University of Warsaw
Faculty of Economic Sciences

Introduction to Exchange Rates and the Foreign Exchange Market

Łukasz Matuszczak, Phd

With the reference to © 2017 Worth Publishers
International Economics, 4e | Feenstra/Taylor

Introduction

- **Exchange rates** affect large flows of international trade by influencing the prices of goods in different currencies, and also affect international trade in assets, via the prices of stocks, bonds, and other investments.

- In the **foreign exchange market**, trillions of dollars are traded each day and the economic implications of shifts in the market can be dramatic.

Introduction

In this lecture, we begin to study the nature and impact of activity in the foreign exchange market.

The topics we cover include:

- Exchange rate basics
- Basic facts about exchange rate behavior
- The foreign exchange market
- Two key market mechanisms: **arbitrage** and **expectations**

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Exchange Rate Essentials

An exchange rate (*E*) is the price of some foreign currency expressed in terms of a home (or domestic) currency.

- Because an exchange rate is the relative price of two currencies, it may be quoted in either of two ways:
  - The number of home currency units that can be exchanged for one unit of foreign currency
  - The number of foreign currency units that can be exchanged for one unit of home currency
- *To avoid confusion, we must specify which country is the home country and which is foreign.*

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Defining the Exchange Rate

When we refer to a particular country's exchange rate, we will quote it in units of home currency per units of foreign currency.

- For example:
  - The U.S. exchange rate with Japan is quoted as U.S. dollars per yen (or $/¥).
  - Denmark's exchange rate with the Eurozone is quoted as Danish krone per euro (or kr/€).

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

TABLE 2-1

Exchange Rate Quotations This table shows major exchange rates as they might appear in the financial media. Columns (1) to (3) show rates on December 31, 2015. For comparison, columns (4) to (6) show rates on December 31, 2014. For example, column (1) shows that at the end of 2015, one U.S. dollar was worth 1.501 Canadian dollars, 6.870 Danish krone, 0.921 euros, and so on. The euro–dollar rates appear in bold type.

		EXCHANGE RATES ON DECEMBER 31, 2015			EXCHANGE RATES ON DECEMBER 31, 2014 *ONE YEAR PREVIOUSLY*		
		(1)	(2)	(3)	(4)	(5)	(6)
Country (currency)	**Currency Symbol**	**Per $**	**Per €**	**Per £**	**Per $**	**Per €**	**Per £**
Canada (dollar)	C$	1.501	1.389	2.047	1.158	1.402	1.806
Denmark (krone)	DKr	6.870	7.463	10.13	6.154	7.446	9.595
Eurozone (euro)	€	**0.921**	—	1.357	**0.826**	—	1.289
Japan (yen)	¥	120.3	130.7	177.3	119.9	145.1	187.0
Norway (krone)	NKr	8.851	9.612	13.05	7.498	9.072	11.69
Sweden (krona)	SKr	8.431	9.158	12.43	7.828	9.473	12.21
Switzerland (franc)	SFr	1.001	1.087	1.485	0.994	1.202	1.549
United Kingdom (pound)	£	0.679	0.737	—	1.559	0.776	—
United States (dollar)	$	—	**1.086**	1.474	—	**1.210**	1.559

$E_{\$/€}$ = 1.086 = U.S. exchange rate (American terms)

$E_{€/\$}$ = 0.921 = Eurozone exchange rate (European terms)

$$E_{\$/€} = \frac{1}{E_{€/\$}} \qquad 1.086 = \frac{1}{0.921}$$

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Appreciations and Depreciations

- If one currency buys more of another currency, we say it has experienced an **appreciation**.
    - We also might say it has *risen in value*, *appreciated,* or *strengthened* against the other currency.
- If a currency buys less of another currency, we say it has experienced a **depreciation**.
    - We also might say it has *fallen in value*, *depreciated*, or *weakened* against the other currency.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Appreciations and Depreciations

In U.S. terms, the following holds true:

- When the U.S. exchange rate $E_{\$/€}$ *rises,* more dollars are needed to buy one euro. The price of one euro goes up in dollar terms, and the U.S. dollar experiences a depreciation. It has fallen in value or weakened against the euro.

