12

Exchange Rates, Interest Rates, and the Foreign Exchange Market

Overview

In this chapter, we learn:

●●● What an exchange rate is

●●● How an exchange rate of currencies is determined

●●● In what market currencies are traded

●●● How fixed and floating exchange rate regimes differ

●●● How interest rates and exchange rates are related

●●● ???

MONEY, n. A blessing that is of no advantage to us excluding when we part with it.

-- Ambrose Bierce, *The Devil's Dictionary*

10.1 Introduction

The **exchange rate** is the key relative price for an economy open to international trade and finance. The price Americans pay for Japanese automobiles imported into the United States depends on how many dollars it takes to buy 100 yen, i.e., the dollar/yen exchange rate. The stronger the dollar, the more yen it will buy, and therefore the cheaper the imported cars will be. At the same time, a strong dollar makes it harder for U.S. firms to profitably sell heavy earth-moving equipment like bulldozers to the rest of the world. The strength of the dollar against other currencies also affects other sectors, besides just the trade in manufactured goods. A strong dollar is good for an American tourist visiting Madrid, but places in the U.S. that cater to foreign tourists, like Las Vegas, do better business when the dollar is weak. And whether one decides to purchase stocks and bonds **denominated**, i.e., priced, in dollars, as opposed to, say, German securities denominated in euros, has a great deal to do with how one expects the dollar to move against the euro over time.

In this chapter, we'll take the first steps to understanding what that the exchange rate is, and how its numerical value is determined. We start this process by first defining some terms, then describing the marketplace for currencies, and finally discussing the linkage between exchange rates and other asset prices.

10.2 Exchange Rates and Currency Trading

As the phrase is most commonly used, an **exchange rate** is the rate of exchange between two currencies. Other meanings include the rate of an exchange of goods, or between a currency and a bundle of other currencies. Mostly, we'll first focus on the first definition, and relate it to trading in currencies. At the end of the chapter, we'll discuss exchange rates between goods and services, and how those relate to exchange rates between currencies.

In the most familiar case, the exchange rate is the number of home currency units required to purchase one unit of foreign currency. In other words, the exchange rate is the price of foreign currency. In Chart 10.1, three exchange rates against the U.S. dollar are shown. In each case, the values refer to the number of U.S. dollars necessary to purchase a single unit of the foreign currency at a given time (sometimes known as a spot exchange rate). Notice that the German mark disappears in 1999, because it is subsumed into a new currency, the euro.

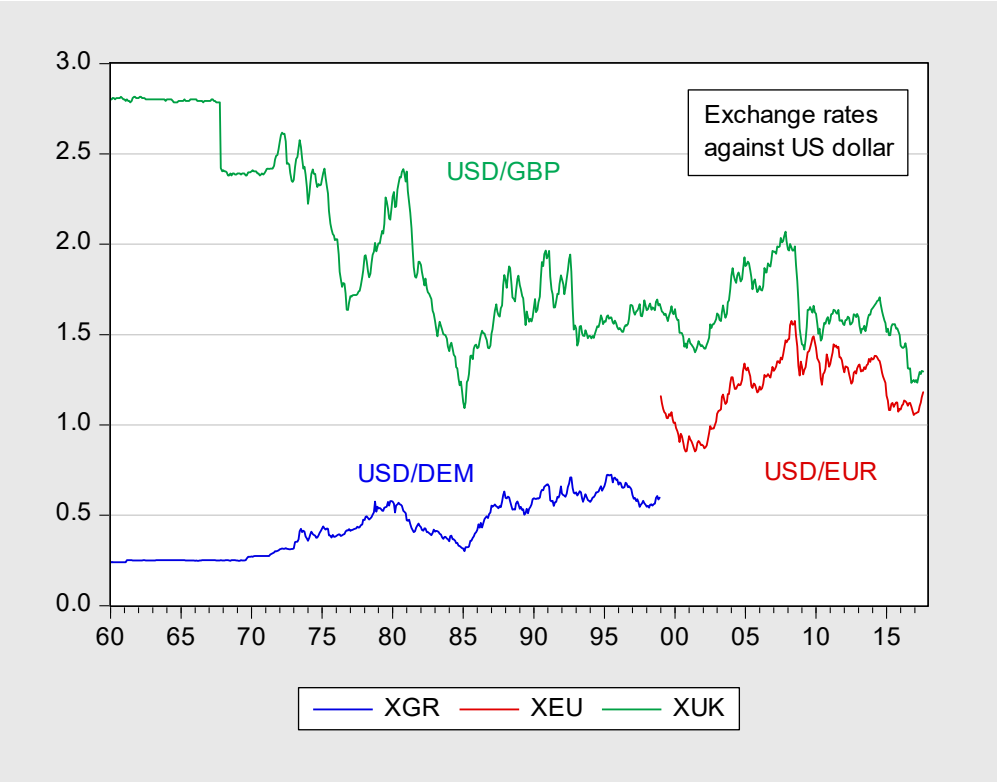


Chart 10.1: Exchange rates for German mark (DEM), British pound (GBP) and euro (EUR) against the U.S. dollar (USD). Higher values denote a weaker dollar against the foreign currency (a depreciation of the dollar).

An exchange rate can be thought of as a relative price of two assets, in this case two currencies. Like most asset prices, the exchange rate reflects the respective valuations of these assets, which in turn depend on a variety of factors, both those in the present, and those expected in the future. Since those expectations change over time, so too does the exchange rate—as illustrated by the wide swings in each of the series in the graph over the past forty years.

The relationship between exchange rates and expectations is explored further in Chapter 15. For now, we take a first try at explaining how are these prices of foreign exchange are determined. At the basic level, the answer is simple—prices are determined in a marketplace. The marketplace, however, is very special. First, it's extremely large; daily turnover in April of 2016 was 5.1 *trillion* U.S. dollars per day. Second, it's global in nature, with trading taking place almost around the clock. And third, it's dominated by a few players: approximately three-quarters of global foreign exchange trading is accounted for by the top ten banks, as shown in Table 10.1.

Rank		Bank	Market Share	
2017	2016		2017	2016
1	1	Citi	10.74%	12.93%
2	2	JPMorgan	10.34%	8.79%
3	3	UBS	7.56%	8.78%
4	5	Bank of America Merrill Lynch	6.73%	6.41%
5	4	Deutsche Bank	5.68%	7.88%
6	8	HSBC	4.99%	4.57%
7	6	Barclays	4.69%	5.68%
8	7	Goldman Sachs	4.43%	4.66%
9	15	Standard Chartered	4.26%	1.82%
10	11	BNP Paribas	3.73%	3.06%

Table 10.1: Share of global foreign exchange in 2016 and 2017. Source: *Euromoney*.

The market is an "**over the counter**" market; hence there is no centralized exchange. Rather, trading takes place between a set of actors – dealers, non-dealer financial institutions, corporations and governments. The latter are "end-users" – that is they demand currencies for use in their activities. In contrast, dealers trade on behalf of their clients, or they trade in order to make profits for their own financial institution.

In recent years, the development of new computer technologies has lowered transaction costs in foreign exchange markets. As a consequence, these actors have been joined by retail investors and by computer-automated traders known as "algorithmic" traders.

The foreign exchange market encompasses trades in different types of assets, as shown in Table 10.2. Of the USD 5.1 trillion in turnover in 2016, a little less than 1/3 is accounted for by **spot transactions** – a single transaction involving an exchange of currencies – and the remainder by derivative transactions. These derivative transactions include outright **forwards**, **foreign exchange swaps**, and **currency swaps**. A full 47% is accounted for by foreign exchange swaps – an exchange of currencies for a predetermined amount of time. These derivatives are further explained in Box 10.1.

OTC foreign exchange turnover

Net-net basis,[1] daily averages in April, in billions of US dollars — Table 1

Instrument	2001	2004	2007	2010	2013	**2016**
Foreign exchange instruments	1,239	1,934	3,324	3,973	5,357	**5,067**
Spot transactions	386	631	1,005	1,489	2,047	**1,652**
Outright forwards	130	209	362	475	679	**700**
Foreign exchange swaps	656	954	1,714	1,759	2,240	**2,378**
Currency swaps	7	21	31	43	54	**82**
Options and other products[2]	60	119	212	207	337	**254**
Memo:						
Turnover at April 2016 exchange rates[3]	*1,381*	*1,884*	*3,123*	*3,667*	*4,917*	***5,067***
Exchange-traded derivatives[4]	*12*	*25*	*77*	*145*	*145*	***115***

[1] Adjusted for local and cross-border inter-dealer double-counting (ie "net-net" basis). [2] The category "other FX products" covers highly leveraged transactions and/or trades whose notional amount is variable and where a decomposition into individual plain vanilla components was impractical or impossible. [3] Non-US dollar legs of foreign currency transactions were converted into original currency amounts at average exchange rates for April of each survey year and then reconverted into US dollar amounts at average April 2016 exchange rates. [4] Sources: Euromoney Tradedata; Futures Industry Association; The Options Clearing Corporation; BIS derivatives statistics. Foreign exchange futures and options traded worldwide.

Table 10.2: Foreign exchange turnover. Source: BIS (2016).

Box 10.1: Foreign Exchange Transactions

Spot transactions	Single outright transactions involving the exchange of two currencies at a rate agreed on the date of the contract for value or delivery (cash settlement) within two business days. The spot legs of swaps are not included among spot transactions but are reported as swap transactions even when they are due for settlement within two days. This means that spot transactions are exclusive of overnight swaps and spot next swaps, as well as other "tomorrow/next day" transactions.
Outright forwards	Transactions involving the exchange of two currencies at a rate agreed on the date of the contract for value or delivery (cash settlement) at some time in the future (more than two business days later). This category also includes forward foreign exchange agreement transactions (FXAs), non-deliverable forwards (NDFs) and other forward contracts for differences. Outright forwards are generally not traded on organised exchanges, and their contractual terms are not standardised.
Foreign exchange swaps	Transactions involving the actual exchange of two currencies (principal amount only) on a specific date at a rate agreed at the time of the conclusion of the contract (the short leg), and a reverse exchange of the same two currencies at a date further in the future at a rate (generally different from the rate applied to the short leg) agreed at the time of the contract (the long leg). Both spot/forward and forward/forward swaps are included. For *turnover*, only the forward leg is reported as such. The spot leg is not reported at all, ie neither as a spot nor as a foreign exchange swap transaction. Short-term swaps carried out as "tomorrow/next day" transactions are also included in this category.
Currency swaps	Contracts which commit two counterparties to exchange streams of interest payments in different currencies for an agreed period of time and/or to exchange principal amounts in different currencies at a pre-agreed exchange rate at maturity.
OTC options	Option contracts that give the right to buy or sell a currency with another currency at a specified exchange rate during a specified period. This category also includes exotic foreign exchange options such as average rate options and barrier options. OTC options include: • The currency swaption: an OTC option to enter into a currency swap contract. • The currency warrant: a long-dated (over one year) OTC currency option.
Other products	Other derivative products are instruments where decomposition into individual plain vanilla instruments such as forwards, swaps or options is impractical or impossible. An example of "other" products is swaps with underlying notional principal in one currency and fixed or floating interest rate payments based on interest rates in currencies other than the notional (differential swaps or "diff swaps").

