $4/3 → €2/3. The left-hand one produces a profit: €1 → $2 → ¥6 → €1.5.
- As noticed, $\frac{\$}{¥}\cdot\frac{¥}{€} < \frac{\$}{€}$: going directly from $ to € is better than going indirectly through ¥. The step "€1 → $2" makes the <u>dollar appreciate</u>, so $/€ falls. The step "$2 → ¥6" makes the <u>yen appreciate</u>, so $/¥ raises. And the step "¥6 → €1.5" makes the <u>euro appreciate</u>, so ¥/€ rises. Hence, the gap between going directly or indirectly is being closed.

Triangular arbitrage /4



Becoming a millionaire in one day /1

- Let $e = 2$ \$/€ today and suppose I expect $e' = 1.9$ \$/€ tomorrow. Imagine that the daily interest rate is 3‰. If my expectation is correct, I can become a millionaire tomorrow. This is the recipe.
- I ask for a loan of, say, €100 million. Tomorrow I will have to return this amount plus €300,000. With my €100 million, and given the rate $e = 2$ \$/€, I purchase \$200 million. I could lend those dollars for a day, but the day has been hard enough. So I just wait for tomorrow.

Becoming a millionaire in one day /2

- Tomorrow comes and I am right. I then sell the \$200 million at the rate $e' = 1.9$ \$/€ and get €105,263,157 (the additional cents, left as a tip).
- I next repay my €100 million debt plus the loan interest of €300,000.
- And I finally search for a fiscal paradise that would welcome my remaining €4,963,157…
- What if I am wrong and, for instance, $e' = 2.1$ \$/€. Then I have a little problem, since, at that rate, I can only obtain €95,238,095.23 from my \$200 million.

Short selling (shorting, going short)

- Wikipedia: "Short-selling […] is the practice of selling assets, usually securities, that have been borrowed from a third party […] with the intention of buying identical assets back at a later date to return to the lender" and make a profit.
- "<u>The short seller hopes to profit from a decline in the price of the assets between the sale and the repurchase</u>, as the seller will pay less to buy the assets than the seller received on selling them. Conversely, the short seller will incur a loss if the price of the assets rises."

Going short vs going long

- Going long is the opposite strategy: an asset is bought expecting that its price will raise.
- The millionaire example is an instance of short selling: I assumed a debt in euros because I expected a depreciation of the euros. Hence, by purchasing dollars, I expected to obtain next more euros for the same dollars, so that the debt could be repaid with cheaper euros.
- To limit market volatility, some restrictions to short selling were imposed in September 2008. Short selling is capable of triggering currency crises.

37 Xrate

Fixed vs floating exchange rates

- There are two basic exchange rate regimes.
- In a fixed exchange rate regime, the government picks an official value of the exchange rate between the domestic currency and some foreign currency (or group of them) and assumes the compromise of defending that value in the foreign exchange market by buying or selling the domestic currency.
- In a floating exchange rate regime, the government lets the market determine the exchange rate. The rest of regimes combine these two (for instance, a floating rate within a fixed fluctuation band).

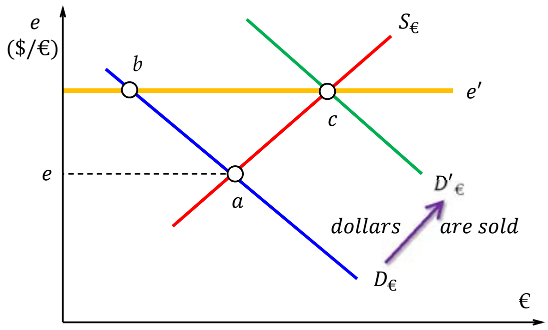
38 Xrate

Currency market intervention /1

- Let e' be the fixed exchange rate, with the central bank instructed by the govt. to sustain that value.
- Imagine that, for some reason, the exchange rate in the market is $e < e'$ (point a in the graph on slide 40). Having e' as fixed exchange rate means that the central bank must intervene to place the market equilibrium along the horizontal line with value e'.
- It may appear that the central bank may either shift $S_€$ to reach point b or shift $D_€$ to reach point c. The first option is not available, since the central bank cannot force a reduction in the supply of euros.

