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**Piet Sercu: International Finance: Theory into Practice**

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# 3

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## Spot Markets for Foreign Currency

In this chapter, we study the mechanics of the spot exchange market. Section 3.1 explains the various ways in which exchange rates can be quoted, and section 3.2 how the exchange markets themselves operate. Section 3.3 then considers exchange transactions in greater detail, focusing on bid and ask rates (that is, the rates at which a bank buys and sells). This also gives us an opportunity to learn about arbitrage. Specifically, in the third section, we shall already apply arbitrage arguments to the simplest possible problem, the relation between rates quoted by different banks for the same currency. Understanding this simple application now will make it easier to digest more complicated versions of similar arguments later. One such application already occurs in section 3.4, where we use arbitrage arguments to explain how exchange rates quoted by, for example, German banks (against EUR) relate to rates offered by New Zealand banks (against the NZD).

The chapter ends with the concepts of, and empirical evidence on, “purchasing power parity” (PPP) rates and real exchange rates. The conclusion of that part will be that exchange rates can make or break an exporting company, not just because of capital losses on foreign-currency-denominated receivables but possibly also because of a loss of competitiveness. Exchange risk even interferes with capital market equilibrium and the CAPM. These findings motivate the attention given to exchange rates in this book.

### 3.1 Exchange Rates

As we begin exploring exchange rates, we first provide a definition. We then describe the convention used to quote exchange rates throughout this book, as well as the conventions used in the exchange market. Finally, we explain how exchange rates are quoted in the presence of bid-ask spreads.

#### 3.1.1 Definition of Exchange Rates

An exchange rate is the amount of a currency that one needs in order to buy one unit of another currency, or it is the amount of a currency that one receives

when selling one unit of another currency. An example of an exchange rate quote is 0.8 USD per CAD (which we will usually denote as “USD/CAD 0.8”): you can, for instance, buy a CAD by paying USD 0.80.

In the above, we have combined currency names following the conventions in physics: EUR/USD means euros per dollar just as “km/h” means kilometers per hour. This is the most logical convention. For instance, if you exchange 3m dollars into euros at a rate of 0.8 euros per dollar, the result is 2.4m euros—a number of euros. This fits with our notation:

$$\text{USD } 3\text{m} \times \text{EUR/USD } 0.8 = \text{EUR } 2.4\text{m}. \quad (3.1)$$

This may seem self-evident. The reason why we bring this up is that the pros do it differently. In the convention typically adopted by traders, bankers, and journalists, EUR/USD is not the dimension of the quote but the name of the exchange rate: it is the *value* of the euro, *expressed* in dollars, not its dimension. That is, the pros write “EUR/USD = 1.2345,” whereas we write “ $S_t = \text{USD/EUR } 1.2345$ .” The dimension the trader asks for is USD/EUR, the inverse of what they write—but they do not mean a dimension, they mean a name.<sup>1</sup> In all our examples we use dimensions. The “name” notation pops up occasionally in press clippings or in pictures of trading screens, etc., and should not be a problem. To harden yourself, stare at the following entries for a full minute:

Currency name	Value
EUR/USD	USD/EUR 0.75
EUR/GBP	GBP/EUR 0.60
USD/CHF	CHF/USD 1.05

The telltale difference is that the dimension is immediately followed (or, occasionally, preceded) by the number. If there is no number, or if there is an “=” or “is” or “equals,” etc., between the ratio and the number, it must be the name of a rate. Sometimes practitioners drop the slash in the name and write EURUSD or EUR:USD instead of EUR/USD, which makes more sense.

It is even more crucial that you understand how exchange rates are quoted. While the notation is occasionally confusing—are we using dimensions or names?—there could be even more confusion as to which currency should be used as the numéraire. While you are familiar with the idea of buying goods and services, you may be less used to buying money with money. With exchange transactions, you need to agree which money is being bought or sold. There would be no ambiguity if one of the currencies were your home currency. A purchase then means that you obtained foreign currency and paid in home currency, the way you would do it with your other purchases too; and a sale

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<sup>1</sup> It is sometimes whispered that the trader notation comes from a kind of pseudo-math like “EUR 1 = USD 1.2345,” where one then “divides both sides by USD.” The mind boggles. This is like denoting a speed as “1 h = 100 km” instead of  $v = 100 \text{ km/h}$ .

means that you delivered foreign currency and received home currency. If neither currency is your home currency, then you need to establish which of the two acts as the home currency.