Source: BIS (2016).

Most of the trading volume is between dealers, while the next most with financial institutions. Non-financial firms followed behind in importance. This pattern highlights the fact that demand for currency is mostly fueled not by any trade in goods and services, but rather by the trade in financial assets. This trade is in turn driven in part by speculative motives – the desire to profit from anticipated changes in asset prices – and in part by the need to move financial capital across national borders.

The pattern of trading in currencies illustrates the relative importance of the two motivations. As shown in Table 10.3, the U.S. dollar, the euro, Japanese yen, and British pound lead in terms of currency trading turnover. The Australian dollar recently moved into fifth place, ahead of the Canadian dollar and the Swiss franc. The U.S. dollar is the outsized leader, and yet this cannot be because the U.S. is the biggest exporter or importer of goods and services. Rather, it's the importance of U.S. financial assets – Treasury bills, and corporate stocks and bonds – that drives the dollar's importance.

Currency distribution of OTC foreign exchange turnover

Net-net basis,[1] percentage shares of average daily turnover in April[2] Table 2

Currency	2001		2004		2007		2010		2013		**2016**	
	Share	Rank	Share	Rank	Share	Rank	Share	Rank	Share	Rank	**Share**	**Rank**
USD	89.9	1	88.0	1	85.6	1	84.9	1	87.0	1	**87.6**	**1**
EUR	37.9	2	37.4	2	37.0	2	39.0	2	33.4	2	**31.4**	**2**
JPY	23.5	3	20.8	3	17.2	3	19.0	3	23.0	3	**21.6**	**3**
GBP	13.0	4	16.5	4	14.9	4	12.9	4	11.8	4	**12.8**	**4**
AUD	4.3	7	6.0	6	6.6	6	7.6	5	8.6	5	**6.9**	**5**
CAD	4.5	6	4.2	7	4.3	7	5.3	7	4.6	7	**5.1**	**6**
CHF	6.0	5	6.0	5	6.8	5	6.3	6	5.2	6	**4.8**	**7**
CNY[4]	0.0	35	0.1	29	0.5	20	0.9	17	2.2	9	**4.0**	**8**
SEK	2.5	8	2.2	8	2.7	9	2.2	9	1.8	11	**2.2**	**9**
NZD[3]	0.6	16	1.1	13	1.9	11	1.6	10	2.0	10	**2.1**	**10**
MXN[3]	0.8	14	1.1	12	1.3	12	1.3	14	2.5	8	**1.9**	**11**
SGD[3]	1.1	12	0.9	14	1.2	13	1.4	12	1.4	15	**1.8**	**12**
HKD[3]	2.2	9	1.8	9	2.7	8	2.4	8	1.4	13	**1.7**	**13**
NOK[3]	1.5	10	1.4	10	2.1	10	1.3	13	1.4	14	**1.7**	**14**
KRW[3]	0.8	15	1.1	11	1.2	14	1.5	11	1.2	17	**1.7**	**15**
TRY[4]	0.0	30	0.1	28	0.2	26	0.7	19	1.3	16	**1.4**	**16**
RUB[3]	0.3	19	0.6	17	0.7	18	0.9	16	1.6	12	**1.1**	**17**
INR[3]	0.2	21	0.3	20	0.7	19	0.9	15	1.0	20	**1.1**	**18**
BRL[3]	0.5	17	0.3	21	0.4	21	0.7	21	1.1	19	**1.0**	**19**
ZAR[3]	0.9	13	0.7	16	0.9	15	0.7	20	1.1	18	**1.0**	**20**
DKK[3]	1.2	11	0.9	15	0.8	16	0.6	22	0.8	21	**0.8**	**21**
PLN[3]	0.5	18	0.4	19	0.8	17	0.8	18	0.7	22	**0.7**	**22**
TWD[3]	0.3	20	0.4	18	0.4	22	0.5	23	0.5	23	**0.6**	**23**
THB[4]	0.2	24	0.2	22	0.2	25	0.2	26	0.3	27	**0.4**	**24**
MYR[4]	0.1	26	0.1	30	0.1	28	0.3	25	0.4	25	**0.4**	**25**
HUF[3]	0.0	33	0.2	23	0.3	23	0.4	24	0.4	24	**0.3**	**26**
SAR[4]	0.1	27	0.0	32	0.1	32	0.1	34	0.1	34	**0.3**	**27**
CZK[4]	0.2	22	0.2	24	0.2	24	0.2	27	0.4	26	**0.3**	**28**
ILS[4]	0.1	25	0.1	26	0.2	27	0.2	31	0.2	29	**0.3**	**29**
CLP[4]	0.2	23	0.1	25	0.1	30	0.2	29	0.3	28	**0.2**	**30**
IDR[4]	0.0	28	0.1	27	0.1	29	0.2	30	0.2	30	**0.2**	**31**
COP[4]	0.0	31	0.0	33	0.1	33	0.1	32	0.1	33	**0.2**	**32**
PHP[4]	0.0	29	0.0	31	0.1	31	0.2	28	0.1	31	**0.1**	**33**
RON[4]	...	37	...	40	0.0	34	0.1	33	0.1	32	**0.1**	**34**
PEN[4]	0.0	32	0.0	35	0.0	36	0.0	36	0.1	35	**0.1**	**35**
OTH	6.6		6.6		7.7		4.7		1.6		**2.1**	
Total	**200.0**		**200.0**		**200.0**		**200.0**		**200.0**		**200.0**	

[1] Adjusted for local and cross-border inter-dealer double-counting (ie "net-net" basis). [2] Because two currencies are involved in each transaction, the sum of the percentage shares of individual currencies totals 200% instead of 100%. [3] Turnover for years prior to 2013 may be underestimated owing to incomplete reporting of offshore trading in previous surveys. Methodological changes in the 2013 survey ensured more complete coverage of activity in emerging market and other currencies. [4] Turnover may be underestimated owing to incomplete reporting of offshore trading.

Table 10.3: Foreign exchange turnover. Source: BIS (2016).

The Australian dollar recent climb in importance reflects its economic role in a part of the world that has grown in prominence on the world economic scene. Interestingly, despite their economic mass, the currencies of the BRICs – Brazil, Russia, India and China – account for only 7.2% of total turnover (of 200%). Despite its substantially larger economy, China's renminbi accounted for 4.0%.

These turnover figures do not fully reflect the central role of the dollar. Not only is dollar turnover high, the dollar is involved in 88% of all currency trades. This is shown in Table 10.4.

OTC foreign exchange turnover by currency pair

Net-net basis,[1] daily averages in April, in billions of US dollars and percentages — Table 3

Currency pair	2001		2004		2007		2010		2013		**2016**	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	**Amount**	**%**
USD / EUR	372	30.0	541	28.0	892	26.8	1,099	27.7	1,292	24.1	**1,172**	**23.1**
USD / JPY	250	20.2	328	17.0	438	13.2	567	14.3	980	18.3	**901**	**17.8**
USD / GBP	129	10.4	259	13.4	384	11.6	360	9.1	473	8.8	**470**	**9.3**
USD / AUD	51	4.1	107	5.5	185	5.6	248	6.3	364	6.8	**262**	**5.2**
USD / CAD	54	4.3	77	4.0	126	3.8	182	4.6	200	3.7	**218**	**4.3**
USD / CNY	...	...	...	...	...	...	31	0.8	113	2.1	**192**	**3.8**
USD / CHF	59	4.8	83	4.3	151	4.5	166	4.2	184	3.4	**180**	**3.6**
EUR / GBP	27	2.1	47	2.4	69	2.1	109	2.7	102	1.9	**100**	**2.0**
EUR / JPY	36	2.9	61	3.2	86	2.6	111	2.8	148	2.8	**79**	**1.6**
EUR / CHF	13	1.1	30	1.6	62	1.9	71	1.8	71	1.3	**44**	**0.9**
JPY / AUD	...	...	...	...	...	...	24	0.6	46	0.9	**31**	**0.6**
Other currency pairs	13	1.1	22	1.1	74	2.2	71	1.8	44	0.8	**116**	**2.3**
All currency pairs	1,239	100.0	1,934	100.0	3,324	100.0	3,973	100.0	5,357	100.0	**5,067**	**100.0**

[1] Adjusted for local and cross-border inter-dealer double-counting (ie "net-net" basis).

Table 10.4: Global foreign exchange market turnover by currency pair. Source: BIS (2016).

The U.S. dollar/euro pair alone accounts for 23% of total turnover. The dollar/yen pair is next in importance. Notice that the high-volume pairs all involve the U.S. dollar, highlighting the dollar's role as the key global currency. The euro/pound and euro/yen pairs together account for a mere 3.6% of total trading turnover.

The popularity of the dollar in currency trading is self-reinforcing. Because dollars are widely traded, traders are in the habit of holding them, therefore tend to charge lower transaction fees when dollars are involved. Lower transaction fees, in turn, encourage people to trade in dollars. When the objective is to exchange, for instance, Swedish kroner for Thai baht, it turns out to be less expensive to exchange kroner for dollars, and then dollars for baht, than to exchange kroner for baht directly.

The figures in Table 10.3 also prove the durability of these trading patterns. The dollar/euro pair remained the most important trading pair throughout the decade. Before 2001, the dollar/German mark held that position consistently for the preceding two decades. The dollar/yen pair has been the second most important pair over the period that the surveys have been conducted (about 25 years).

Why is the dollar so dominant in all these foreign exchange transactions – far out of proportion to the United States' share of global GDP? This is a complicated question, but the sort answer is that the dollar enjoys unique status as an **international currency**. See Box 10.1 for more on this topic.

Box 10.2: Why Is the Dollar the World's International Currency?