39 Xrate

Currency market intervention /2



40 Xrate

Currency market intervention /3

- What the central bank can do is to increase the de-mand for euros. Hence, to reach value e' from point a, the central bank must demand enough euros to shift the market demand function from $D_€$ to $D'_€$.
- The problem is that, at point a, the market does not value the euro as the government intends. The solution is to demand more euros to rise its value.
- But the purchase of euros to rise the value from e to e' must be paid in dollars. So in passing from a to c, the central bank spends dollars. Obviously, to sell dollars the central bank must have them.

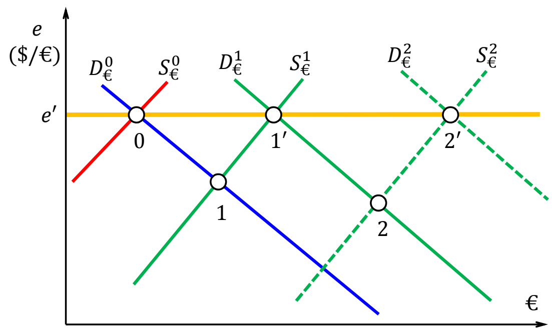
41 Xrate

Currency crises /1

- A currency crises occurs when a fixed exchange rate cannot be defended (achieved through the intervention of the central bank).
- What if market participants believe that a given ra-te cannot be defended? They will engage in short-selling: expecting the euro to lose value, they will ask for loans in euros, and buy dollars with them.
- That shifts $S_€$ to the right, so the euro loses value. And here it is a self-fulfilling prophecy: what agents do in response to what they expect to occur contributes to cause what they expect to occur.

42 Xrate

Currency crises /2



Currency crises /3

- On slide 43, the market is initially at 0. A speculative attack unfolds through a massive sale of euros (to repurchase them later at a smaller rate). This attack shifts $S_€$ from $S_€^0$ to $S_€^1$, moving the market equilibrium from point 0 to point 1.
- The central bank reacts by selling dollars, shifting $D_€$ from $D_€^0$ to $D_€^1$. Equilibrium moves from 1 to 1′.
- A second attack shifts $S_€$ from $S_€^1$ to $S_€^2$, reaching 2. If the central bank still has enough dollar reserves, equilibrium may be moved to 2′. If not, the attack is successful and market equilibrium remains at 2.

Revaluation and devaluation

- A devaluation is a reduction of the fixed exchange rate. It occurs when the government accepts that the former fixed rate cannot be upheld.
- In the previous example, if market participants believe the "right" value to be the one associated with point 2 and the central bank has not enough dollars to sustain any other higher value, declaring the market value to be the new fixed exchange rate means devaluating the exchange rate.
- A revaluation is the opposite of a devaluation: an increase of the fixed exchange rate.

A famous successful speculative attack

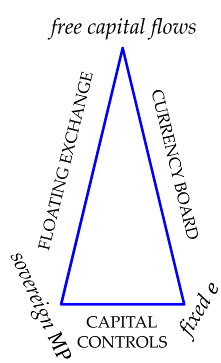
- Took place on the 16th of September, 1992: the Black Wednesday.
- On that date, George Soros became famous for forcing the British government to withdraw from the European Exchange Rate Mechanism (a fixed exchange rate agreement, predecessor of the euro).
- Soros made over $1 billion by short selling pound sterlings. Newspapers revealed that the British Treasury spent £27 billion trying to sustain the value of the pound.

The impossible trinity

- Due to R. Mundell, it is the trilemma according to which it is not possible to simultaneously have
  - a fixed exchange rate,
  - an independent monetary policy, and
  - free international capital mobility = no capital control.
- Justification: if e is fixed and a monetary policy that expands M1 is applied, then domestic i falls, so e falls. To defend e, domestic currency must be bought in the currency market, so M1 is reduced.

Only two out of three possible

- Independent monetary policy + no capital control ⇒ exchange rate must float (UK, Canada).
- Fixed exchange rates + free mobility of capital ⇒ no independent monetary policy (the countries of the eurozone).
- Fixed exchange rates + independent monetary policy ⇒ capital controls needed (China until recently).



Real exchange rate

- The real exchange rate e_r is the nominal exchange rate expressed in terms of goods.
- Interpreting "goods" as the basket of goods in the CPI, e_r is the price of the basket in one economy in terms of the basket of the other. Specifically:

$$e_r = \frac{P}{P^*} \,.$$

where e is quoted indirectly, P is the domestic CPI, and P^* is the foreign CPI. So e_r is e adjusted by the price indices of the two economies. Note that e_r is measured in foreign baskets/domestic basket.