**Example 3.1.** In a Paris bank, a tourist hands over USD 1,000 to the bank clerk and receives CAD 1,250 in return. This event would be described differently depending on whether the person is a U.S. tourist, a Canadian, or a Frenchman:

- The U.S. tourist would view this as a purchase of CAD 1,250 at a total cost of USD 1,000, implying a unit price of  $[\text{USD } 1,000]/[\text{CAD } 1,250] = \text{USD}/\text{CAD } 0.8$ .
- The Canadian would think of this transaction as a sale of USD 1,000 for CAD 1,250, implying a unit price of  $[\text{CAD } 1,250]/[\text{USD } 1,000] = \text{CAD}/\text{USD } 1.25$ .
- The Frenchman would regard this as an exchange of two foreign currencies, and would be at a loss if he were asked which of these is being sold and which bought.

Among pros, the currency in which the price is expressed is called the *quoting currency*, and the currency whose price is being quoted is called the *base currency* or *reference currency*. We avoid the terms, except in the next two lines. We have just noted that pros denote a rate as base/quoting (or, better, base:quoting) while its dimensions are quoting/base. A different issue is whether the quoting currency is the home or the foreign one.

### 3.1.2 Our Convention: Home Currency per Unit of Foreign Currency

Once we agree which country is, or acts as, the home country, we can agree to quote exchange rates as the price in units of home currency (HC) per unit of foreign currency (FC). That is, we quote the rate as HC/FC throughout this text, meaning that one unit of FC is worth  $N$  HC units (dimension HC/FC). As we shall see, some people do it differently and state that, with one unit of home currency, they can buy  $M = 1/N$  units of foreign currency (FC/HC). We adopt the HC/FC convention because it is the most natural one. It is the convention we use when buying goods. For example, we say “the price is five dollars per umbrella” (HC/umbrella), not “with one dollar you can buy one-fifth of an umbrella” (umbrellas per unit of home currency).

#### Example 3.2.

1. A quote like USD/EUR 1.25 is an American’s natural quote for the EUR; it is the USD price an American gets or pays per EUR. For Germans or other Eurolanders, a quote as EUR/USD (euros per dollar) is the more natural one.
2. A quote like USD/CAD 0.75 is an American’s natural quote for the CAD, since the CAD is the currency in the denominator: a price in USD per CAD.

Expressing prices in HC is the convention for not just umbrellas but also for financial assets. Thus, standard finance results hold: the current market value is the expected future value (including interest earned), discounted at a

rate that takes into account the risk. Under the alternative quotation, confusingly, the current value would be determined by the inverse of the expected inverse of future value, multiplied by unity plus the required return. (If you just felt you had to read this sentence twice, you may want to consider reading technical note 3.1 at the end of the chapter instead.)

The direct (HC/FC) quoting convention used to be standard in continental Europe, and is called the “direct” quote, or the “right” quote. In the United States, a price with dimension USD/FC is called “American terms.” The alternative is called the “indirect” or “left” quote or, in the United States, “European terms.” Let’s see who uses which and why.

### 3.1.3 The Indirect Quoting Convention

One group of people using mostly indirect quotes are professional traders in the United States. Between 1944 and the mid 1980s, each and every exchange deal went through the USD; even when a German needed to buy CHF, the DEM would first be converted into USD and these dollars were then exchanged for CHF. Naturally, when New York traders talk to, say, their German counterparts, both must talk the same language, quotewise; otherwise too much time would be wasted inverting each other’s rates all the time. Both Germans and Americans actually preferred to quote in terms of DEM/USD rather than USD/DEM, for the simple reason that the official parities, set by the German government, were expressed in DEM/USD.<sup>2</sup> More generally, U.S. professionals use the exchange-rate convention as quoted in the other country. Thus, for countries that quote directly themselves, like Japan, New York traders would talk JPY/USD. But in the case of countries that quote indirectly themselves, like the United Kingdom, the pros would also use USD/GBP. Thus, U.S. pros use indirect quotes for countries that themselves quote directly, and direct quotes for countries that themselves quote indirectly.

