

AcF305:
International Financial and Risk Management
Week 2

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Outline

- Essential reading: Chapter 3 of Sercu (2009).
- Topics:
 - **The Bitcoin:** A cryptocurrency: What is it and how it works?
 - **Exchange rates:** What are they? What are bid/ask rates?
 - **Foreign exchange markets:** How are FX markets organized? What trading mechanisms are available?
 - **Law of One Price:** What is it? What mechanisms enforce it? What is the difference between ‘arbitrage’ and ‘shopping around’? How is arbitrage done across market makers? Across foreign currencies?
 - **Purchasing Power Parity:** What is it? What forms of purchasing power parity exist and do they hold? How is purchasing power parity related to the real exchange rate? And, before, how is the real exchange rate defined? What is its intuitive meaning?

The Bitcoin

- Bitcoin is a digital currency created in 2009 by the mysterious Satoshi Nakamoto – who is not identified.
- Bitcoin offers the promise of lower transaction fees than traditional online payment mechanisms and is operated by a decentralized authority, unlike government-issued currencies.
- Market cap for all bitcoin (abbreviated BTC or, less frequently, XBT) in circulation was almost ~\$114 billion in October 2018.
- There are no physical bitcoins, only balances kept on a public ledger in “the cloud”.
- Bitcoins are not issued or backed by any bank or government.

What is Bitcoin?

- Bitcoin is digital cash. It doesn't require a central authority involved in the economic transactions (e.g., think of payments with debit cards)
- Thousands of “alternative coins”, in addition to the most common such as Ethereum (ETH), Litecoin (LTC) and Ripple (XRP), with rather different characteristics and features
- Cryptocurrencies are traded on more than 300 exchanges worldwide (see <http://coinmarketcap.com>).
- Cryptocurrencies is a new and mostly unregulated asset class. This widens the investment landscape to a variety of speculative and arbitrage opportunities, which could be ultimately reflected in the managers' decisions and risk taking behaviors

How does Bitcoin work?

- Independent individuals and companies (called *nodes* or *miners*) guarantee Bitcoin transactions. They guarantee that there is a **unique history** for every Bitcoin.
- When a new transaction is broadcasted (publicly) all miners solve difficult cryptographic problems to record the transaction in the ledger/blockchain.
- Miners gain incentives from the release of new bitcoin (for each transaction they secure) and transaction fees paid in Bitcoin. Transactions are grouped in blocks, and when one miner finds the *nonce* that produces a *hash* with specific characteristics (e.g., number of starting zeros), this is released to the whole system.
 - A hash is a string of numbers and characters
 - A nonce is the number to be added to a hash to find another hash with specific characteristics
- The Bitcoin White Paper can be found here:

https://www.ussc.gov/sites/default/files/pdf/training/annual-national-training-seminar/2018/Emerging_Tech_Bitcoin_Crypto.pdf

What is the price of a Bitcoin?

Bitcoin is a great deal, and we missed it!! (timespan 2009-2017)

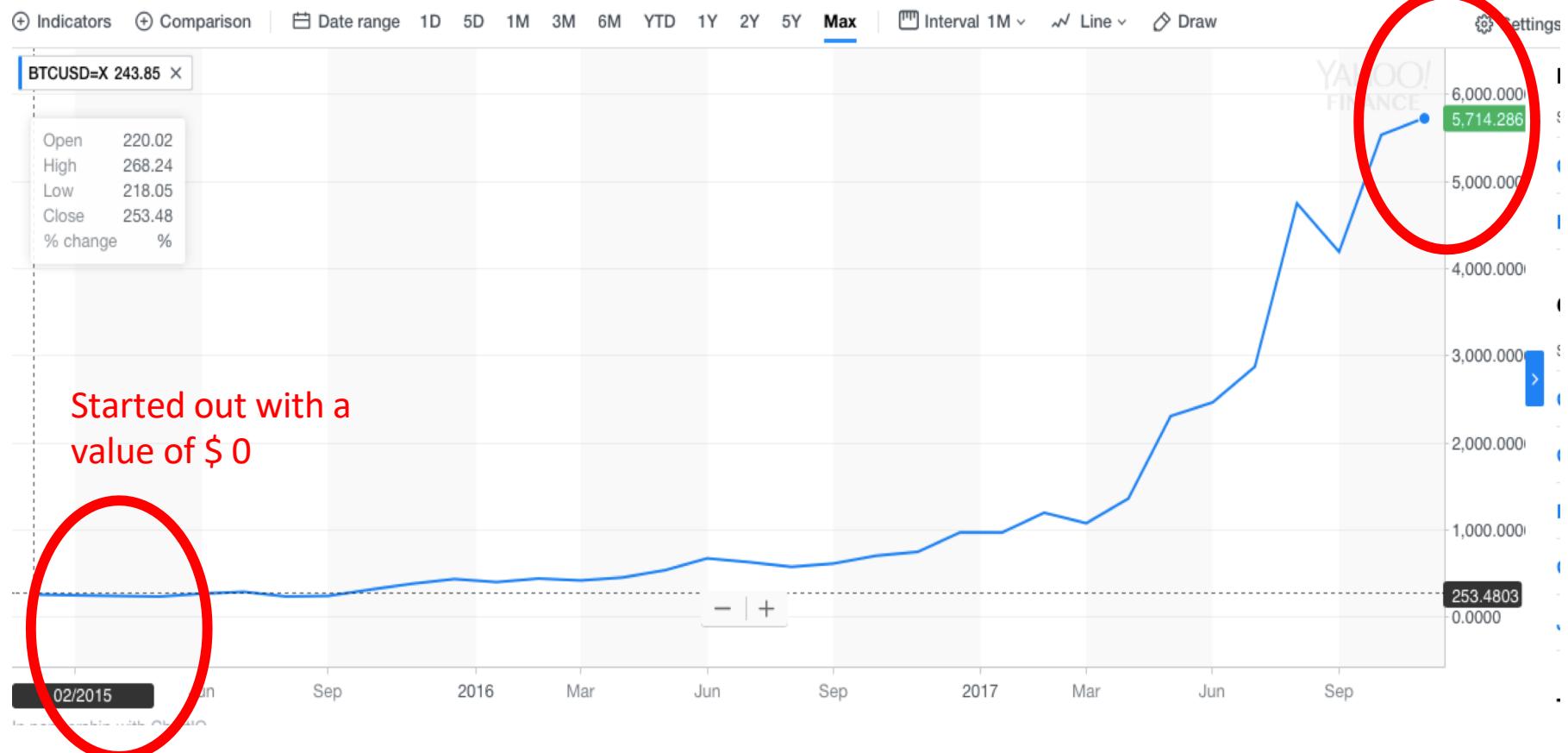
BTC/USD (BTCUSD=X) [☆ Add to watchlist](#)