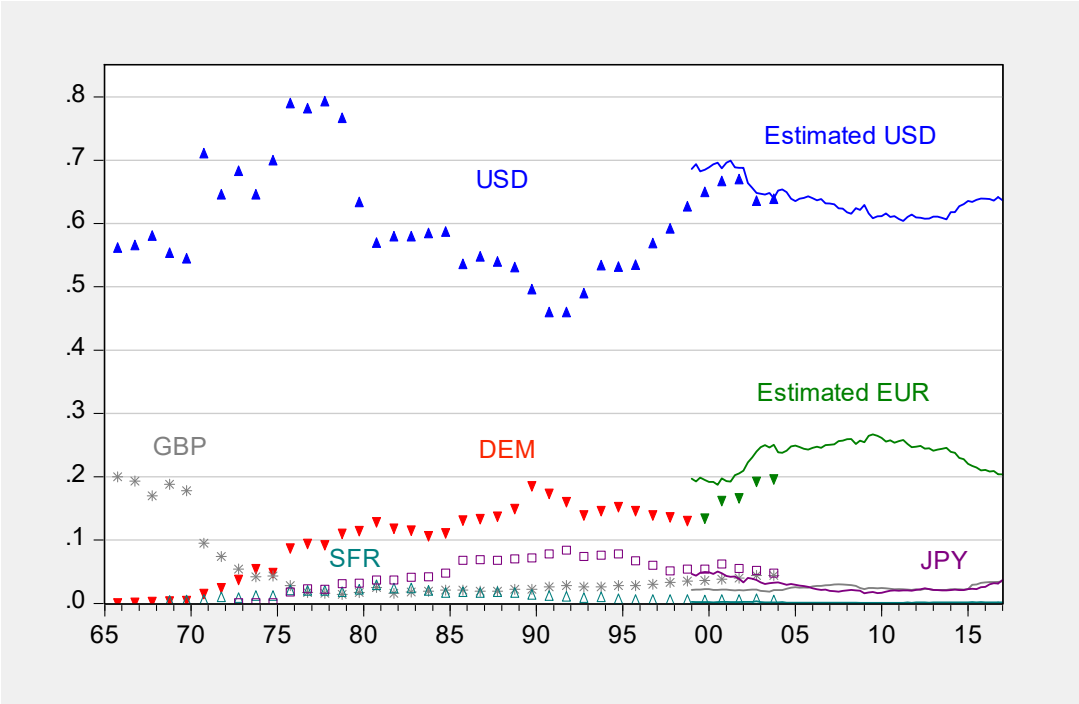
An international currency is one that fulfills the roles of money – unit of account, medium of exchange, and store of value – for both private actors and governments. Private actors use certain currencies primarily because of patterns in trade and finance, but also because of the ease with which those currencies can be traded. Governments hold foreign currencies in order to have a means of taking quantities of their own currencies in and out of circulation, and in order to conduct direct transactions with other governments.

Table 1

Adapted from Kenen		
Function of money:	***Governments***	***Private actors***
Store of value	International reserve holdings	Currency substitution (private dollarization)
Medium of exchange	Vehicle currency for foreign exchange intervention	Invoicing trade and financial transactions
Unit of account	Anchor for pegging local currency	Denominating trade and financial transactions

Box Table 10.1: Functions of an international currency. Source: Kenen (1983).

The dollar has been the dominant currency in the holdings of central banks since the end of World War II and, as shown in Box Chart 10.1, has retained that lead even as America's share of world GDP has shrunk to about a quarter. The only other currency that really registers on the graph is the euro. The Japanese yen and the British pound vie for third place. Notable by its absence is the Chinese currency, the yuan.



Box Chart 10.1: Currency shares in central bank foreign exchange holdings. Source: IMF, *Annual Reports*, Chinn and Frankel (2008), and IMF, Currency Composition of Official Exchange Reserves (COFER), June 30, 2017. Data for USD and EUR since 2000 are estimated.

Statistical analyses suggest that the compositions of governments' reserve holdings depend on patterns of production and trade, the configuration of financial markets, global confidence in various currencies' values, and also "network externalities."

Patterns of Trade. The currency of the country with the biggest share of international trade has an immediate advantage over other contenders for the status of world **reserve currency**. The U.S. economy remains the world's largest in terms of output and trade so it's no surprise it's the world's reserve currency. But the euro should be a close (rather than a distant) number two, given the eurozone's trading volume. Furthermore, Japan barely registered as a reserve currency even before the advent of the euro, when Japan was the second largest economy.

Financial markets. To attain international currency status, capital and money markets in the home country must be not only open and free of controls, but also deep and well developed. Nobody wants to hold large sums of a currency that is difficult to trade. Hence, the large financial marketplaces of New York and London clearly benefit the dollar and pound relative to the euro, as Frankfurt is still less well-developed. The Tokyo and Frankfurt financial markets have changed a lot over the last two decades, but they still lag far behind New York

and London. Meanwhile, Singapore and Hong Kong have gained ground, as well.

Confidence. The more it is believed a currency will retain its value, the more likely that currency is to be held as a reserve currency. With the decline in inflation in the United States since the 1980s, the dollar's share of central-bank holdings has rebounded from the lows recorded in the 1970s.

Inertia. Finally, the dollar benefits because everybody is already using it, by the accident of the U.S.'s being the dominant economic force right after World War II. Once the global market has settled on a reserve currency, it is hard to switch, unless that currency becomes sufficiently unattractive on the three other counts as just described.

Chinn and Frankel (2007) conducted a statistical analysis of the determinants of the composition of central bank reserve holdings and found that financial development was the key determinant (along with inertia). This finding suggests that -- even with China's rapid economic growth – as long as its *financial system* remains underdeveloped and largely closed to the rest of the world, the Chinese yuan will not become a major reserve currency.[1]

Currency trading is concentrated not only by currency but also by geography. However, the geographic distribution is not what one might expect. As shown in Chart 10.2, by far the largest center for foreign exchange trading is in the United Kingdom, despite the fact that the pound sterling is *not* the most traded currency. Next up is the United States, with Japan a distant third. Frankfurt's percentage is in the low single digits, because even though it is in the heart of the eurozone, most euro trading occurs in London, illustrating how trade in a particular currency need not be geographically concentrated in the country of issue.

[1] For more discussion of the prospects of the renminbi as a major reserve currency, see Chinn (2015).

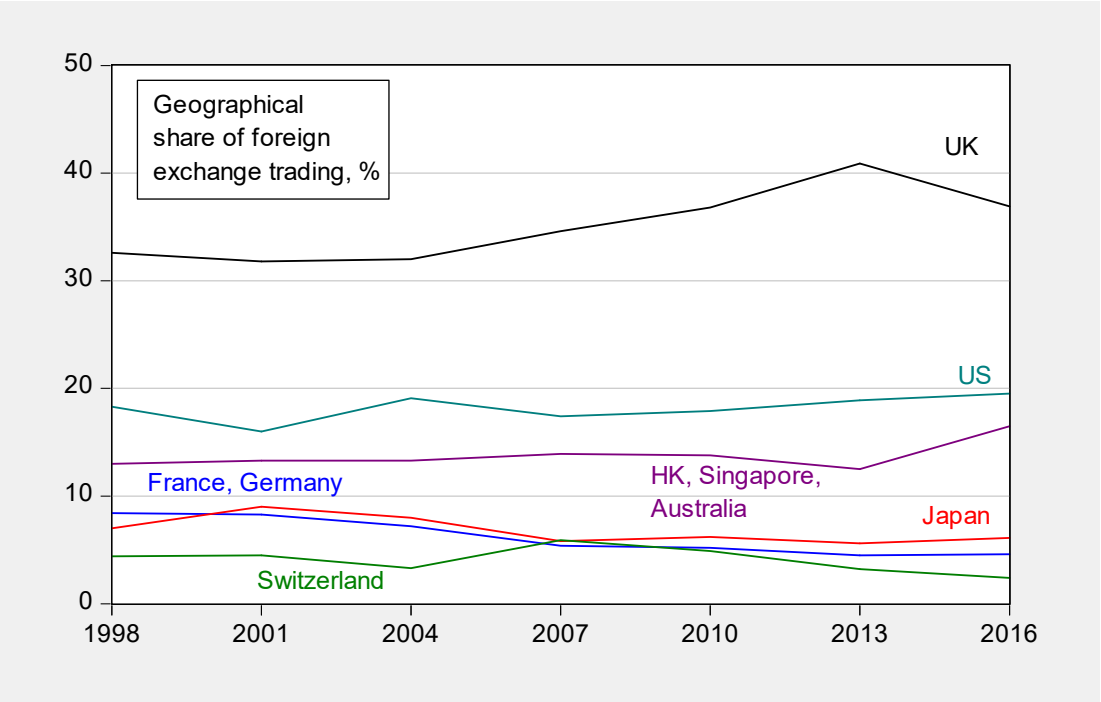


Chart 10.2: Source: BIS (2013, 2016).

10.3 Supply, Demand and Exchange Rates under Fixed and Floating Regimes

Thus far, we have discussed some features of the markets wherein the various actors – traders, corporations, central banks – buy and sell currencies. However, we have not explained how market forces interact to determine the price of a particular foreign currency.

Currency supply and demand

It turns out we can use the standard supply and demand framework as a means of thinking about how the exchange rate – the price of foreign currency – is determined. Let the proceeds from exports of goods and sales of assets constitute the supply of foreign currency. Spending on imports and purchases of assets are the sources of demand for foreign exchange.[2]

Now consider a diagram where the price of the foreign currency (S) is on the vertical axis, and the quantity of foreign currency is on the horizontal.[3] In the example shown in Figure 10.1 below, the market for euros is examined from the perspective of a U.S. resident. The demand for euros is essentially derived from the underlying demand for goods and assets denominated in euros. Similarly, the supply of euros is derived from the underlying demand for supply of goods and assets that eurozone residents purchase.

[2] If someone holding dollars wants to buy a good priced in Russian rubles, at some point someone, either the buyer or the seller, is going to want to unload dollars (supply) and acquire rubles (demand).
[3] S is the **spot exchange rate**, the price for an exchange conducted immediately ("on the spot"). A rate written into a contract to exchange currencies in the future (normally in 1, 3, 6, 9 or 12 months), is called a **forward exchange rate**, F for short.

The demand curve is downward sloping because as euros become cheaper, the quantity demanded rises. (Goods priced in euros attract more foreign buyers.) The supply curve is upward sloping because as euros become more expensive, the quantity supplied increases. (Holders of euros start buying more foreign goods.) The equilibrium exchange rate – when the market is allowed to determine the price, in what is called a **floating exchange rate regime** – is S_0. At this point, the quantity supplied equals the quantity demanded.

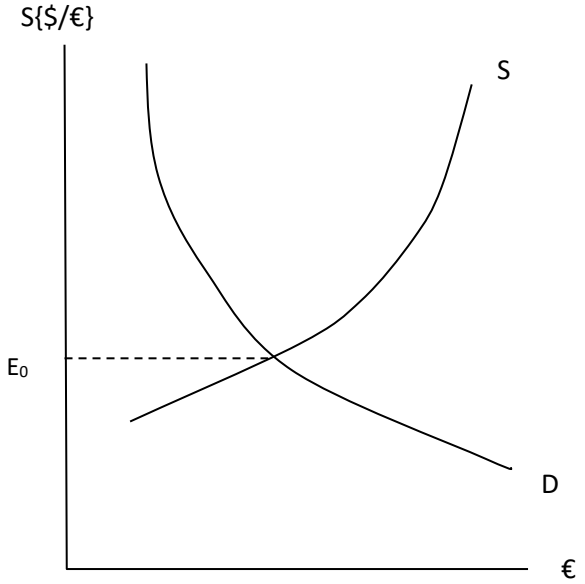


Figure 10.1: Supply and demand for euros

When supply or demand changes, the exchange rate responds. Consider for instance what happens if the demand for euros increases – because, let's say, the demand for European food exports such as wine, cheese, and olive oil has increased. Then the demand curve shifts outward, and the exchange rate rises from S_0 to S_1 (Figure 10.2).