As already hinted at, in the United Kingdom one uses the reverse quote, the number of foreign units that can be bought with one pound, or FC/HC. Some former British or Commonwealth countries (e.g., Australia and New Zealand) and, until 1979, Ireland do likewise.<sup>3</sup> One reason is that, before World War I, the pound was the world’s reserve currency and played the role taken over by the dollar after World War II. In addition, until 1967 the GBP was still severely nondecimal—one pound consisted of twenty shilling, each worth twelve pence<sup>4</sup>—while currencies not based on the pound had gone decimal long before. It is much easier to multiply or divide by a decimal number, say

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<sup>2</sup>Recall from the previous chapter that, until 1972, countries declared an official parity in relation to the USD, say DEM/USD 4. Intervention kept the actual rates between an upper and lower bound expressed, likewise, in DEM/USD.

<sup>3</sup>Canada and South Africa went off the pound ages ago, which is why they quote differently.

<sup>4</sup>Recall there also was a dollar (10s.), a crown (5s.), and a guinea, worth 21s. in the end; and in Elizabethan times many wages were expressed in marks (13s.4d., i.e., 160d.). But by modern times most prices were in pounds, shillings, and pence.

**Table 3.1.** Key exchange rates: pros' notation, dimensions, and nicknames.

Symbol	Currency pair	Dimension	Trading terminology
USDJPY	U.S. dollar, in Japanese yen	JPY/USD	Dollar yen
USDCHE	U.S. dollar, in Swiss francs	CHF/USD	Dollar Swiss or Swissy
USDCAD	U.S. dollar, in Canadian dollars	CAD/USD	Dollar Canada
USDZAR	U.S. dollar, in South African rand	ZAR/USD	Dollar ZAR or South African rand
GBPUSD	British pound, in U.S. dollars	USD/GBP	Cable
GBPCHF*	British pound, in Swiss francs	CHF/GBP	Sterling Swiss
GBPJPY*	British pound, in Japanese yen	JPY/GBP	Sterling yen
AUDUSD	Australian dollar, in U.S. dollars	USD/AUD	Australian dollar
NZDUSD	New Zealand dollar, in U.S. dollars	USD/NZD	New Zealand dollar or Kiwi
EURUSD	Euro, in U.S. dollars	USD/EUR	Euro
EURGBP*	Euro, in British pounds	GBP/EUR	Euro sterling
EURJPY*	Euro, in Japanese yen	JPY/EUR	Euro yen
EURCHF*	Euro, in Swiss francs	CHF/EUR	Euro Swiss
CHFJPY*	Swiss franc, in Japanese yen	JPY/CHF	Swiss yen
GLDUSD	Gold, in U.S. dollars per troy ounce	USD/ozXAU	Gold
SLVUSD	Silver, in U.S. dollars per troy ounce	USD/ozXAG	Silver

\*Cross rate, from the U.S. perspective. Most names should be obvious, except perhaps CHF (*Confederatio Helvetica*, Latin for Switzerland—the way a four-language country solves a political conundrum). The ZAR, the South African rand, is not to be confused with SAR, the Saudi riyal. GLD and SLV are unorthodox: the official codes as used by, for example, Swift are XAU and XAG, with X signalling a nonstandard currency (also like the CFA franc and the ecu of old), and the Latin *aurum* and *argentum*. “Cable” for USDGBP refers to the fact that it is about bank-account money, with payment instructions wired by telegram cable rather than sent by surface mail. There was a time when telegraphy was cutting-edge technology.

FC/GBP 0.792 08, than with a number like £1/s5/d3 (one pound, five shillings, three pence). So everyone preferred to talk FC units per pound.

A third (and more recent) class of people using the indirect quote are the Eurolanders, who always quote rates as USD/EUR or JPY/EUR even though they traditionally quoted directly (as DEM/USD). Cynics conjecture that the Europeans may have coveted the reserve-currency status associated with an indirect quote. Another possible reason is that, initially, the euro was foreign to all existing currencies. For example, to Germans the euro was introduced as worth 2 DEM, so they would quite naturally introduce it to Americans and Japanese as being worth 1.20 USD or 110 JPY. When, eventually, the euro had become the home currency, the habit simply stuck.