CCY - CCY Delayed price. Currency in USD

5,680.4702 +156.47 (+2.83%)

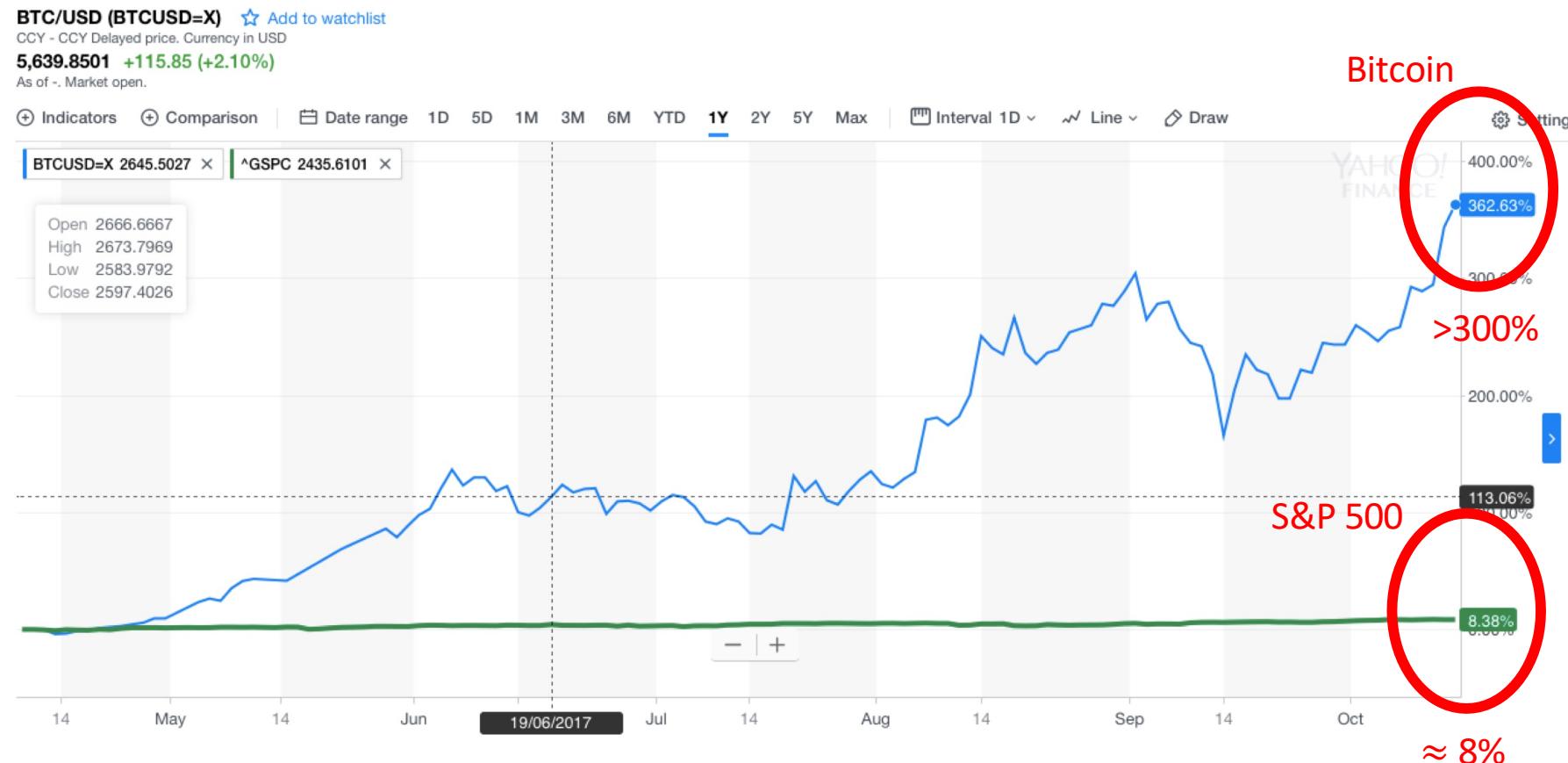
As of ~. Market open.

Now it's worth more
than \$ 5,000



How does Bitcoin compare with the S&P 500?