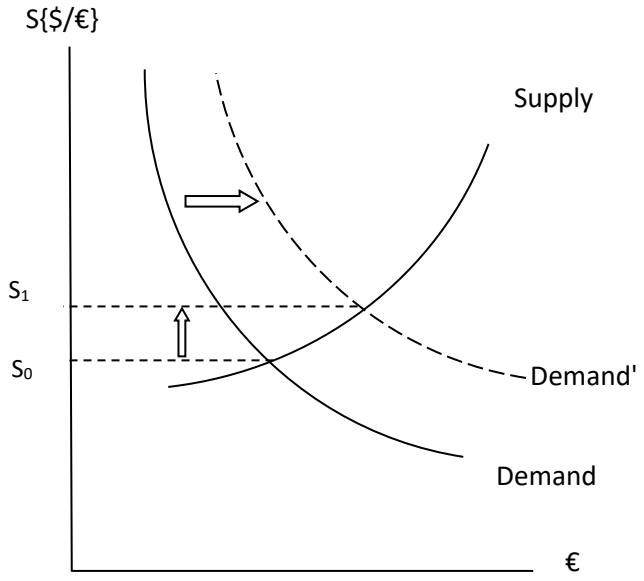


Figure 10.2: An increase in demand for euros (€) and an associated rise in their price ($/€)

Notice that when the exchange rate rises, the foreign currency becomes more expensive. On the flip side, the home country currency, which in this case is the dollar, loses value. Hence, the rise in *S* represents a dollar **depreciation**.

Next we consider what happens if the supply of foreign currency rises, as shown in Figure 10.3. This could happen if foreign demand for U.S.-made bulldozers increases.

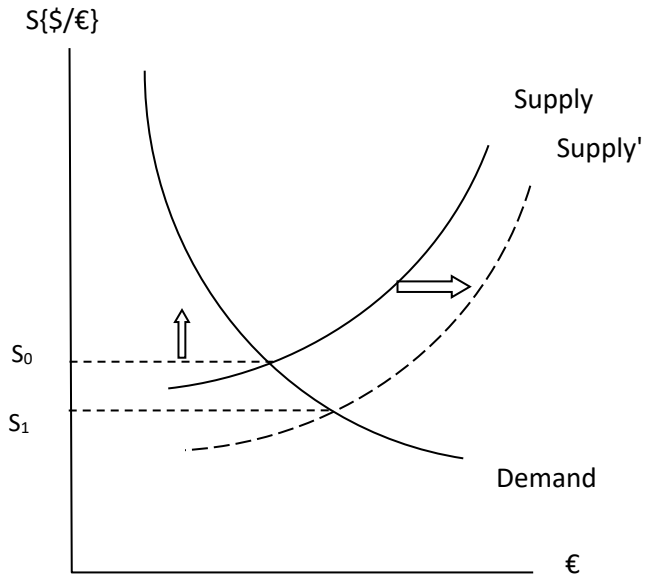


Figure 10.3: An increase in supply of euros and an associated drop in their price

The equilibrium exchange rate falls from S_0 to S_1. This represents a decrease in the price of euros in terms of dollars, so the dollar is becoming more valuable. Hence, this is an ***ap*preciation** of the dollar.

Fixed rate regimes

In the two preceding examples, we've analyzed the repercussions of shifts in supply and demand in a system where the exchange rate is free to adjust to equilibrate the quantities supplied and demanded. This type of regime is called a freely **floating exchange rate regime**. In many cases, however, the exchange rate is not allowed to freely move; sometimes the exchange rate is fixed – or "pegged" – to a specific value against another currency. In fact, the extreme stability of the dollar/German mark and the dollar/pound exchange rates in the late 1960's to early 1970's shown in Figure 10.1 hinted at this possibility. Under a **fixed exchange rate regime**, somebody has to step in to maintain that price. In foreign exchange markets, that somebody is the central bank of the nation issuing the currency.

The central bank's role is easiest to explain by resorting to the same type of supply-demand graph used above. This time, instead of taking the perspective of a U.S. resident, we'll take the perspective of a Chinese resident prior to 2005, the year China began allowing their currency, the Chinese yuan, to float against the U.S. dollar. Figure 10.4 depicts the market for U.S. dollars, which are now the foreign currency. The exchange rate is set to S_{Peg}, the number of Chinese yuan (CNY) necessary to purchase one U.S. dollar. In this case, the **exchange rate peg** is above the equilibrium exchange rate, so that there is excess supply of dollars in the foreign exchange market.

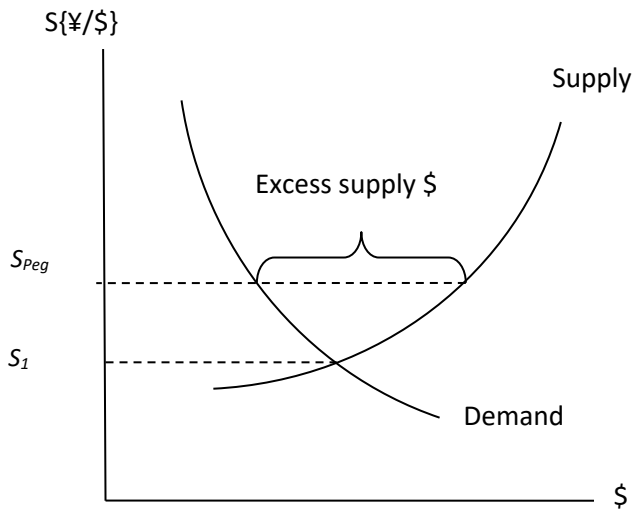


Figure 10.4: Chinese supply and demand for dollars under a fixed exchange rate regime

In the absence of any other forces, the exchange rate would gravitate downward to S_1. That is, the Chinese yuan would appreciate. Under a fixed exchange rate regime, however, the central bank commits itself to maintaining the currency at the official exchange rate. Hence, the central bank, in this case the People's Bank of China, absorbs the excess supply of dollars by purchasing those dollars in the foreign exchange market. In essence, the central bank artificially creates the added demand necessary to set the exchange rate at the pegged level.

Figure 10.4 depicts a situation where the peg is set above the equilibrium rate. We can consider the opposite case, where the peg is set below the equilibrium rate. Then there is excess demand for dollars, which the central bank must satisfy by selling dollars.

In sum, if policymakers aim to keep the exchange rate at a depreciated level relative to the equilibrium determined by private supply and demand, then the central bank must purchase foreign currency; if the policy is to keep the exchange rate at an appreciated level, then the central bank must sell foreign currency.

10.4 Exchange Rate Regimes in the Real World

The preceding discussion has depicted a sharp distinction between floating and fixed exchange rate regimes. In practice, countries are seldom purists regarding the exchange rate regime they pursue. Rather, countries – particularly emerging-market and less-developed countries -- will often allow exchange rates to float in managed fashion, for instance intervening to smooth movements in rates. Or a country might alternate between a floating and a fixed-rate regime. China, for example, has re-pegged the yuan to the dollar several times since 2005.

Why might a country's policymakers seek to fix the exchange rate? One reason is that eliminating variations in the exchange rate makes planning by exporters, importers and those wishing to borrow and lend in foreign currencies, a lot easier. For instance, if a Chinese exporter were considering whether to build a new factory to sell steel to the United States, but the factory would take a couple years to complete, the decision whether to proceed or not would be much easier if one knew what the yuan/dollar exchange rate would be in two years.

On the other hand, keeping the exchange rate fixed imposes, if not certain costs, at least certain trade-offs in terms of what the policymakers can do with respect to monetary policy and the free flow of capital across the border. Those trade-offs are discussed in Chapter 13.

Each year, countries report to the International Monetary Fund the exchange rate arrangements they claim to follow. The IMF reports in the *Annual Report on Exchange Arrangements and Exchange Restrictions* (*AREAER*) these *de jure* policies for 2016. The tabulation is reported in Table 10.5. At the top are the most rigid, or fixed, exchange rate regimes. As one reads down the table, the exchange rate regimes become more flexible. Reading across the table, one can identify the currency which is used as the anchor

– most currencies are linked to the dollar or the euro, with some others to a basket of currencies ("composite").

Exchange rate arrangement (number of countries)	Monetary Policy Framework: Exchange rate anchor: U.S. dollar (39)	Euro (25)	Composite (9)	Other (9)	Monetary aggregate target (24)	Inflation-targeting framework (38)	Other[1] (48)
No separate legal tender (14)	Ecuador El Salvador Marshall Islands Micronesia Palau Panama Timor-Leste Zimbabwe	Kosovo Montenegro San Marino		Kiribati Nauru[2] (04/16) Tuvalu			
Currency board (11)	Djibouti Hong Kong SAR **ECCU** Antigua and Barbuda Dominica Grenada St. Kitts and Nevis St. Lucia St. Vincent and the Grenadines	Bosnia and Herzegovina Bulgaria		Brunei Darussalam			
Conventional peg (44)	Aruba The Bahamas Bahrain Barbados Belize Curaçao and Sint Maarten Eritrea Iraq Jordan Oman Qatar Saudi Arabia Turkmenistan United Arab Emirates Venezuela	Cabo Verde Comoros Denmark[3] São Tomé and Príncipe **WAEMU** Benin Burkina Faso Côte d'Ivoire Guinea Bissau Mali Niger Senegal Togo **CEMAC** Cameroon Central African Rep. Chad Rep. of Congo Equatorial Guinea Gabon	Fiji Kuwait Morocco[4] Libya (01/15)	Bhutan Lesotho Namibia Nepal Swaziland			Solomon Islands[5] Samoa
Stabilized arrangement (18)	Guyana Lebanon Maldives Trinidad and Tobago	FYR Macedonia	Singapore Vietnam[6]		Bangladesh[6] Bolivia[6] Burundi[6] Democratic Rep. of the Congo[6] Nigeria[6] (03/15) Suriname[6] Yemen[6]	Czech Rep.[7]	Costa Rica[6,8] Lao P.D.R.[6] (01/15) Sudan[6] (01/15)
Crawling peg (3)	Honduras Nicaragua		Botswana				
Crawl-like arrangement (10)		Croatia	Iran[6]		Ethiopia[6] Uzbekistan[6]	Dominican Republic[6]	Jamaica[6,8] Mauritania[6,9] (09/14) Papua New Guinea[6] Sri Lanka[6,8,9] (10/14) Tunisia[3,8]
Pegged exchange rate within horizontal bands (1)							Tonga[5]

Exchange rate arrangement (number of countries)	Monetary Policy Framework: Exchange rate anchor: U.S. dollar (39)	Euro (25)	Composite (9)	Other (9)	Monetary aggregate target (24)	Inflation-targeting framework (38)	Other[1] (48)
Other managed arrangement (20)	Cambodia (03/15) Liberia		Syria		Algeria Belarus (01/15) China[9] (12/14) The Gambia (05/15) Guinea (02/15) Myanmar Rwanda (03/15) Tajikistan (03/15)		Angola (06/15) Azerbaijan (12/15) Egypt (01/15) Haiti (06/15) Kyrgyz Rep. Malaysia Pakistan South Sudan (12/15) Vanuatu
Floating (40)					Afghanistan Madagascar Malawi Mozambique Seychelles Sierra Leone Tanzania	Albania Armenia[9] (11/14) Brazil Colombia Georgia Ghana Guatemala Hungary Iceland India Indonesia Israel Kazakhstan (12/15) Korea Moldova New Zealand Paraguay Peru Philippines Romania Serbia South Africa Thailand Turkey Uganda Uruguay[9]	Argentina[8] (12/15) Kenya[8] Mauritius Mongolia[8] Switzerland (01/15) Ukraine Zambia
Free floating (31)						Australia Canada Chile Japan Mexico[10] (11/15) Norway Poland Russia (07/15) Sweden United Kingdom	Somalia[11] United States EMU Austria Belgium Cyprus Estonia Finland France Germany Greece Ireland Italy Latvia

Exchange rate arrangement (number of countries)	Monetary Policy Framework						
	Exchange rate anchor				Monetary aggregate target (24)	Inflation-targeting framework (38)	Other[1] (48)
	U.S. dollar (39)	Euro (25)	Composite (9)	Other (9)			
							Lithuania (01/15) Luxembourg Malta Netherlands Portugal Slovak Rep. Slovenia Spain

Source: IMF staff.
Note: If the member country's de facto exchange rate arrangement has been reclassified during the reporting period, the date of change is indicated in parentheses.
CEMAC = Central African Economic and Monetary Community; ECCU = Eastern Caribbean Currency Union; EMU = European Economic and Monetary Union; WAEMU = West African Economic and Monetary Union.