49 Xrate

The real exchange rate: an example

- Suppose $e = 4$ \$/€, $P = 100$ €/basket$_{\text{EU}}$, and $P^* = 200$ \$/basket$_{\text{US}}$. With these values, how many baskets$_{\text{US}}$ could be obtained from one basket$_{\text{EU}}$?
- As $P = 100$, basket$_{\text{EU}}$ could be sold for €100. At the rate $e = 4$ \$/€, €100 exchange for \$400. With \$400 and $P^* = 200$, 2 baskets$_{\text{US}}$ can be purchased.
- This says that the purchasing power of 1 basket$_{\text{EU}}$ is 2 baskets$_{\text{US}}$. That is, $e_r = 2$ baskets$_{\text{US}}$/basket$_{\text{EU}}$.
- Applying the formula, $e_r = 4 \cdot 100/200 = 2$ ($4 \cdot 100$ is the cost in dollars of the basket$_{\text{EU}}$).

50 Xrate

Competitiveness of an economy

- The real exchange real is a measure of competitiveness: the smaller e_r, the higher the competitiveness of the domestic economy.
- For instance, in passing from $e_r = 1$ to $e_r = 2$ domestic competitiveness is eroded: with $e_r = 1$, foreigners could obtain a domestic basket with just one of their baskets; with $e_r = 2$, they must deliver 2 of their baskets to get a domestic basket.
- Going from $e_r = 1$ to $e_r = 2$ means that it is more expensive for foreigners to purchase our basket, so the domestic economy becomes less competitive.

51 Xrate

Real appreciation & real depreciation

- A real appreciation is an increase of e_r (a loss of domestic competitiveness).
- A real appreciation of the exchange rate means that the domestic basket can buy more foreign baskets: the purchasing power of the domestic basket raises.
- A real depreciation is a decrease of e_r (an improvement of domestic competitiveness).
- A real depreciation of the exchange rate means that the domestic basket can buy fewer foreign baskets: the purchasing power of the domestic basket falls.

52 Xrate

Purchasing power parity (PPP)

- PPP is the theory that, in the long run, e moves to make e_r equal to 1, so one domestic basket exchanges for one foreign basket (same purchase power).
- The value of e that makes $e_r = 1$ is $e_{\text{PPP}} = P^*/P$.
- With domestic and foreign baskets being the same, PPP holds that the price of the basket should be the same in both economies when expressed in the same currency: $e \cdot p = P^*$, which holds if $e = e_{\text{PPP}}$.
- If $e > e_{\text{PPP}}$, then domestic currency is said to be overvalued (with respect to its parity value). If $e < e_{\text{PPP}}$, it is said to be undervalued.

53 Xrate

PPP and commercial arbitrage /1

- In the absence of transportation costs, PPP can be justified by commercial arbitrage: to buy goods where cheap and to sell them where expensive.
- To illustrate the idea with a simple example, suppose that only one good can be traded between Euroland and the US: Macroeconomic textbooks.
- The price of a textbook in the US is $p^* = \$100$; in Euroland, $p =$ €50. Imagine that $e = 4$ \$/€. Hence, the price in dollars of a Euroland textbook is 4 \$/€ $\cdot$ €50 $= \$200$. This suggests that textbooks are cheap in the US.

54 Xrate

PPP and commercial arbitrage /2

- Commercial arbitrageurs would buy textbooks in the US to subsequently ship them to Euroland. Once sold there, euros are converted into dollars.
- The purchase of books in the US tends to <u>rise</u> p^*. The sale of those books in Euroland make p <u>fall</u>. The rise in the demand for dollars induces a <u>reduction of e</u>.
- Initially, $e \cdot p > p^*$. Thanks to arbitrage, $e \cdot p$ tends to fall and p^* tends to rise. Eventually, $e \cdot p = p^*$. This condition stops arbitrage.