April 2017 to October 2017



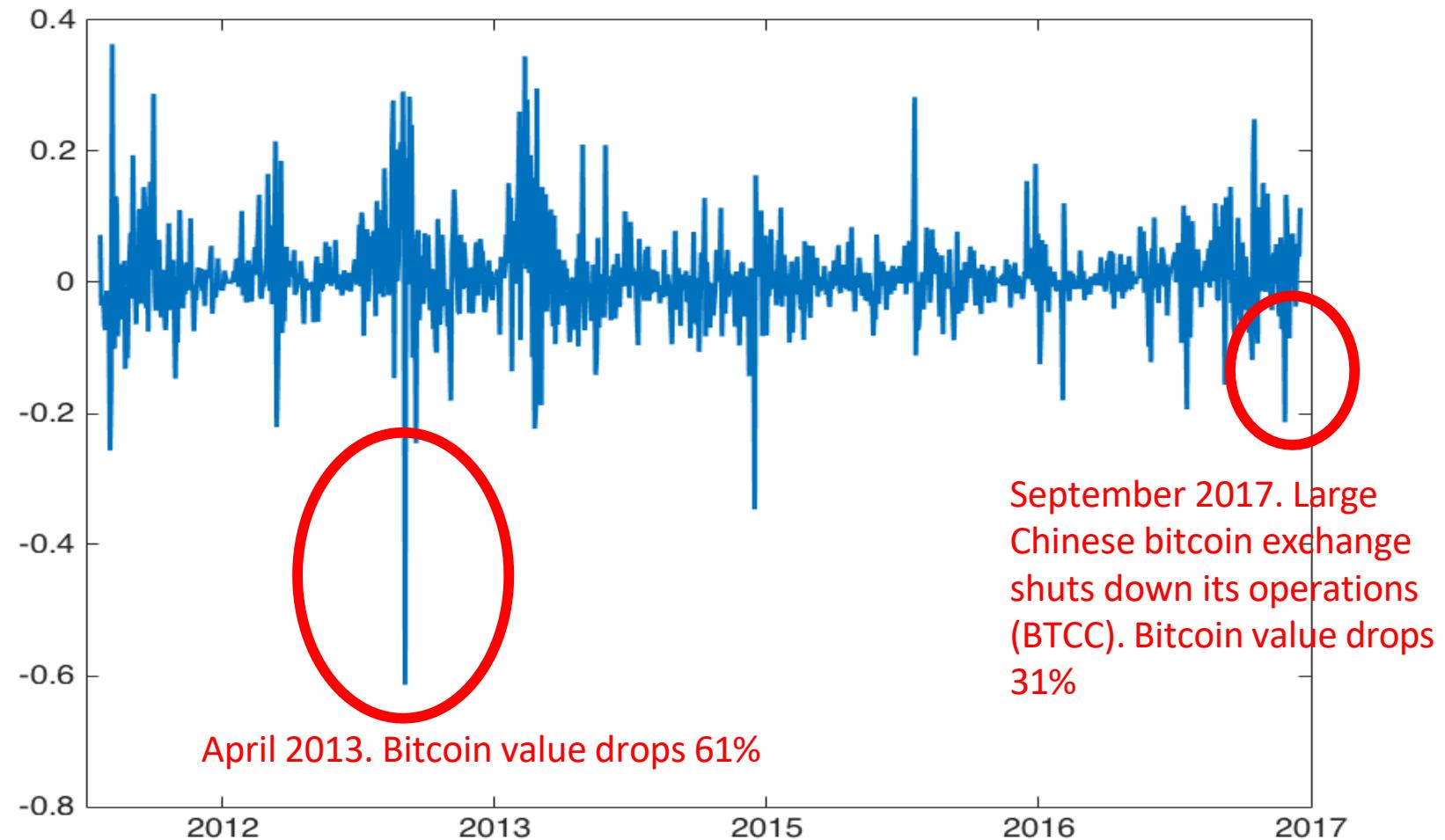
Bitcoin has its shortcomings

It has suffered episodes of big losses



In partnership with ChartIQ

Bitcoin returns



Did we see something like this before?

The dot-com bubble (Example: CISCO)



Did we see something like this before?

The dot-com bubble (Example: CISCO)



...and then it happened again



Some controversy among investors and academics

- JPMorgan CEO Jamie Dimon says bitcoin is a 'fraud' that will eventually blow up

<https://www.cnbc.com/2017/09/12/jpmorgan-ceo-jamie-dimon-raises-flag-on-trading-revenue-sees-20-percent-fall-for-the-third-quarter.html>

- Buffett blasts bitcoin as 'mirage': 'Stay away!'

<https://www.cnbc.com/2014/03/14/buffett-blasts-bitcoin-as-mirage-stay-away.html>

- Some support from Spanish economist Daniel Lacalle

<http://www.dlacalle.com/bitcoin-free-currency-bubble-or-ponzi-scheme/>

- “Bitcoin Myths and Facts” by Campbell Harvey

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2479670

Exchange Rates

- **Definition:** The amount of a currency that one needs in order to buy one unit of another currency or the amount of a currency that one gets when selling one unit of another currency.
 - *Example:* USD/CAD 0.80 (dimension of the currency).
- Dimension can be used to convert USD → CAD or CAD → USD:
 - $1,000 \text{ CAD} * 0.80 \frac{\text{USD}}{\text{CAD}} = 1,000 * 0.80 \frac{\text{CAD} * \text{USD}}{\text{CAD}} = 800 \text{ USD}$.
- **Warning:** Traders quote $\text{USD/CAD} = 1.25 \rightarrow$ *name* of the currency, not the *dimension*. For the dimension, you will never see an equality sign.
- **Remember:** Whenever possible, we quote the dimension as HC/FC, similar to any other product or service a resident of one specific country could buy with the HC.
 - We say “the price is GBP 5 per umbrella” (HC/umbrella) and not “one-fifth of an umbrella buys one GBP” (umbrella/HC).
 - HC/FC: ‘direct’ or ‘right’ quote (USD, GBP, EUR).
 - FC/HC: ‘indirect’ or ‘left’ quote (all other currencies).

Bid and Ask Rates

- Traders need to give up more HC for buying FC than they gain HC from selling off FC.
 - Example: Sell USD: $\underbrace{1.20 \text{ CAD/USD}}_{\text{bid rate}}$ vs. Buy USD: $\underbrace{1.21 \text{ CAD/USD}}_{\text{ask rate}}$.
 - Bid and ask defined from bank's perspective, i.e., bank bids 1.20 CAD for one USD or bank offers one USD for 1.21 CAD.
 - Remember: If currency of interest in denominator, bid always lower than ask (sell low, buy high = bank profits from transaction).
 - Bid minus ask = bid-ask spread.
- Inversion of FX rates without spreads: $HC/FC = (FC/HC)^{-1}$.
- Be careful in the presence of spreads:
$$S_{\text{bid},t}^{\text{CAD/USD}} = \frac{1}{S_{\text{ask},t}^{\text{USD/CAD}}} \quad \text{and} \quad S_{\text{ask},t}^{\text{CAD/USD}} = \frac{1}{S_{\text{bid},t}^{\text{USD/CAD}}}$$
 - $S_{\text{ask},t}^{\text{USD/CAD}}$ (USD price for buying CAD) $> S_{\text{bid},t}^{\text{USD/CAD}}$ (USD gain from selling CAD) to prevent arbitrage. Similarly for CAD/USD: $S_{\text{ask},t}^{\text{CAD/USD}} > S_{\text{bid},t}^{\text{CAD/USD}}$.
 - The inverse of a higher number is a lower number, thus the above rule.

Foreign Exchange Markets I

- Not an organized market (e.g., fixed opening hours, etc.), but more an informal network consisting of a wholesale and a retail tier.
 - **Wholesale tier:** Network of about 500 banks and currency brokerages that deal with one another and large corporations.
 - **Retail tier:** Network of individuals and brokers.
- FX markets are open 24-hours a day (see later slide).
- Three mechanisms how banks operate : (i) Market makers, (ii) auction platforms and (iii) brokers.
 - (i) **Market maker** banks must provide a *binding* two-way (bid/ask) quote, even without knowing counterparty's intention.
Limits: (1) Immediacy, (2) size, (3) # outstanding contracts.
 - Market maker transactions normally conducted through chat windows:

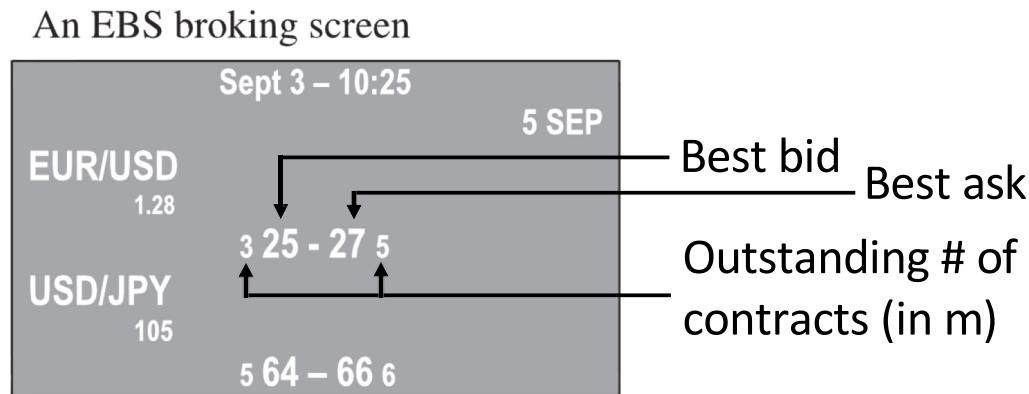
A Reuters conversation

From: GENP
Hi: EUR/USD in 5 pse?
Hi 25 27 +
Mine 5 at 27 val 5/9 +
Tks \$ to Citi Bibi

abbreviated name (Jenpi, Jean-Pierre)
Can I have a quote for EUR in USD for quantity 5m (dollars) please?
bid: 25, ask: 27
I buy 5 (million) at the ask, 27, for value date September 5.
Thanks, I'll send the dollars to Citibank. Bye bye.