[1] Includes countries that have no explicitly stated nominal anchor, but rather monitor various indicators in conducting monetary policy.
[2] Nauru became a member of the IMF on April 12, 2016.
[3] The member participates in the European Exchange Rate Mechanism (ERM II).
[4] Within the framework of an exchange rate fixed to a currency composite, the Bank Al-Maghrib adopted a monetary policy framework in 2006 based on various inflation indicators with the overnight interest rate as its operational target to pursue its main objective of price stability.
[5] The country maintains a de facto exchange rate anchor to a composite.
[6] The country maintains a de facto exchange rate anchor to the U.S. dollar.
[7] The country maintains a de facto exchange rate anchor to the euro.
[8] The central bank has taken preliminary steps toward inflation targeting.
[9] The exchange rate arrangement or monetary policy framework was reclassified retroactively, overriding a previously published classification.
[10] The exchange rate arrangement was reclassified twice during this reporting period, reverting back to the classification in the previous year's report.
[11] Currently the Central Bank of Somalia does not have a monetary policy.

Table 10.5: *De Facto* Classification of Exchange Rate Arrangements and Monetary Policy Frameworks, April 30, 2016. Source: Table 2, from IMF, *Annual Report on Exchange Rate Arrangements and Exchange Restrictions, 2016*.

It is interesting that there are quite a few countries that claim to peg their exchange rate (42), as well free floating (24). But even more numerous are those that claim to follow some version of an intermediate regime (50)! Another forty claim to be floating but not free floating, which could also be interpreted as an intermediate regime.

The *AREAER* categorizations are a useful summary of the types of exchange rate regimes in place. However, we would like to also know the degree to which the exchange rate is allowed to move, once a country is not on a hard fixed exchange rate regime.

Carmen Reinhart and Kenneth Rogoff (year?) have taken up that challenge. They classified exchange rate regimes by their degree of flexibility. Rather than categorizing regimes by their stated policies (e.g., de jure), but rather by how exchange rates actually behave. They used the following criteria to classify exchange rate regimes into fifteen categories, with the lowest value indicating the highest degree of exchange rate rigidity, and the highest value indicating the highest degree of exchange rate flexibility. The distribution of exchange rate regimes for 2000 is shown in Chart 10.3.

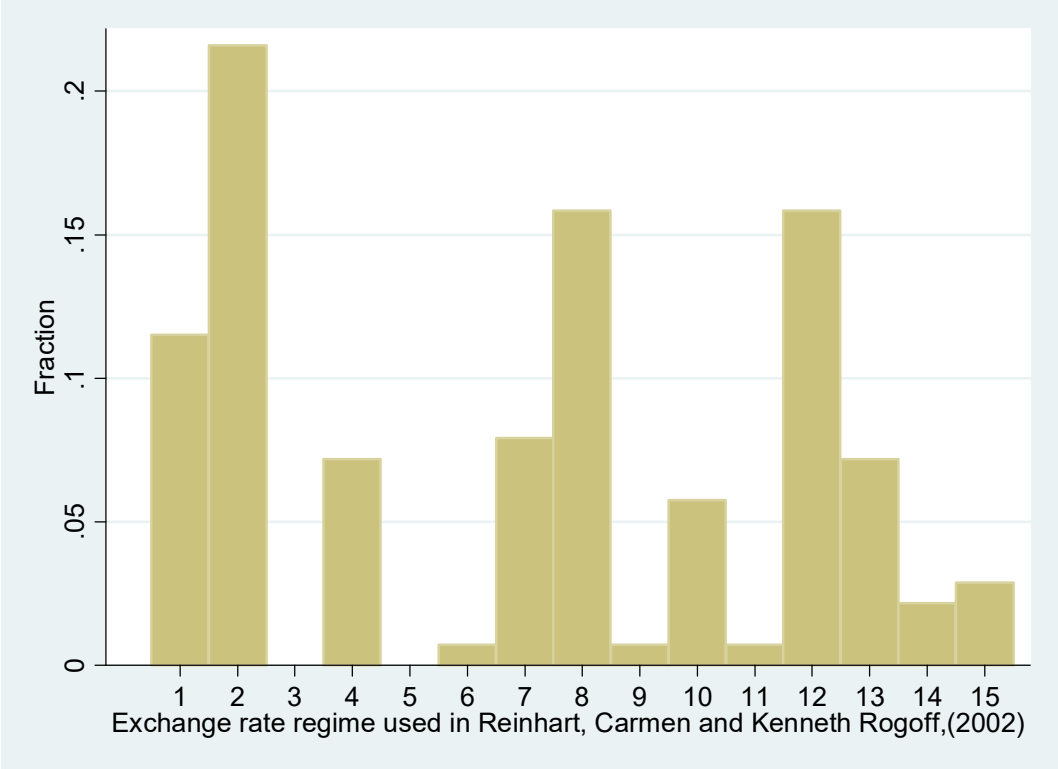


Chart 10.3: Frequency histogram of *de facto* exchange rate regimes in 2000. Source: Reinhart and Rogoff (2004).

Category 1 pertains to countries with no separate legal tender – that is they are part of a currency union, such as the euro. Category 15 – "free falling" – describes currencies that are losing value as in a crisis situation. Category 2 corresponds to what was described as a fixed exchange rate regime in Section 10.3, while Category 14 corresponds to floating exchange rate regimes.[4]

Chart 10.3 reflects the fact that few countries manage their currencies in such a way as to fit our characterization of prototypical exchange rate regimes. Most countries allow some flexibility, limiting day-to-day changes in currency value. The countries that allow their currencies to float still manage their rates either by use of occasional foreign intervention (buying and selling currencies in the foreign exchange market), or by changing interest rates in order to influence currency values. The relationship between interest rates and currency exchange rates is the subject of the next section.

[4] The full description is as follows: No separate legal tender (1), Pre announced peg or currency board arrangement (2), Pre announced horizontal band that is narrower than or equal to +/- 2% (3), De facto peg (4), Pre announced crawling peg (5), Pre announced crawling band that is narrower than or equal to +/- 2% (6), De facto crawling peg (7), De facto crawling band that is narrower than or equal to +/- 2% (8), Pre announced crawling band that is wide than or equal to +/- 2% (9), De facto crawling band that is narrower than or equal to +/- 5% (10), Moving band that is narrower than or equal to +/- 2% (11), Managed floating (12), Freely floating (13), Freely falling (14).

The correlation between the *de jure* and *de facto* measures is surprisingly low. Even when the Reinhart and Rogoff categories are collapsed into 3 aggregate categories, the correlation is only 33%, and the percentage of coincidences is only 55%.[5]

10.5 The Relationship between Exchange Rates and Interest Rates

Why do households and firms trade currencies? One reason is their need for foreign currency to conduct cross-border transactions – for instance, buying goods from another country. That was the motivation for the shifts in the supply and demand curves in Section 10.3. However, that's not the only motivation. Firms, in particular, often have funds that they which to save while earning the highest possible rate of return. How can we analyze the decision-making process facing a firm in that position?

First, consider the two basic options facing the firm's manager: save domestically or save overseas. The firm could save $1 in a U.S. Treasury bond and earn i^{US} in interest at the end of a year. The firm could convert that same dollar into euros at the rate of $1/S$ euros per dollar, buy a euro-denominated security, and receive i^{Euro} in interest at the end of the year. Thus the firm has the following two possible returns of principal with interest:

Save in U.S.	Save in Euro Area
$(1+i^{US})$ in $	$(1+i^{Euro})/S$ in €

Presumably, if you are an American, you don't really care how many euros you expect to have. Rather, you care how many dollars you expect to have, so your decision must also depend upon what you think the exchange rate will be at the end of the year (call this is S^e_{+1}). Hence, the relevant comparison is between these two outcomes:

[5] Frankel (2004). Other researchers have tabulated de facto exchange rate regimes, including Levy-Yeyati and Sturzennegger (2003), and Ghosh, Gulde, Ostry and Wolf (2002); the correlations are of a similar magnitudes.

Save in U.S.	Save in Euro Area
$(1+i^{US})$ in \$	$(1+i^{Euro})S^e_{+1}/S$ in \$

The comparison is a little difficult using those formulas. Using approximations that assume i^{Euro} and the change from S to S^e_{+1} to be small, the comparison can be recast as follows:

Save in U.S.	Save in Euro Area
i^{US}	$i^{Euro} + (S^e_{+1} - S)/S$
interest return on U.S.Treasury bond	interest return on euro area bond *plus* depreciation of dollar against euro

If all the saver cares about is the expected return, then if the left hand side is greater than the right hand side, put the savings in the U.S. If the reverse is true, then put them in the euro area.

If everybody thought the same thing about what the exchange rate would be in a year, all financial capital would migrate in the same direction, driving interest rates up in the "from" location and down in the "to" location until, and similarly affecting present and expected exchange rates, until the two returns were equal. The resulting identity can be rewritten as:

(10.1) $$i_t^{US} - i_t^{Euro} = \frac{S_{t+1}^e - S_t}{S_t} \equiv \Delta s_{t+1}^e$$

That is, the interest differential equals the expected depreciation. If, for example, the U.S. interest rate is 5% and the euro area interest rate is 3%, then in equilibrium the expected depreciation of the dollar should equal 2%. This is a type of "**no-arbitrage condition,**" meaning that there's no profit to be made by exploiting pricing differences among two more or more assets. The particular condition described here is called *interest rate parity*, more specifically **uncovered interest parity**, or UIP for short. (The "uncovered" will be explained in a moment.)