**Example 3.3.** Have a look at table 3.1, showing the most important rates in the way they are always quoted by pros. The primary rates are in non-U.S. currencies except for the GBP, NZD, and AUD, or for the EUR; you know why. Cross rates for the EUR are in non-EUR currencies, and likewise for the GBP.

**Table 3.2.** Sample spot exchange rate quotes. (From the *Wall Street Journal Europe*, which sensibly shows both the natural and indirect quotes.)

AMERICAS	Per euro	In euros	Per	In	EUROPE	Per euro	In euros	Per	In
			U.S. dollar	U.S. dollars				U.S. dollar	U.S. dollars
Argentino peso-a	3.9628	0.2523	3.0838	0.3243	Euro zone euro	1	1	0.7782	1.2851
Brazil real	2.9588	0.3380	2.3025	0.4343	Czech Rep koruna-b	28.260	0.0354	21.992	0.0455
Canada dollar	1.438	0.7073	1.1002	0.9089	Denmark krone	7.4576	0.1341	5.8034	0.1723
Chile peso	683.07	0.001464	531.55	0.001881	Hungary forint	262.82	0.003805	204.52	0.004890
Columbia peso	3186.28	0.0003138	2479.50	0.0004033	Malta lira	0.4294	2.3288	0.3342	2.9926
Ecuador US dollar-f	1.2850	0.7782	1	1	Norway krone	7.800	0.1282	6.0698	0.1648
Mexico peso-a	14.5307	0.0688	11.3075	0.0884	Poland zloty	3.9369	0.2540	3.0637	0.3264
Peru sol	4.2368	0.2360	3.2970	0.3033	Russia ruble-d	34.669	0.02884	26.979	0.03707
Uruguay peso-e	30.841	0.0324	24.000	0.0417	Slovak Rep koruna	37.7856	0.02647	29.4040	0.03401
U.S. Dollar	1.2850	0.7782	1	1	Sweden krona	9.2662	0.1079	7.2108	0.1387
Venezuala bolivar	2759.39	0.000362	2147.30	0.000466	Switzerland franc	1.5604	0.6109	1.2103	0.8262
...	...	...	...	...	...	...	...	...	...

a—floating rate b—commercial rate c—government rate d—Russian Central Bank rate f—Special Drawing Rights from the International Monetary Fund; based on exchange rates for U.S., British and Japanese currencies.

Note: Based on trading among banks in amounts of \$1million and more, as quoted by Reuters

**Example 3.4.** Look at the *Wall Street Journal Europe* excerpt in table 3.2, conveniently showing both quotes; the value in USD or EUR of one unit of the third (“foreign”) currency, and the value of 1 USD or EUR in units of that third (“foreign”) currency. The natural quote for Americans or Europeans would be the first one, but U.S. traders and Eurolanders may use the other quote. Take a minute to look at table 3.2 and see if you understand the exchange rates as quoted.

**Q1.** What is the dollar equivalent of one euro, according to the quotes in the *Wall Street Journal*?

**A1.** If your answer is USD 1.285, you are correct.

**Q2.** Determine the amount of Peruvian soles per EUR.

**A2.** If you answered 4.2368 soles per EUR, you are right.

### 3.1.4 Bid and Ask Rates

When you deal with foreign currency, you will discover that you pay a higher price at the time of purchase than when you sell one currency for another. For example, for dollar-rouble deals the currency booth in your hotel will quote two numbers, say RUB/USD 35–36. This means that if you sell USD for RUB, you receive RUB 35, while if you wish to buy USD you will have to pay RUB 36. The rate at which the bank will buy a currency from you is called the *bid* rate: they bid (i.e., they announce that they are willing to pay) 35 per dollar; and the rate at which the bank will sell a currency to you is the *ask* rate (they ask 36 per dollar). It is, initially, safer not to think about the meaning of bidding and asking because the words refer to the bank’s view, not yours. Just remember that *you* buy at the bank’s ask rate, and *you* sell at the bank’s bid rate. The bid is the lower quote, and ask is the higher one. The ask comes higher in the alphabet—use any trick that works, until you get used to it.