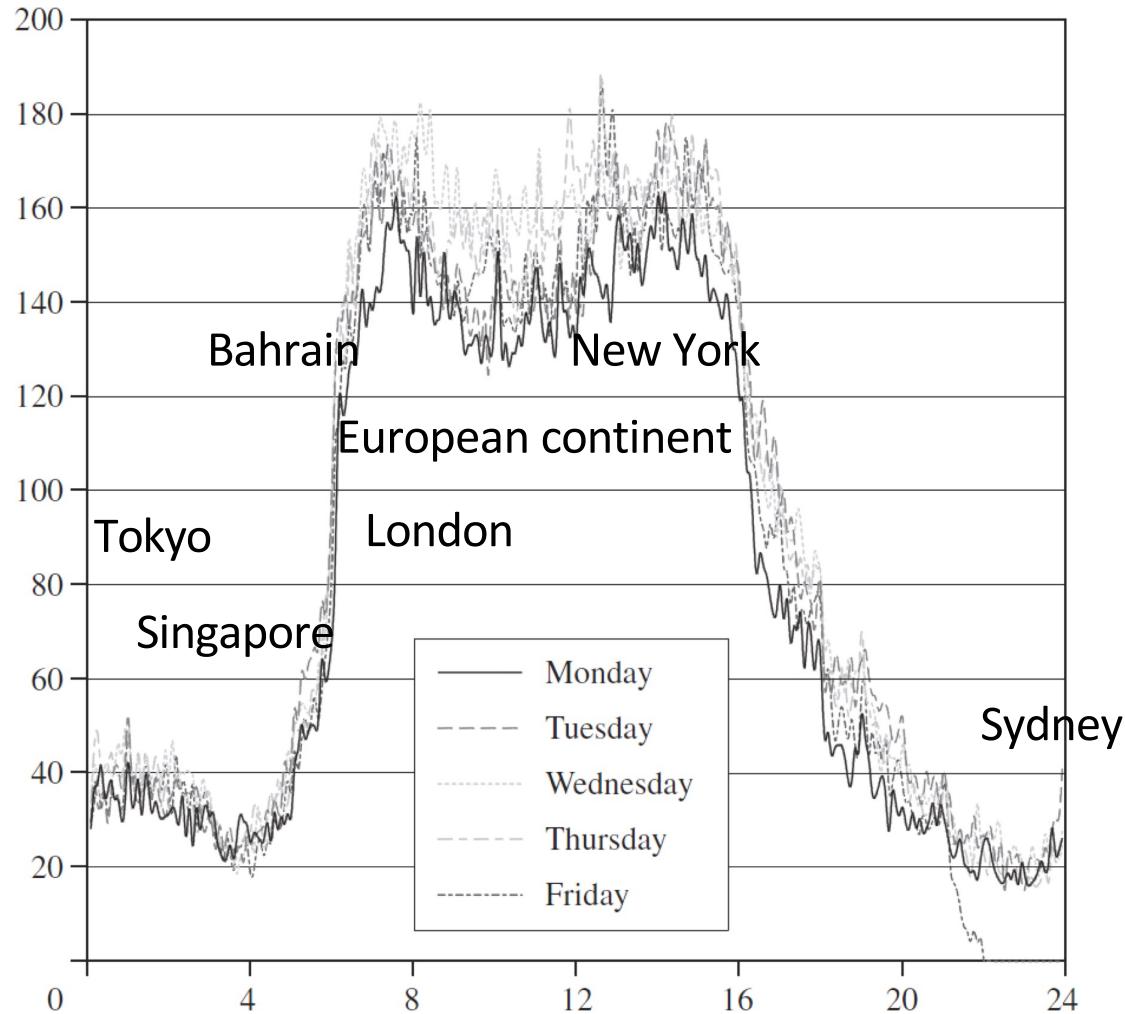
Foreign Exchange Markets II

- (ii) **Auction platforms** work through economic agents entering their bids and asks into a public limit-order book.
 - *Example:* Bank A has EUR 30m for sale and wants at least USD/EUR 1.3007 for them – an ask price. Bank A posts this information in the limit order book (EBS or Reuters 3000).
- At each point in time, the limit order book shows the best bid and ask:



- Traders can either (a) click on the quote they like and enter the amount or (b) enter a limit order that is automatically matched, partially or wholly.
- (iii) **Brokers** act as middle-persons between two economic agents.

Trading Activity on FX Market over a day



Summary Statistics on FX Market (Currency Pairs)