In the real world, it's precisely because everybody *doesn't* have the same expectations about future exchange rates that such a large proportion of the trade in foreign currencies involves the financial sector. In the example just given, people who think the dollar will lose more than 2% of its value over the year will convert dollars to euros in order to invest in euro area bonds. Meanwhile, holders of euros who think the dollar will lose less than 2% will be moving their money to the U.S.

Uncovered interest parity is more a convenient theoretical reference point than an empirical reality, as far as can be determined. Box 10.1 examines the evidence for and against UIP holding in the real world.

Since we don't ever actually see the market's expectations, the uncovered interest parity condition cannot be verified. However, market participants can enter into agreements to trade in the future. These contracts

are called forward exchange contracts, or forwards for short. In this case, the relevant equation, in which case one can't make higher *certain* returns saving in the U.S. or in the euro area, is:

(10.2) $$i^{US} - i^{Euro} = (F - S)/S$$

Then the interest differential equals what is called the forward discount. This is another no-arbitrage condition, called **covered interest parity** (CIP for short). Suppose, for example, that the U.S. interest rate is 10% and the Euro area interest rate is 7%. Then, in order for one to not be able to get a higher dollar return in one location versus another, the forward exchange rate for a trade one year hence must be 3% higher than the exchange rate today. Then, one obtains 10% returns whether one saves in the U.S. (10% interest) or in the Euro area (7% in interest plus 3% in the gain of the euro against the dollar).

Because this kind of transaction locks in the returns (*F* and *S* are both written into the contract), it will be appealing if one doesn't like taking chances -- that is one is "risk averse." But in avoiding unexpected losses, one also foregoes unexpected gains. If the dollar loses 5% of its value instead of 3%, then one still only obtains a 10% return, instead of the 12% return one would have received via the uncovered route.

Interest rate parity, uncovered or covered, will only hold if governments do not put up any barriers to the movement of financial capital. The historical reality is that almost all governments have put up barriers, such as restrictions on how much cash one can move in or out of the country at one time. Such barriers are termed **capital controls** and are discussed at greater length in Chapter 13. Currently, the extent of such barriers is very modest for developed countries like the U.S., Germany, the UK, and Japan.[6] Hence, covered interest parity holds between such countries.[7]

For developing nations, however, like India, China, most African countries, and some Latin American countries, significant capital controls are likely to be in place, and enforced. Moreover, there is always the threat of the government imposing new restrictions on the movement of capital in and out of the country, or even seizing it outright. In such cases, it would be highly unlikely that you would find covered interest parity conditions holding.

Box 10.3 Does Uncovered Interest Parity Hold?

It is hard to test for uncovered interest parity, since expected depreciation is part of the calculation, and expectations can't be directly observed. All we observe are actual exchange rate depreciations. However, assuming the expected depreciations are reasonably close to the actual ones, we would expect to see a positive correlation between the interest differential $i^{US} - i^{Euro}$ and the rate changes. In fact, we see something much different, as in Chart 10.2.

[6] One will hear often discussions of the Eurodollar and Eurobond markets. These are offshore markets, not necessarily in Europe. (The term arose because the first such markets were in Europe). These markets arose because they enable trade outside of the control of regulatory institutions in the various countries. For instance, a British bank can take deposits in dollars and pay in dollars. Because the bank is in London, it is not subject to the control of the American authorities. These markets originally arose in response to the aforementioned capital controls. They still exist, because they circumvent all sorts of national banking regulations.

[7] See Coffey, Hrung, Nguyen, and Sarkar (2009) and Griffoli and Ranaldo (2009) for a discussion of deviations from CIP during the financial crisis

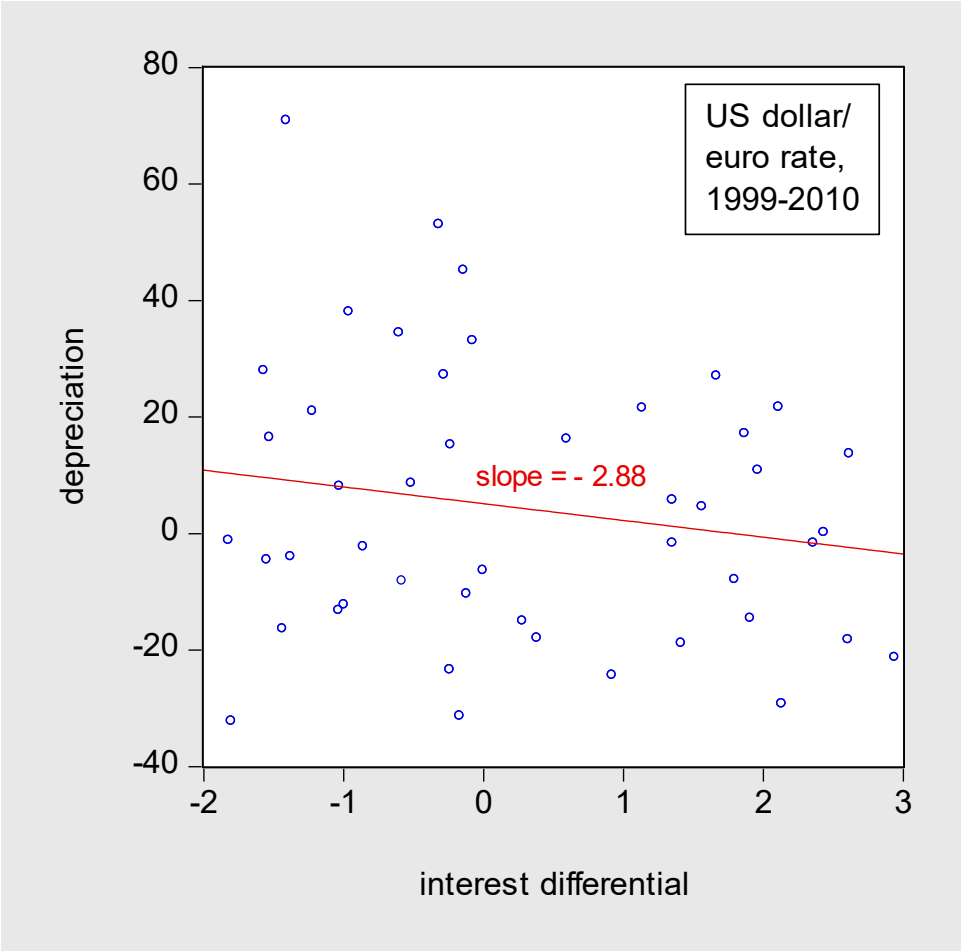
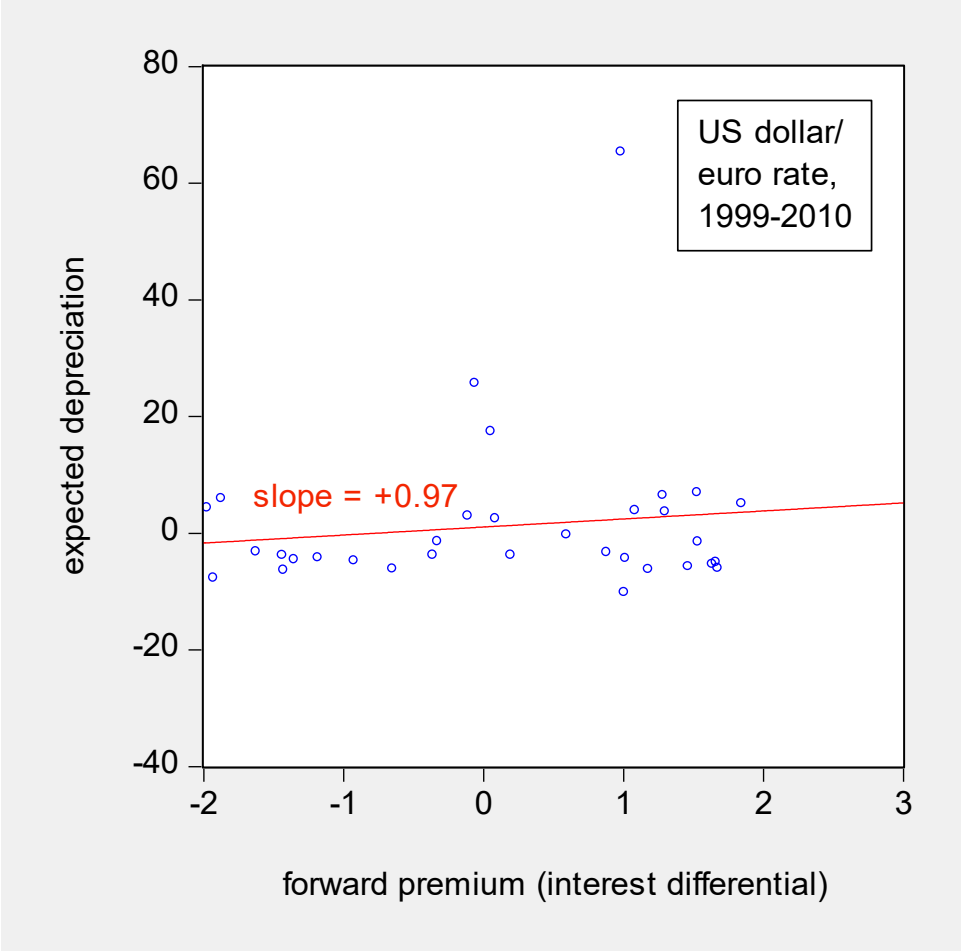


Chart 10.2: Annualized 3-month depreciation of U.S. dollar/euro exchange rate against U.S.-euro area 3-month interest rate differential, in percentage points

The slope of the trend line is negative, rather than positive. This is not a finding specific to the dollar/euro exchange rate. It is also holds true for other currencies, and remains one of the most robust stylized facts in the literature.

There are several possible explanations for this suprising finding. First, it might be that the participants in the foreign exchange market have systematically wrong expectations about future exchange rate changes. This hypothesis is difficult to test, again because we don't directly observe expectations. However, several organizations survey individuals at major financial institutions involved in foreign exchange trading. Presumably these people's views are representative of the relevant market participants. Statistical tests confirm that their expectations are biased – expectations of exchange rate changes are on average wrong, so much so that for the dollar-euro exchange rate, the dollar appreciates when it's expected to depreciate.

Plotting *expected* depreciation against the interest differential leads to a substantially different picture (Box Chart 10.3). Then the observations line up much more in line with what's expected.



Box Chart 10.3: Annualized 3-month expected depreciation of U.S. dollar/euro exchange rate against U.S.-euro area 3-month forward premium, in percentage points.

The regression slope of 0.97, which is statistically indistinguishable from one, is consistent with the view that investors do equalize expected returns – it's just that investors are not very good in making their expectations.[8][9] This finding also holds for other exchange rates, such as the Swiss franc and Norwegian krone.