Indeed, if exchange rates are being quoted with the currency of interest—the currency you are buying or selling—in the denominator, then the ask rate will be higher than the bid rate. Obviously, it could not be the other way around: with a bid rate above the ask rate you would be able to make huge risk-free profits by buying at the ask and immediately reselling at the assumedly higher bid. No bank will allow you to buy low and then immediately resell at a profit without taking any risk, because your sure gains would obviously mean sure losses for the bank. In theory, there could still be room for a situation “bid rate = ask rate” (which offers no such arbitrage opportunities). Yet the real-world situation is invariably “bid rate < ask rate”: banks want to make some money from foreign-currency transactions.

Another way to think of this difference between the ask and the bid rates is that the difference contains the bank’s commission for exchanging currencies. The difference between the buying and selling rates is called the *spread*, and you can think of the bank’s implicit commission as being equal to half the spread. The following example explains why the commission is half of the spread rather than the spread itself.

**Example 3.5.** Suppose that you can buy CAD at RUB/CAD 38.6 and sell at RUB/CAD 38.0. With these rates, you can think of a purchase as occurring at the midpoint rate (RUB/CAD 38.3), grossed up with a commission of 0.30. Likewise, a sale can be thought of as a sale at the midpoint, 38.3, from which the bank withholds a commission of 0.30. Thus, the equivalent commission per one-way transaction is the difference between the bid (or ask) and the midpoint rate, that is, half the spread. (The spread itself would be the cost of a round-trip deal—buy and then sell.)

To get an idea of whether your house bank charges a low commission, you can ask for a two-way quote to see if the spread is small. If this is the case, you probably do not have to check with other banks. However, for large transactions, you should also compare the spot quotes given by different banks. (This will be examined further in section 3.3, especially section 3.3.3.) We discuss the determinants of spreads later, after we have described the market microstructure.

### 3.1.5 Primary Rates versus Cross Rates

As of 1945 and until well into the 1980s, all exchange rates in the wholesale segment were against the USD. They were and are called *primary rates*, while any rate not involving the USD would be called a *cross rate* and would traditionally be regarded as just implied by the primary rates. You will find an example for midpoint rates in table 3.3. The primary rates are in the first column (FC/USD) or the bottom line (USD/FC).<sup>5</sup> The rest of the table is obtained

<sup>5</sup> Many newspapers give currency  $j$  the  $j$ th row and the  $j$ th column instead of the  $(N - j)$ th row and the  $j$ th column, but the layout is not crucial. The orientation of the empty diagonal (or the unit diagonal, as other tables might show it) is the sign to watch.







