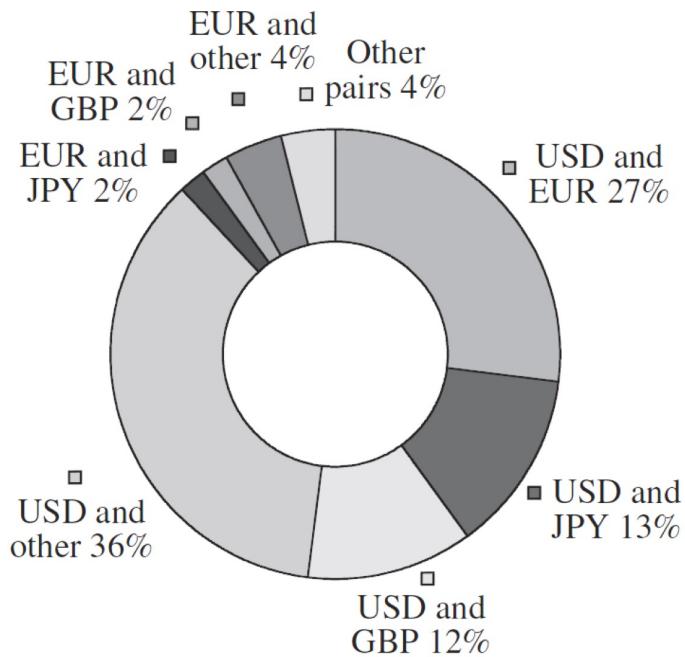
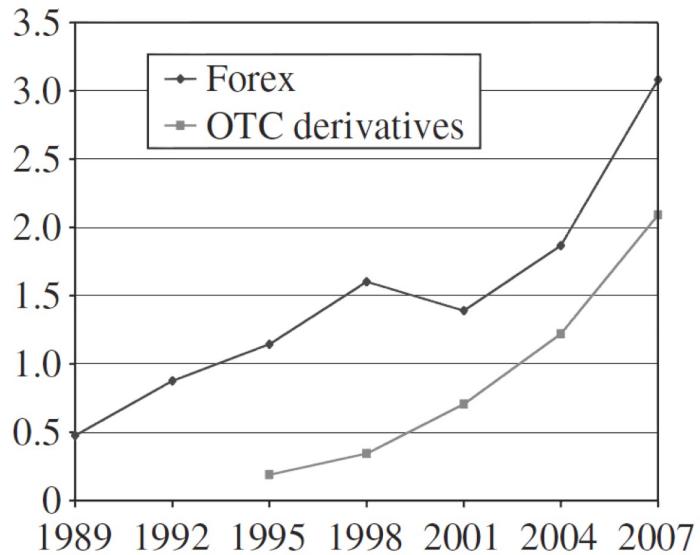


Figure 3.5. Forex turnover, daily, billions of USD, and market shares of currency pairs.
Source: BIS, *Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity in April 2007*, Preliminary Global Results, September 2007.

Foreign Exchange Markets III

- The FX market consists of two core segments:
 1. **Spot market:** Exchange market for quasi-immediate payment (in HC) and delivery (of FC).
 - Quasi-immediacy implies 2 working days in most cases.
 - Spot rate will be denoted by S_t .
 2. **Forward market:** Exchange market for payment (in HC) and delivery (of FC) at some future date (e.g., 3 months from now), at the rate agreed on today.
 - Future rate will be denoted by $F_{t,T}$, where t = contracting date (when trader entered contract) and T = delivery date.
- Volume: Spot market (<50%), forward and swap market (>50%) and currency-futures contracts and currency options ($\approx 3\%$).

Law of One Price

- Law of One Price: Two assets with the same future payoff must have the same price. Otherwise, buy cheaper asset and sell more expensive asset.
 - Example: Assets A and B have the same payoff at time T . However, $P_A = \text{USD } 10 < P_B = \text{USD } 20$. A clever trader would then buy P_A and sell P_B for an immediate profit of USD 10.
 - At time T , the payoff of his strategy would be zero.
- This strategy is an arbitrage: Make a certain profit with no risk.
- Arbitrage transactions enforce the law of one price:
 1. A clever trader would repeat the arbitrage strategy unless $P_A = P_B$.
→ demand (supply) for A \uparrow (\downarrow) and demand (supply) for B \downarrow (\uparrow).
 2. As a result, the arbitrage strategy will equalize the prices of the two assets **in perfect markets without transaction costs and the like**.
- A weaker mechanism: shopping around.
 - In contrast to arbitrage, this is a one-trip transaction.
 - The idea: Buy at the lower price (but do not sell) or sell at the higher price (but do not buy) → used for portfolio re-shuffling.

Arbitrage across Market Makers

- The bid/ask rates (in INR/NZD) offered by market makers X, X' and Y are as shown:

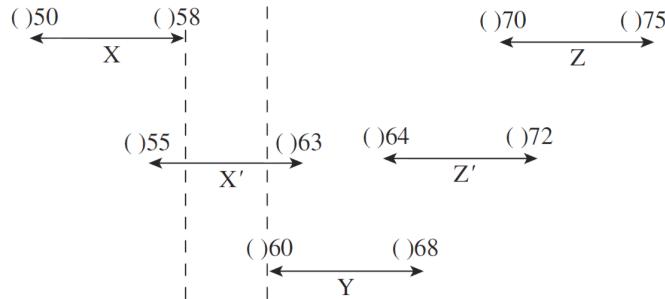


Figure 3.6. Arbitrage and shopping-around opportunities across market makers.

- The quotes of X and Y allow for an arbitrage, i.e., trader can buy NZD at 20.158 and immediately resell them for 20.160 (profit = INR 0.002).
 - Keep in mind:** Empty space between quotes (from 58 to 60 in this example) reveals an arbitrage opportunity.
- The quotes of X' and Y do not allow for an arbitrage. However, sooner or later they must also converge:
 - All buyers of NZD will deal with X' → X' accumulates INR – all sellers of NZD will deal with Y → Y accumulates NZD.
 - At some point, these reserves will become excessive (inventory risk), and then X' and Y must change their bid-ask quotes.

Arbitrage across Currencies I

- Traders could make a profit from buying (selling) a currency at the cross-rate and immediately selling (buying) it at the direct rate.
- Definition of cross rate (or synthetic rate): The buying or selling of a currency with another currency through a third currency.

- Example: Buy GBP with JPY through USD (third currency).

$$[JPY/GBP] = \underbrace{[JPY/USD]}_{\text{Buy dollars with yens}} * \underbrace{[USD/GBP]}_{\text{Buy pounds with dollars}}$$

- Bid/ask rates make these calculations slightly more “complicated”:

- Assume: JPY/USD 101.07 (bid) – 20 (ask) and USD/GBP 1.3840 – 50.

$$\begin{aligned} S_{t,ask}^{JPY/GBP} &= S_{t,ask}^{JPY/USD} * S_{t,ask}^{USD/GBP} \\ &= \underbrace{101.20}_{\text{Buy dollars - pay higher price!}} * \underbrace{1.3850}_{\text{Buy pounds - pay higher price!}} = 140.16 \end{aligned}$$

- The Synthetic $S_{t,bid}^{JPY/GBP}$ can be computed in a similar way.

Arbitrage across Currencies II

- Arbitrage: buy at the lower rate and sell at the higher rate, where the rate is either the direct quote or the synthetic quote (two-way trip).
- Shopping around: buy at the lower rate *or* sell at the higher rate (one-way trip).