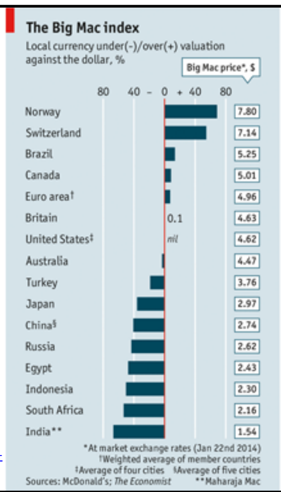
Over and undervaluation: an example

- With $p^* = \$100$, $p = €50$, and $e = 4$ \$/€, the euro is overvalued with respect to the dollar. In fact, $e_{PPP} = p^*/p = 100/50 = 2$ \$/€. This is reasonable: since the price of a book in the US doubles the price of a book in Euroland, purchasing power parity demands that €1 be capable of purchasing \$2.
- Having $e = 4$ instead of $e = 2$ implies that the euro has more purchasing power than it should : with €50, one book can be bought in Euroland; given $e = 4$, €50 can buy 2 books in the US. The euro is the a 100% overvalued: $\frac{e - e_{PPP}}{e_{PPP}} = \frac{4-2}{2} = 1 = 100\%$.

Big Mac index

- It is an index set by *The Economist* to test PPP.
- The basket chosen is the Big Mac (BM).
- The chart shows the under/overvaluation of several currencies with respect to the dollar (on the 22nd Jan 2014).

http://www.economist.com/news/finance-and-economics/21595037-our-bun-loving-guide-currencies-grease-proof-taper



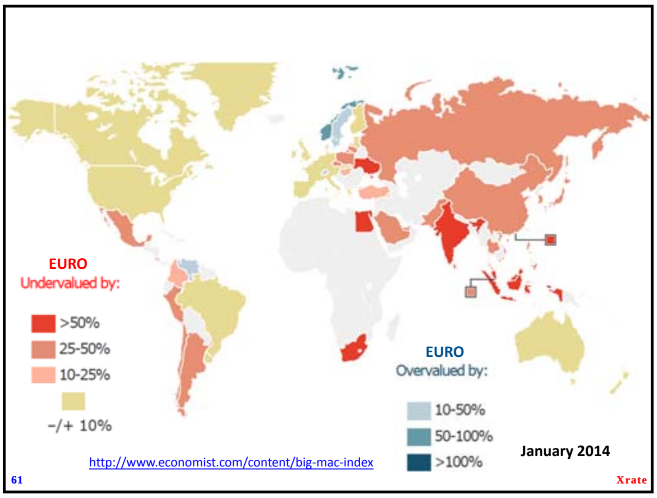
US = home economy	P^* = BM home price	BM price in \$ = P^*/e	PPP of \$ = P^*/P	market e on 22 Jan 2014	Over (+) under (–) valuation against the \$
US	P = 4.62	–	–	–	–
Brazil	12.4 R\$	5.25	2.68	2.36	13.48
UK	2.79 £	4.63	1.66 \$/£	1.66 \$/£	0.06
China	16.6 ¥	2.74 \$	3.59 ¥/\$	6.05 ¥/\$	-40.68
Eurozone	3.65 €	4.96	1.26 \$/€	1.35 \$/€	7.3
India	95 ₹	1.54	20.54	61.85	-66.78
Russia	89 руб	2.62	19.25	33.94	-43.29
Sweden	40.7 kr	6.29	8.8	6.47	35.97
Venezuela	45 Bs.F.	7.15	9.73	6.29	54.66