	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	
2	EUR	USD	1,4868		EUR/USD	EBS	1,4868	1,4869	27,1302	27,1320								EUR/NOK	USD/NOK				
3	EUR	JPY	157,9300	157,9400	RD2002	Reuters	1,4868	1,4869									RD2002	8,0745	8,0765	5,4321	5,4304	Via EUR	
4	EUR	GBP	0,7477	0,7478	Reuters	1,4868	1,4871										Reuters	8,0758	8,0768	5,4303	5,4323	Reuters	
5	EUR	CHF	1,6050	1,6053															EUR/DKK	USD/DKK			
6	EUR	AUD	1,6673	1,6683	RD2002	Reuters	0,7477	0,7478	1,9884	1,9887	RD2002						RD2002	7,4527	7,4530	5,0122	5,0128	Via EUR	
7	EUR	CAD	1,4846	1,4853	Via USD	Reuters	0,7478	0,7478	1,9884	1,9886	Via EUR						Reuters	7,4533	7,4535	5,0123	5,0128	Reuters	
8	EUR	CZK	26,062	26,08	Reuters	0,7477	0,7480		1,9884	1,9887	Reuters								EUR/CAD	USD/CAD			
9	EUR	DKK	7,4527	7,4530													Via USD	1,4846	1,4851	0,9985	0,9988	RD2002	
10	EUR	EEK	15,645	15,648	EBS	157,93	157,94	106,21	106,22	EBS							Reuters	1,4846	1,4853	0,9986	1,6539	Reuters	
11	EUR	HKD	11,5940	11,5960	RD2002	0,00	0,00	106,21	106,23	RD2002									EUR/AUD	AUD/USD			
12	EUR	HUF	259,41	259,61	Via USD	157,91	157,94	106,21	106,23	Via EUR							Via USD	1,6676	1,6681	0,8914	0,8916	RD2002	
13	EUR	IDR	13877	13877	Reuters	157,93	157,97	106,20	106,24	Reuters							Reuters	1,6673	1,6683	0,8914	0,8916	Reuters	
14	EUR	ISK	96,75	96,82															EUR/INZ	NZD/USD			
15	EUR	LTL	3,4526	3,4528	EBS	1,6050	1,6053	1,0795	1,0796	EBS							Via USD	1,8955	1,8963	0,7841	0,7844	RD2002	
16	EUR	LVL	0,6973	0,6983	Via USD	1,6050	1,6053	1,0794	1,0797	Via EUR							Reut/Re	1,8950	1,8968	0,7837	0,7847	Reuters	
17	EUR	MYR	4,8086	4,8137	Reuters	1,6049	1,6052	1,0795	1,0798	Reuters									EUR/SGD	USD/SGD			
18	EUR	NOK	8,0745	8,0765													Via USD	2,1074	2,1077	1,4174	1,4175	RD2002	
19	EUR	NZD	1,8950	1,8966	RD2002	9,4715	9,4735	6,3700	6,3717	Via EUR							Reuters			1,4172	1,4177	Reuters	
20	EUR	PHP	60,19	60,257	Reuters	9,4726	9,4756	6,3698	6,3708	Reuters									<b>koers in kleine pips</b>	<b>26,5</b>			

**Figure 3.8.** A dealer's shopping-around spreadsheet. Courtesy of Paul Goossens, dealer at KBC Brussels. Paul's spreadsheet shows the best quotes from EBS's broking screens, from Reuters Dealing 2002, and the indirect quotes (via USD or EUR). The latter are obviously rounded. Check how the indirect quotes are always wider at one side at least. (With only two pips between the best direct quotes, and with rounding of the synthetic quotes, one side must always seem to match.) The wider quotes labeled Reuters are the indicative, nonbinding ones from the Reuters FX/FX pages; they mean nothing except that some banks are willing to quote. See how Paul's sheet gets the EUR/USD quote from EBS into the darker parts of the spreadsheet. Cell I1 is selected; spot the underlying command =RtGet("IDN": "EUR=EBS" : "BID") in the enter function box above the spreadsheet. From the imported data in the black part, synthetic rates are computed.









**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	riyal	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

exchange rates. Figure 3.10 shows this graphically. To “shrink” the outliers and give the smaller numbers more space, we plot the log of the actual against the log of the PPP rate. (This explains why there are negative rates: numbers below unity produce negative logs.) There is obviously a very strong link.

**DIY Problem 3.3.** Knowing that the Big Mac costs 3.10 in the United States and 155 in Freedonia, and that the spot rate is 100 crowns per dollar, complete Freedonia’s PPP rates in the table:

	Currency	Local price	Actual value of \$	PPP rate of \$	Real rate of \$	Actual value in \$	PPP rate in \$	Real rate in \$
Freedonia	korona	155	100					

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	kroner	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

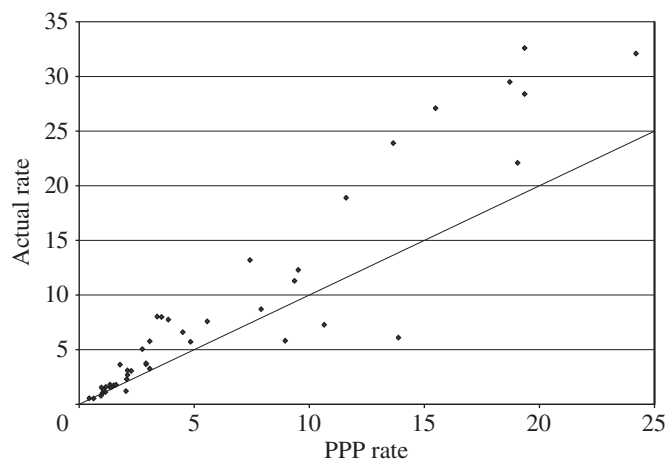


Figure 3.11. PPP versus actual rates, HC/USD.  
Source: Based on data from the *Economist*, May 26, 2006.