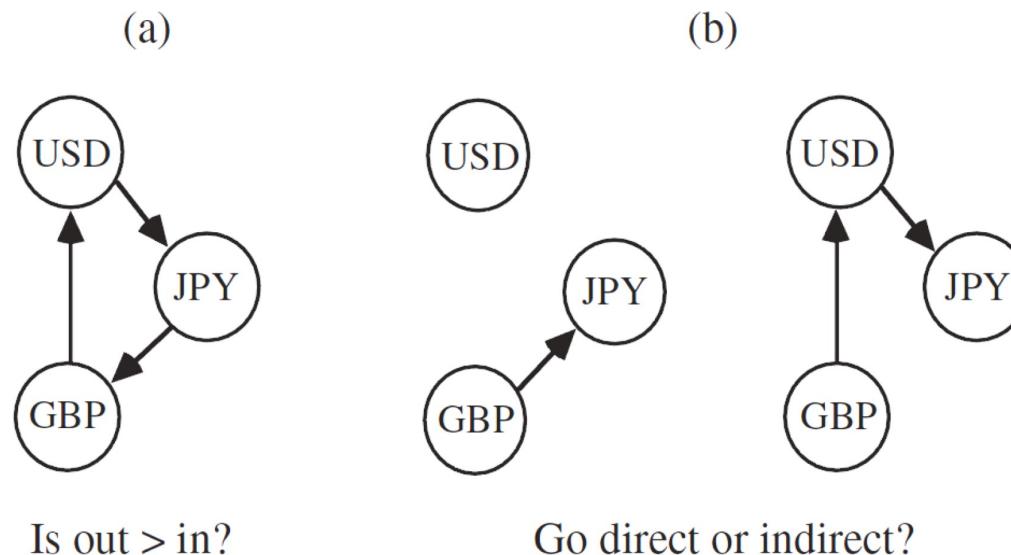


Figure 3.7. (a) Triangular arbitrage (do I make money doing this?) and (b) triangular shopping around (which of the two gives me the best price?).

Purchasing Power Parity 购买力平行

- An implied nominal exchange rate which translates an amount of foreign currency into domestic currency **with equal purchasing power**.
- *Underlying idea:* Assume A, a resident of the United States, earns USD 500, while B, a resident of Poland, earns EUR 400. Is A richer than B?
 - **Solution 1:** Translate both amounts into USD at prevailing FX rate.
Problematic, as it does not consider price levels.
 - **Solution 2:** Find Polish income level which would buy one exactly the same number of goods in Poland as the USD 500 buy one in the United States.

Assume: consumption basket = USD 200 (in U.S.) and EUR 125 (in Poland).

$$\frac{\hat{Y}}{\Pi_t} = \frac{Y^*}{\Pi_t^*} \leq \hat{Y} = \frac{\Pi_t}{\Pi_t^*} Y^* = \frac{\text{USD } 200}{\text{EUR } 125} * \text{EUR } 400 = \text{USD } 640$$

As a result, A is poorer than B.

- $\hat{S}_t^{PPP} = (\Pi_t / \Pi_t^*) \rightarrow$ purchasing power parity (PPP) rate.

Alternative Forms of Purchasing Power Parity

商品价格平价

- **Commodity Price Parity (CPP)**: Exchange rates equalize the prices of goods & services across countries.

$$\text{CPP holds if } \frac{P_{j,t}}{S_t} = P_{j,t}^*$$

where the j subscript indexes the individual goods or services.

- *Empirical evidence*: Unsurprisingly, CPP does not hold (transaction costs, non-instantaneous trading, etc.).
- **Absolute Purchasing Power Parity (APPP)**: Exchange rates equalize the prices of (identical) consumption baskets across countries.
 - Assume all the typical individual consumes is a ‘hamburger menu’. If this menu is double the price in country A compared to country B, then the value of A’s currency must be half compared to B’s currency.

$$\text{APPP holds if } \frac{\Pi_t}{S_t} = \Pi_t^*$$

Where Π_t denotes the (standard) consumption basket (= price level).

Real Exchange Rate

- Related to APPP is a concept called the ‘real exchange rate’. The real exchange rate is defined as:

$$RER_t = \frac{S_t}{\hat{S}_t^{PPP}} = \frac{S_t * \Pi_t^*}{\Pi_t}$$

→ Nominal exchange rate divided by purchasing power parity rate.

- **Note:** If APPP holds (i.e. if $\Pi_t = S_t * \Pi_t^*$), then $RER = 1$. If $RER \neq 1$, then one country is cheaper than the other.
- Here’s an intuitive explanation for what’s going on:
 - Mr Smith, living in country F (= foreign), has earned just enough money to afford himself the standard consumption basket (s.c.b.) in country F.
 - He could move to country H (= home). What would his money be worth there?
 - Translated into H’s currency, he would have $S_t^{HC/FC} * \Pi_t^*$. To compute how much of the s.c.b. this would buy him in country H, he then divides this number by the s.c.b.’s price in H ($= S_t^{HC/FC} * \Pi_t^* / \Pi_t$).
- If this number $> (<) 1$, he can consume more in H (F) \leftrightarrow H (F) is relatively cheap and F (H) is relatively expensive.

Relative Purchasing Power Parity

- RPPP implies that the change in the RER equals zero.
- If RPPP does not hold, then changes in RER reveal which countries become more or less expensive compared to other countries (see next slide).
- APPP implies RPPP, but RPPP does not necessarily imply APPP.

Changes in Competitiveness = Changes in RER (U.S. Perspective)