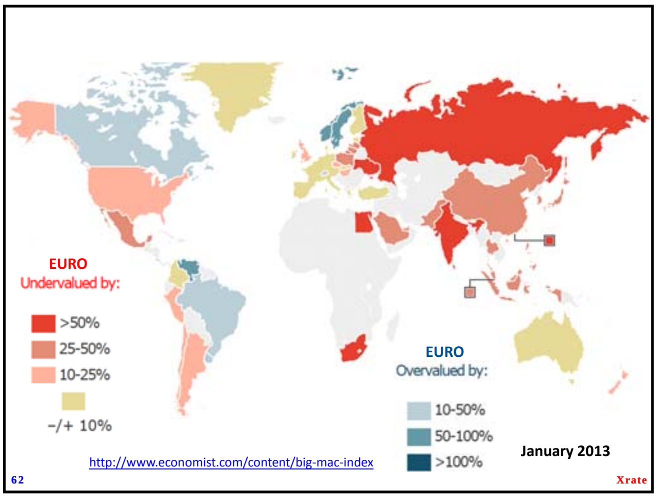
Interpreting the Big Mac index data /1

- In Venezuela, the BM was priced at Bs. F. 45. Given the market rate of 6.29 Bs. F./\$, the price in dolars of a BM is \$7.15. If PPP between Bs. F. and \$ held, it should had been \$4.62 (the US price). With respect to the \$, the Bs. F. is overvalued a $\frac{7.15-4.62}{4.62} \approx 54\%$.
- At the market exchange rate in January 2014, the \$ price of the BM in China was \$2.74. Since the price of the BM in the US was \$4.62, the yuan was undervalued a $\frac{2.74-4.62}{4.62} \approx 40\%$ with respect to the \$. PPP predicts that the *Bolívar fuerte* will eventually depreciate and the yuan will appreciate.

Interpreting the Big Mac index data /2

- In the China case, undervaluation results from the comparison of P (the US price of the BM) with P^*/e (the China price of the BM given the exchange rate).
- Undervaluation follows from the fact that $P^*/e < P$, since $2.74 < 4.62$. <u>Adopting the Chinese perspective as domestic</u>, $1/e < P/P^*$. Whereas $1/e$ is the market exchange rate (in \$/¥ units), P/P^* is the PPP exchange rate (in \$/¥ units as well).
- In fact, $1/e$ and P/P^* can be used to calculate undervaluation: $\%undervaluation = 100 \cdot \frac{1/e - P/P^*}{P/P^*} \approx 100 \cdot \frac{1/6.05 - 4.62/16.6}{4.62/16.6} \approx 100 \cdot \frac{0.165 - 0.278}{0.278} \approx 40.6\%$.


EURO
Undervalued by:
>50%
25-50%
10-25%
−/+ 10%
EURO
Overvalued by:
10-50%
50-100%
>100%
January 2014
http://www.economist.com/content/big-mac-index
61
Xrate


EURO
Undervalued by:
>50%
25-50%
10-25%
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EURO
Overvalued by:
10-50%
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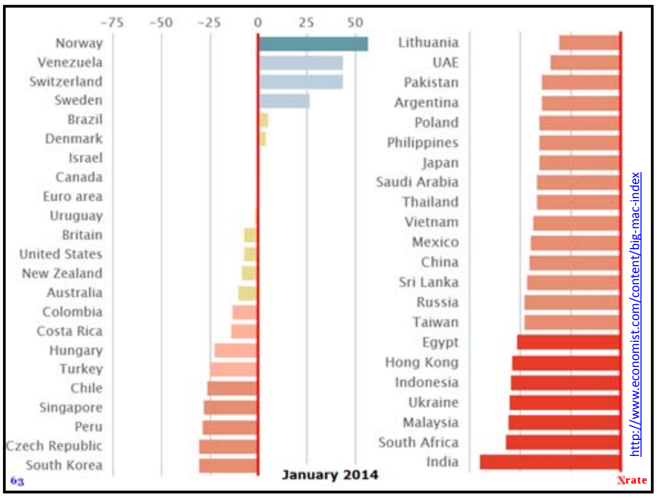
Xrate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Chile
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South Korea
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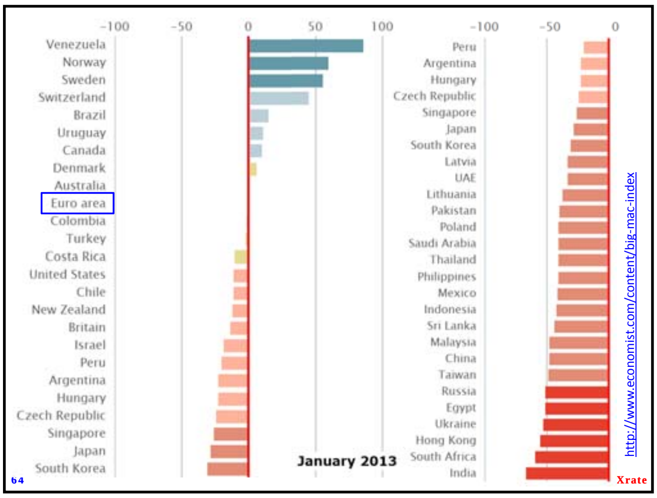
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Venezuela
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Canada
Denmark
Australia
Euro area
Colombia
Turkey
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United States
Chile
New Zealand
Britain
Israel
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Argentina
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Czech Republic
Singapore
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