[8] These data differ from the data used in Box Chart 10.1, which were dated at the end of each quarter. These data pertain to the third Thursday in the last month of each quarter. The variable that stands in the stead of the interest differential is the forward premium, which should equal the interest differential, but in practice differs slightly. Finally, the slope coefficient reported in Box Chart 10.2 is based on a regression which excludes the observation for December 2008, which pertains to the height of the global financial crisis. Including this observation results in a regression coefficient of 1.7, also statistically indistinguishable from the value of one.

[9] These results are based on data drawn from *Currency Forecasters Digest* and *FX4casts*, and used in Chinn (2014). Earlier contributions in this vein were Dominguez (1986), Frankel and Froot (1987), and Froot and Frankel (1989).

An alternative explanation for the finding that interest rates wrongly predict the direction of exchange rate changes is that an **exchange risk premium** drives a wedge between exchange rate depreciation and interest rate differentials. This explanation is an alternative to the first one, but not incompatible with it. The idea here is that some currencies are riskier than others.

(10.3) $$i_t - i_t^* - \Delta s_{t+1}^e \equiv rp_t$$

The risk premium is the excess return on securities denominated in a given currency, taking into account expected changes in currency values. When uncovered interest parity holds, the risk premium is zero. But there is no reason that this need be true in the real world. It might be that each household and firm around the world holds a portfolio of assets that includes, for instance, U.S. government bonds, Japanese government bonds, and German government bonds. If households and firms think of these bonds as imperfect substitutes, so that for instance they have a preference for Japanese bonds, then when the expected dollar return on German bonds exceeds that of Japanese bonds, everybody doesn't dump the Japanese bonds in favor of the German bonds. They might try to increase their holdings of those German bonds, but still retain a few of the Japanese bonds.

In a world where government bonds are not perfect substitutes, the expected excess return on, say, U.S. bonds might be there to compensate for the fact that the U.S. government has issued more bonds than households and firms around the world desire (how much are desired could depend on how the currency and interest rates move together, or with consumption), as well as the extent to which those actors are risk averse. If agents are risk neutral, then the risk premium should be zero, and uncovered interest parity holds.

10.6 More on Exchange Rates

An exchange rate, as the phrase is usually understood, is the price of one currency in terms of a single other currency. This is sometimes called a *bilateral* exchange rate. There are, however, other ways the concept of an exchange rate can be developed. Here we consider two.

The value of a single currency

It would be nice to have a summary measure of the value of a specific currency, not in terms of any one other currency but generically, as it were. In Figure 10.1 we can see that in mid-2016, the dollar remains stable against the euro, even as it appreciates against the pound. Can we say anything about how the dollar is performing *on average* in 2016?

The natural move is to calculate the value of a currency against the value of a basket of currencies, to obtain what is called an **effective exchange rate index**. However, taking a simple average would not make sense. In constructing an index to track the dollar, should the currency of Lithuania, which has very little economic interaction with the United States, be weighted the same as the currency of Canada, the

U.S.' largest trading partner? Clearly not. A typical practice is to weight the currencies in the basket by the amount of trade conducted between the home and foreign countries. For instance, if the U.S. conducted 3/5 of its trade with the Euro area, 2/5 with China, and 1/5 with the rest of the world, the weights would be 3/5 for the euro, 2/5 for the yuan, and 1/5 for all the other currencies combined. This is an example of a **trade weighted exchange rate index**, which is the most common version of an effective exchange rate index. Perhaps confusingly, these indices are usually expressed in value terms, i.e., the higher the value, the stronger the home currency. That is the reverse of the convention used for bilateral exchange rates.[10]

Chart 10.4 presents the values of the currencies examined in Figure 10.1. Note that in this case, the rise in each series is interpreted as an increase in the value of the indicated currency (i.e., German mark, euro and Japanese yen).

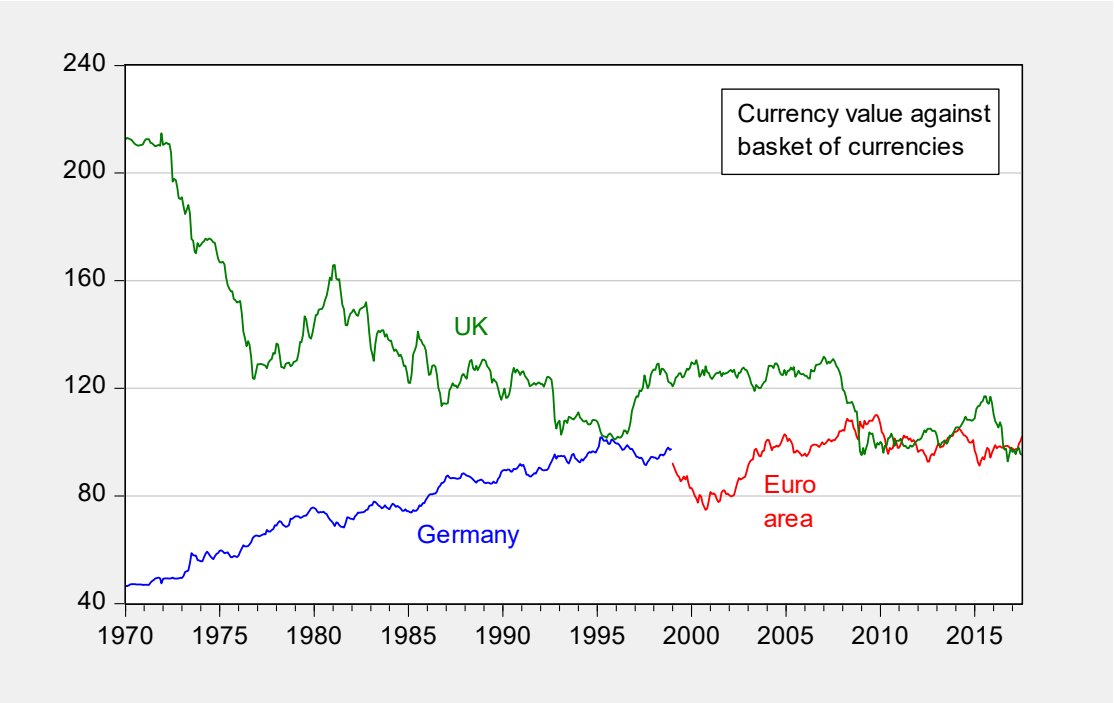


Chart 10.4: Exchange rates for the German mark (blue), the British pound (green) and the euro (red) against a basket of currencies, weighted by trade flows and scaled so that all currencies are at 100 in 2010. Higher values indicate a stronger currency.

Exchange rates for goods

So far we have been discussing what are called nominal exchange rates, as they pertain to the tradeoff between paper assets (currencies). However, for economic transactions, we are often concerned with real magnitudes; is there a real counterpart to these nominal exchange rates. In fact there is, conceptually. This

[10] So then the index for the dollar would be calculated as $(3/5)/S^{Euro} + (2/5)/S^{China} + (1/5)/S^{Other}$. But the construction of the indices is actually slightly more complicated than laid out here. Instead of an arithmetic weighted average, the indices constructed by statistical agencies use a geometric weighted average. Chinn (2006) describes the construction of the various types of effective exchange rate indices.

is most easily understood by explicitly considering the units. Let's consider for instance the nominal exchange rate between the U.S. and the euro area, from the perspective of a U.S. resident.

S{USD/EUR}

Which is the number of dollars required to obtain a single euro. The **real exchange rate** measures the rate of exchange of real goods. Define the prices of widgets in the U.S. and euro area as:

P{USD/U.S. widget}

P*{EUR/Euro area widget}

The real exchange rate is thus given by:

(10.3) $$q\{\text{U.S. widgets/Euro area widgets}\} \equiv \frac{S\{^{USD}/_{EUR}\} \times P^*\{^{EUR}/_{Euro\ area\ widget}\}}{P\{^{USD}/_{US\ widget}\}}$$

In other words, the real exchange rate is the number of U.S. widgets one has to give up to obtain a single foreign widget.

If U.S. widgets traded off one for one with Euro area widgets, then q=1, and the price of a U.S. widget in USD should equal the price of a Euro area widget in USD terms.

(10.4) $$P\{\text{USD/U.S. widget}\} = S\{\text{USD/EUR}\} \times P^*\{\text{EUR/Euro area widget}\}$$

In a world where U.S. and Euro area widgets were exactly the same, and there were no impediments to trading those widgets across borders and prices could be easily adjusted, a reasonable value for *q would* be 1. However, in the real world there are barriers to trade and firms do not seem to adjust prices moment by moment; as a consequence, *q* might not always equal 1, although it would seem reasonable that over time *q* would gravitate toward that value.

In general, we don't care about widgets, but rather bundles of goods and services. One measure of prices of bundles of goods purchased by consumers, namely **consumer price indices** (CPIs). Figure 10.3 shows the bilateral real exchange rates corresponding to the nominal rates in Figure 10.1, deflated using CPIs.

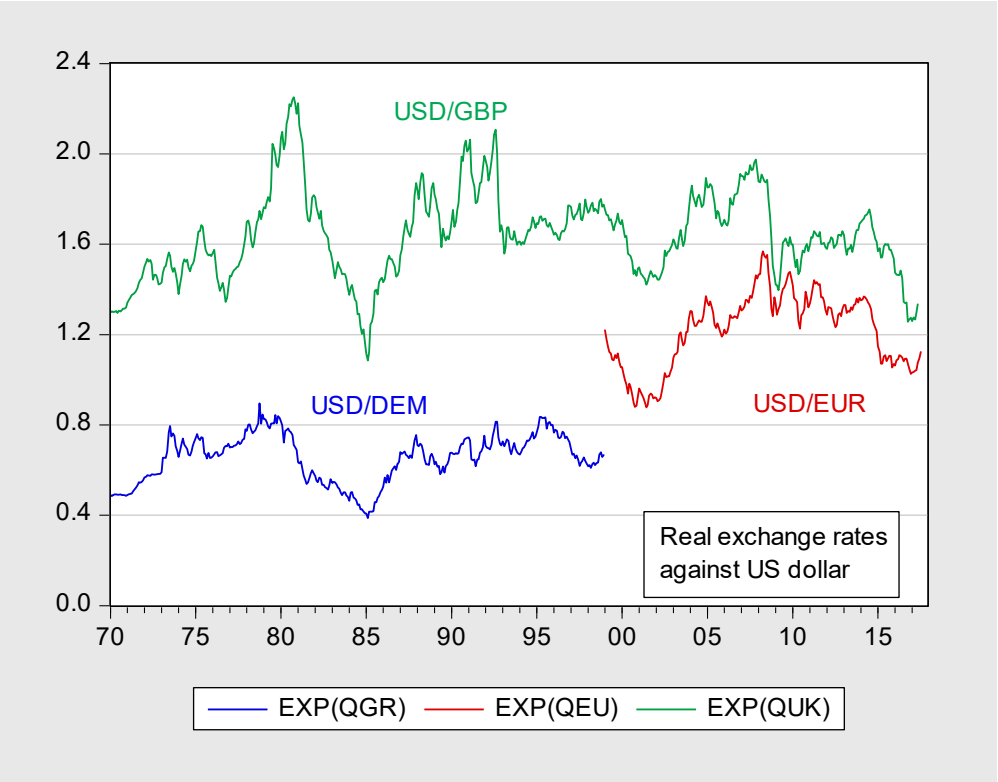


Chart 10.5: Real exchange rates for Deutsche mark (blue), British pound (green) and euro (red) against USD. Exchange rates deflated using consumer price indices (2010=100). Higher values denote a weaker dollar against the foreign currency (a depreciation).