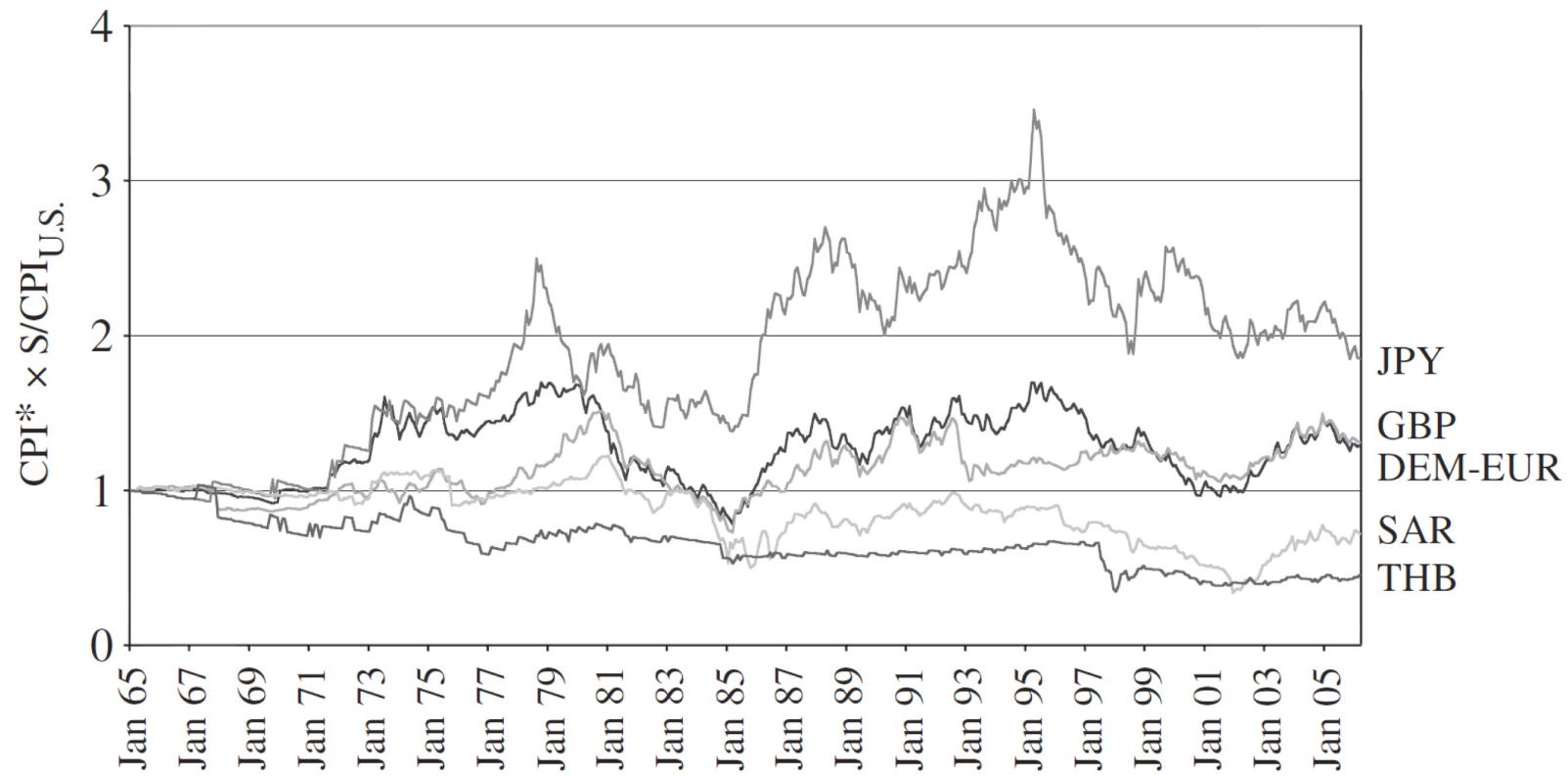


Figure 3.13. [Actual rate]/[PPP rate] against the USD, 1965 = 1.00.

Source: Underlying data are from DataStream.

Big Mac Index of The Economist I

Table 3.6. PPP rates based on Big Mac prices from the *Economist*, May 26, 2006.

	Currency	Local price	Actual value of \$	PPP rate of \$	Real rate of \$	Actual value in \$	PPP rate in \$	Real rate in \$
China	yuan	10.5	8.03	3.39	2.371	0.125	0.295	0.422
Macau	pacata	11.1	7.99	3.58	2.231	0.125	0.279	0.448
Malaysia	ringgit	5.5	3.63	1.77	2.046	0.275	0.564	0.489
Hong Kong	dollar	12	7.75	3.87	2.002	0.129	0.258	0.499
Indonesia	rupia	14600	9325	4709.68	1.980	0.000	0.000	0.505
Philippines	peso	85	52.6	27.42	1.918	0.019	0.036	0.521
Paraguay	guarani	9000	5505	2903.23	1.896	0.000	0.000	0.527
Egypt	pound	9.5	5.77	3.06	1.883	0.173	0.326	0.531
Ukraine	hryvna	8.5	5.05	2.74	1.842	0.198	0.365	0.543
Moldava	leu	23	13.2	7.42	1.779	0.076	0.135	0.562
Uruguay	peso	42.3	23.9	13.65	1.752	0.042	0.073	0.571
Russia	ruble	48	27.1	15.48	1.750	0.037	0.065	0.571
Dominican Rep	peso	60	32.6	19.35	1.684	0.031	0.052	0.594
Sri Lanka	rupee	190	103	61.29	1.681	0.010	0.016	0.595
Honduras	lempira	35.95	18.9	11.60	1.630	0.053	0.086	0.614
Bulgaria	lev	2.99	1.54	0.96	1.597	0.649	1.037	0.626
Slovakia	koruna	58	29.5	18.71	1.577	0.034	0.053	0.634
Poland	zloty	6.5	3.1	2.10	1.478	0.323	0.477	0.676
Thailand	baht	60	28.4	19.35	1.467	0.035	0.052	0.682
South Africa	rand	13.95	6.6	4.50	1.467	0.152	0.222	0.682
Pakistan	rupee	130	60.1	41.94	1.433	0.017	0.024	0.698
Venezuela	bolivar	5701	2630	1839.03	1.430	0.000	0.001	0.699
Costa Rica	colon	1130	510	364.52	1.399	0.002	0.003	0.715
Japan	yen	250	112	80.65	1.389	0.009	0.012	0.720
Singapore	dollar	3.6	1.59	1.16	1.369	0.629	0.861	0.730
Guatemala	quetzal	17.25	7.59	5.56	1.364	0.132	0.180	0.733
Argentina	peso	7	3.06	2.26	1.355	0.327	0.443	0.738
Georgia	lari	4.15	1.8	1.34	1.345	0.556	0.747	0.744
Taiwan	dollar	75	32.1	24.19	1.327	0.031	0.041	0.754
Estonia	kroon	29.5	12.3	9.52	1.293	0.081	0.105	0.774
Saudi Arabia	rial	9	3.75	2.90	1.292	0.267	0.344	0.774
Lithuania	litas	6.5	2.69	2.10	1.283	0.372	0.477	0.779
Australia	dollar	3.25	1.33	1.05	1.269	0.752	0.954	0.788
UAE	dirham	9	3.67	2.90	1.264	0.272	0.344	0.791
Latvia	lats	1.35	0.55	0.44	1.263	1.818	2.296	0.792
Mexico	peso	29	11.3	9.35	1.208	0.088	0.107	0.828
Colombia	peso	6500	2504	2096.77	1.194	0.000	0.000	0.837
Croatia	kuna	15	5.72	4.84	1.182	0.175	0.207	0.846
South Korea	won	2500	952	806.45	1.180	0.001	0.001	0.847