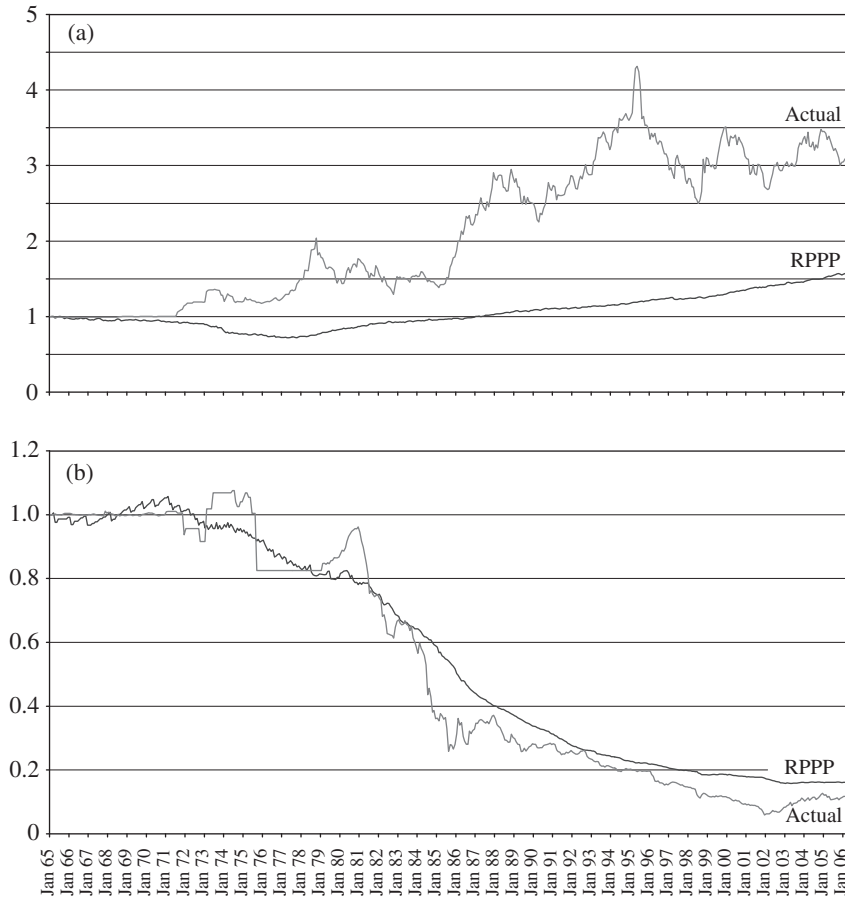
But a closer look at the table reveals big relative deviations, which are hard to spot from a log graph dominated by outliers. Kicking out the twenty highest cases so as to be able to forgo logs, this time, we get figure 3.11. Note how the observations tend to be above the equality line (where actual = PPP): the dollar tends to be too expensive, by Big Mac PPP standards. Yet there are also important deviations below the 45° line, where the slope of the ray through the dot is even below 0.5 in one case. The slope of this ray is called the *real exchange rate*, to which we now turn.











**Figure 3.14.** RPPP versus actual rates against USD, 1965 = 1.00. (a) JPY RPPP versus actual; (b) SAR RPPP versus actual. *Source:* Underlying data are from DataStream.

For this reason, deviations from RPPP are important. Are they large? Figure 3.13 shows time-series data, taking January 1965 as the base period, on relative real rates against USD, for the DEM-EUR, JPY, GBP, SAR, and THB. We note four facts.

- (i) First, there are huge swings in the medium run, with the real rate appreciating by 50% and then going back—and occasionally even doubling or halving—in a matter of years, not decades. Imagine being caught in this as an exporter.
- (ii) Second, in the short run there is lots of inertia: once the rate is above its mean, it tends to stay there for years. Statistical analysis shows that the average half-life is three to five years, meaning that it takes three to five years, on average, for a deviation to shrink to half its original size. Thus, when you get into a bad patch, you can expect that this will be a matter of years rather than weeks or months.