Each of these series can be interpreted as the number of bundles of U.S. consumer goods and services required to purchase a single bundle of foreign consumer goods and services.

One interesting aspect of these series is that they exhibit less-pronounced trends than the corresponding series displayed in Chart 10.1. This contrast makes sense, given our discussion of q. Chart 10.1 pertains to the relative price of pieces of paper, namely currencies. Those can drift far apart as demand and supply of pieces of paper vary. Chart 10.5 depicts the relative price of bundles of goods and services. If an American bundle of goods and services is similar to a bundle of European goods and services, then there would seem to be a bound to how far away from a one for one tradeoff.

NEED ANOTHER SUBSECTION HEAD SOMEWHERE. HERE?

Finally, it is of interest to consider how the bilateral real exchange rates against USD compare against the real trade weighted USD exchange rate. Chart 10.6 illustrates that the trade weighted real exchange rate (with up defined as depreciation) is a useful way to summarize overall movements in a currency.

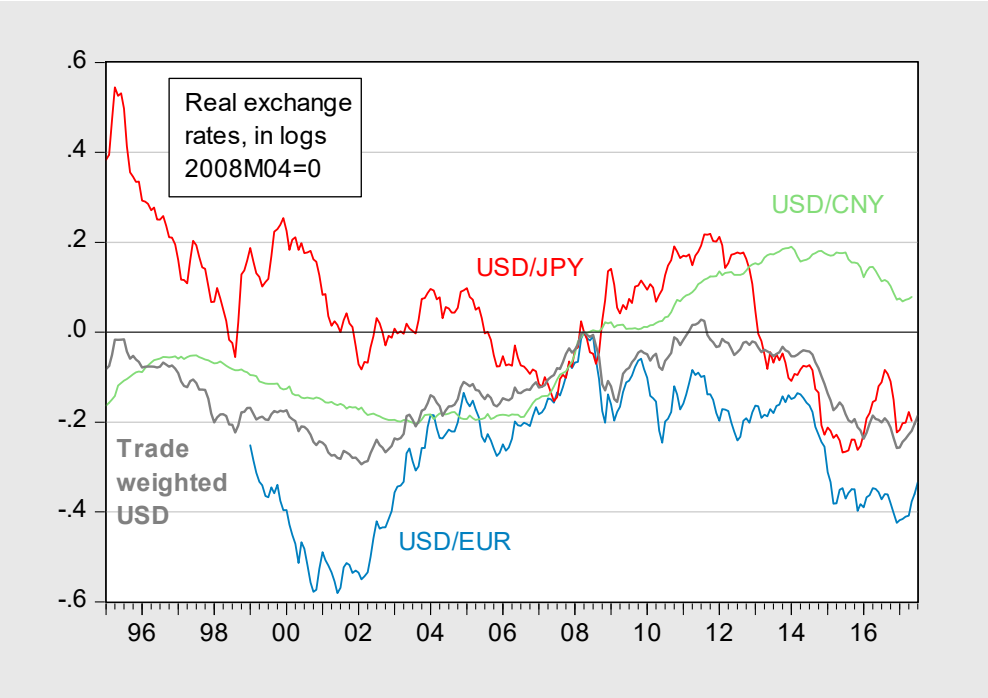


Chart 10.6: Log exchange rate for euro (dark blue), Japanese yen (red) and Chinese yuan (light green) against USD, and log real trade weighted exchange rate index for USD (bold gray), inverted and normalized to 2008M04=0. Exchange rates deflated using consumer price indices. Higher values denote a weaker dollar (a depreciation).

When the USD/EUR real exchange rate depreciates, the trade weighted real exchange rate tends to depreciate, since the U.S. has a large amount of trade with the euro area. However, the two series don't move in lockstep, exactly because the Japanese yen (as well as the Chinese yuan) is moving in a different direction at various points in time.

10.7 Application

10.8 Conclusion

There are many different exchange rates, which pertain to different relative prices. The nominal bilateral exchange rate is the relative price of two currencies, specifically how many units of the home currency necessary to acquire one unit of the foreign one. The real bilateral exchange rate is the relative price of two bundles of goods and, analogously to the nominal rate, the number of bundles of home goods necessary to obtain one of the foreign bundles.

The nominal effective exchange rate (usually expressed as the value of a home currency against several other currencies); the real effective exchange rate is the inflation-adjusted version of the nominal one. The weights for effective exchange rates are typically based on the importance in terms of trade. The greater the extent of the trade with a given country, the heavier the weight ascribed to that country's currency.

Institutionally, nominal exchange rates are determined in a market in foreign exchange, where a limited number of large international banks bid for and offer to sell currencies. Each day, something around $1.5

trillion in foreign currencies are traded. The most-often traded currency pair is the U.S. dollar-euro, with the second being the U.S. dollar-yen.

Summary Points

1. The nominal exchange rate is the price of foreign currency, in terms of home currency.
2. Under a floating exchange rate regime, supply and demand determine the price. Under a fixed exchange rate regime, the central bank must buy and sell the currency in order keep its relative price at the official exchange rate.
3. Under a floating (fixed) rate regime, a rise in the price is called a depreciation (devaluation), while a fall is an appreciation (revaluation).
4. Most exchange rate regimes in existence incorporate intermediate degrees of flexibility.
5. The forward exchange rate is the rate one can contract in the present for a trade of currencies in the future.
6. The forward and the current (or spot) exchange rate are linked to interest rates by covered interest parity, when there are no barriers to financial capital flows.
7. In theory, if traders did not care about risk, and there were no barriers to financial capital flows, expected returns in one country would equal those in another country.
8. The real exchange rate is the relative price of a bundle of foreign goods, in terms of bundles of home goods.
9. The effective exchange rate index is the value of a currency relative to a bundle of foreign currencies, where the weights are based on trade flows.

Key Concepts

Appreciation

Capital controls

Covered interest parity

Currency swaps

Depreciation

Devaluation

Effective exchange rate index

Exchange rate

Exchange rate peg

Exchange risk premium

Fixed exchange rate regime

Floating exchange rate regime

Foreign exchange swaps

Forwards

International currency

No arbitrage profits condition

Over the counter	Revaluation
Peg	Spot transactions
Real exchange rate	Trade weighted exchange rate index
Reserve currency	Uncovered interest parity

Exercises

1. The foreign exchange market. Using a supply and demand diagram, and defining the U.S. as the home country and either the Philippines or Japan as the foreign, show what happens in the following situations (assuming a floating exchange rate regime).

a. U.S. demand for Japanese autos increases.

b. Japanese demand for American real estate decreases.

c. Remittances from Filipino citizens in the U.S. back to the Philippines increase (use a graph of the USD/Philippine Peso market).

2. An exchange rate peg in operation.

a. Draw a diagram of the foreign exchange market from the perspective of Jordan. Assume the relevant foreign currency is the U.S. dollar. Show the floating market equilibrium.

b. Assume the Jordanian monetary authorities peg their currency at a value stronger than the floating market equilibrium. Show the excess supply or demand for foreign currency.

c. What does the central bank have to do in order to sustain the peg? Show that action in the graph.

d. Suppose Jordan's central bank runs out of U.S. dollars. What can the central bank do?

3. Tracking exchange rates. Using the "Trade, exchange rates, budget balances and interest rates" Table in the *Economist*, http://www.economist.com/, answer the following questions.

a. Calculate the percentage change (depreciation) of the U.S. dollar against the euro over the prior year.

b. From the perspective of a resident of the euro area, calculate the percentage change (depreciation) of the euro against the U.S. dollar. Is this number the exact opposite of your answer to Part a?

c. How many U.S. dollars does it take to buy a single Canadian dollar now? How many did it take a year ago? Has the U.S. dollar appreciated or depreciated against the Canadian dollar?

d. What is the exchange rate of euros for Canadian dollars (CAD), i.e., how many euros does it take to purchase a single Canadian dollar?

4. Nominal vs. real exchange rates. Consider the following data on the dollar/pound exchange rate, and the consumer price indexes (CPI's) in the U.S. and the United Kingdom. The CPI's are normalized to equal 1.00 in 1985.

Year	USD/GBP	CPI US	CPI UK
1983	1.5159	0.926	0.914
1984	1.3368	0.966	0.953
1985	1.2974	1.000	1.000
1986	1.4677	1.019	1.033
1987	1.6398	1.056	1.066

1988	1.7813	1.099	1.107
1989	1.6382	1.152	1.165
1990	1.7841	1.215	1.246
1991	1.7674	1.266	1.340
1992	1.7663	1.304	1.397
1993	1.5016	1.343	1.432

a. Calculate the nominal rate of depreciation of the U.S. dollar against the pound between 1989 and 1992.

b. Calculate the real exchange rate for 1989 and 1992, using the CPI's for the U.S. and the UK.

c. Calculate the real rate of depreciation of the U.S. dollar against the pound between 1982 and 1992.

5. Interest parity conditions. Using the "Trade, exchange rates, budget balances and interest rates" Table in the *Economist*, http://www.economist.com/, answer the following questions.

a. Using the 3-month interest rates, and assuming uncovered interest parity holds, calculate the expected change in the dollar/euro exchange rate over the next three months. Be sure to state what the rate will be, in annualized terms.

b. Considering the actual experience over the 1999–2010 period, what is actual depreciation you actually expect for the dollar/euro exchange rate, on an annualized basis?

c. Assume covered interest parity holds. What is the forward rate today for a trade 3 months hence?

d. Using 10-year bonds, calculate the implied annual change in the dollar/pound exchange rate, over the next ten years.

6. Effective exchange rate index. Suppose country X conducts ¼ of its trade with country Y and ¾ with country Z.

a. Suppose X's currency holds steady against Y's currency but appreciates by 10% against Z's. What is the change in the trade weighted exchange rate index?

b. Suppose X's currency depreciates by 10% against Y's currency but appreciates by 10% against Z's. What is the change in the trade weighted exchange rate index?

c . Suppose that in Part b, the inflation rate is 10% higher in X than in either Y or Z. What is the change in the real trade weighted exchange rate index?

Worked Exercise

4. Nominal vs. real exchange rates

a. Depreciation = (1.7663 – 1.6382)/1.6382 = 0.0782, or 7.82%

b. q = SP*/P; so for 1989, q = 1.6382×1.165/1.152 = 1.657; for 1992, q = 1.7663×1.397/1.304 = 1.892

c. Real depreciation = (1.892 – 1.657)/1.657 = 0.1418, or 14.18%

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