United states dollar 3.1 1 1.00 1.000 1.000 1.000

HC HC/USD

Table 3.6. *Continued.*

	Currency	Local price	Actual value of \$	PPP rate of \$	Real rate of \$	Actual value in \$	PPP rate in \$	Real rate in \$
Czech Rep	koruna	59.05	22.1	19.05	1.160	0.045	0.052	0.862
Fiji	dollar	4.65	1.73	1.50	1.153	0.578	0.667	0.867
Hungary	forint	560	206	180.65	1.140	0.005	0.006	0.877
Turkey	lire	4.2	1.54	1.35	1.137	0.649	0.738	0.880
New Zealand	dollar	4.45	1.62	1.44	1.129	0.617	0.697	0.886
Slovenia	tolar	520	189	167.74	1.127	0.005	0.006	0.888
Aruba	florin	4.95	1.79	1.60	1.121	0.559	0.626	0.892
Brazil	real	6.4	2.3	2.06	1.114	0.435	0.484	0.898
Morocco	dirham	24.5	8.71	7.90	1.102	0.115	0.127	0.907
Peru	new sol	9.5	3.26	3.06	1.064	0.307	0.326	0.940
Chile	peso	1560	530	503.23	1.053	0.002	0.002	0.949
United states	dollar	3.1	1	1.00	1.000	1.000	1.000	1.000
Canada	dollar	3.52	1.12	1.14	0.986	0.893	0.881	1.014
Britain	pound	1.94	0.532	0.63	0.850	1.880	1.598	1.176
Euroland	euro	2.94	0.781	0.95	0.824	1.280	1.054	1.214
Sweden	krona	33	7.28	10.65	0.684	0.137	0.094	1.462
Denmark	krone	27.75	5.82	8.95	0.650	0.172	0.112	1.538
Switzerland	franc	6.3	1.21	2.03	0.595	0.826	0.492	1.680
Iceland	kronur	459	72	148.06	0.486	0.014	0.007	2.056
Norway	kroner	43	6.1	13.87	0.440	0.164	0.072	2.274

- PPP rate of \$ = $10.5/3.1 = 3.39$
- Real rate of \$ = $8.03/3.39 = 2.371$
- Actual value in \$ = $1/\text{Actual value of \$} = 1/8.03 = 0.125$
- PPP rate in \$ = $1/\text{PPP rate of \$} = 1/3.39 = 0.295$
- Real rate in \$ = $1/\text{Real rate of \$} = 1/2.371 = 0.422$

Big Mac Index of The Economist II

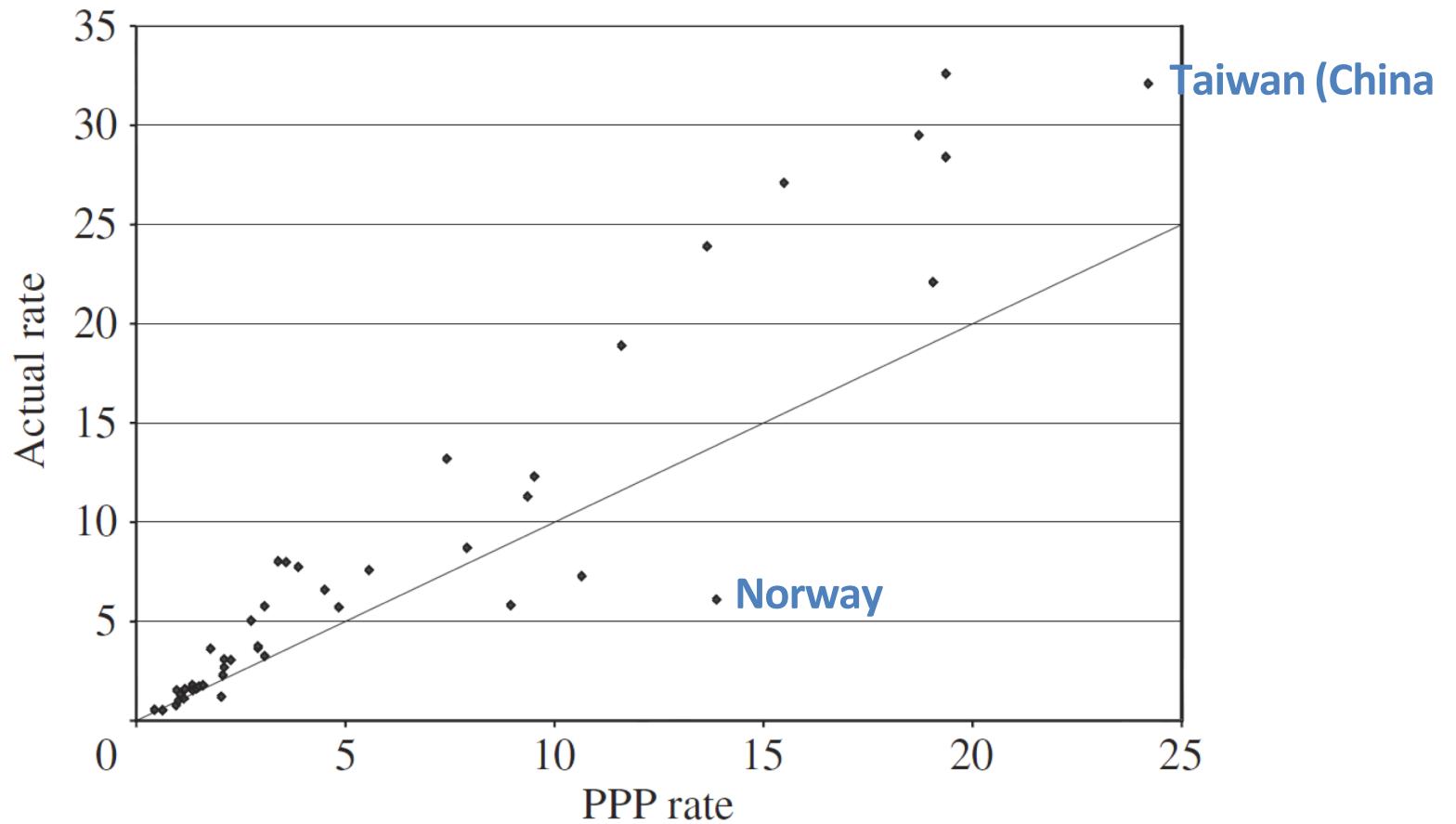


Figure 3.11. PPP versus actual rates, HC/USD.

Source: Based on data from the *Economist*, May 26, 2006.

Summary, Homework and Additional Reading

- **In this lecture**, we dealt with:
 - Exchange rates: Quoting conventions, bid/ask rates.
 - Foreign exchange markets: informal, but huge. Major players: market makers, auction platforms and brokers.
 - Law of One Price: Assets with identical payoffs must have same price, law enforced by arbitrage (two-way trip) or shopping-around (one-way trip).
 - Purchasing Power Parity: CPP, APPP, RPPP and their relation to the RER and changes in the RER.
- **At home**, you will need to cover:
 - Practice to deal with bid/ask rates and to implement arbitrage strategies.
- **Additional reading:**
 - The Economist (2013), “The Big Mac index: Value meal”, *The Economist*, 13 July 2013.
 - Rogoff, K. (1996), “The Purchasing Power Parity Puzzle”, *Journal of Economic Literature* 34(2), 647-668.
 - Two bitcoin readings (see links for the readings in the slides)
[Recommended]