- When the U.S. exchange rate $E_{\$/€}$ *falls,* fewer dollars are needed to buy one euro. The price of one euro goes down in dollar terms, and the U.S. dollar experiences an appreciation. It has risen in value or strengthened against the euro.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Appreciations and Depreciations

To determine the size of an appreciation or depreciation, we compute the proportional change, as follows:

- In 2014, at time *t,* the dollar value of the euro was

  $E_{\$/€,t} = \$\ 1.211.$

- In 2015, at time $t + 1$, the dollar value of the euro was

  $E_{\$/€,t+1} = \$\ 1.086.$

- The change in the dollar value of the euro was

  $\Delta E_{\$/€,t} = 1.086 - 1.211 = -\$\ 0.125.$

- The percentage change was

  $\Delta E_{\$/€,t} / E_{\$/€,t} = -0.125/1.211 = -10.32\%.$

- Thus, the dollar *appreciated* against the euro by 10.32%.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Appreciations and Depreciations

Similarly, over the same year:

- In 2014, at time *t,* the euro value of the dollar was
  $E_{€/\$,t}$ = € 0.826.
- In 2015, at time $t + 1$, the euro value of the dollar was
  $E_{€/\$,t+1}$ = € 0.921.
- The change in the euro value of the dollar was
  $\Delta E_{€/\$,t} = 0.921 - 0.826 =$ + € 0.095.
- The percentage change was
  $\Delta E_{€/\$,t} / E_{€/\$,t} = +\, 0.095/0.826 = +\, 11.50\%$.
- Thus, the euro *depreciated* against the dollar by 11.50%.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Multilateral Exchange Rates

Economists calculate *multilateral* exchange rate changes by aggregating *bilateral* exchange rates using trade weights to construct an average over each currency in the basket. The resulting measure is called the change in the **effective exchange rate**. For example:

- Suppose 40% of Home trade is with country 1 and 60% is with country 2. Home's currency appreciates (-)10% against 1 but depreciates (+)30% against 2.

- To find the change in Home's effective exchange rate, multiply each exchange rate change by the trade share and sum:

$$(-10\% \bullet 40\%) + (30\% \bullet 60\%) = (-0.1 \bullet 0.4) + (0.3 \bullet 0.6) =$$

$$-0.04 + 0.18 = 0.14 = +14\%.$$

- Home's effective exchange rate has depreciated by 14%.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Multilateral Exchange Rates

In general, suppose there are *N* currencies in the basket, and Home's trade with all *N* partners is:

$$\text{Trade} = \text{Trade}_1 + \text{Trade}_2 + \ldots + \text{Trade}_N.$$

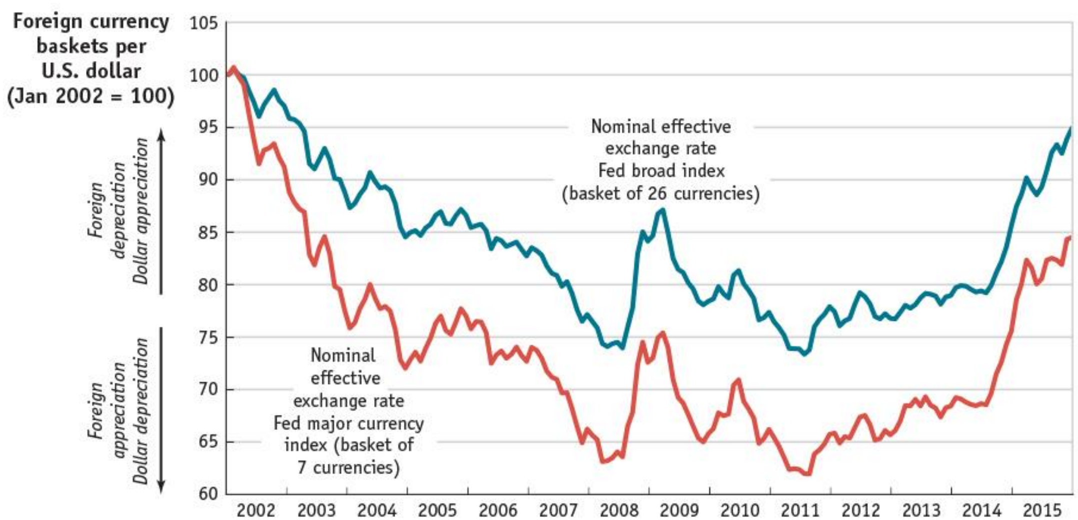
Applying trade weights to each bilateral exchange rate change, the home country's effective exchange rate ($E_{\text{effective}}$) will change according to the following weighted average:

$$\frac{\Delta E_{\text{effective}}}{E_{\text{effective}}} = \underbrace{\frac{\Delta E_1}{E_1}\frac{\text{Trade}_1}{\text{Trade}} + \frac{\Delta E_2}{E_2}\frac{\text{Trade}_1}{\text{Trade}} + \cdots + \frac{\Delta E_N}{E_N}\frac{\text{Trade}_N}{\text{Trade}}}_{\text{Trade}-\text{weighted average of bilateral nominal exchange rate changes}}$$

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Multilateral Exchange Rates

FIGURE 2-1



Effective Exchange Rates: Change in the Value of the U.S. Dollar, 2002–2015 The chart shows the value of the dollar using two different baskets of foreign currencies. Against a basket of 7 major currencies, the dollar had depreciated by 35% by early 2008. Against a broad basket of 26 currencies, the dollar had lost only 25% by 2008. This is because the dollar was floating against the major currencies, but the broad basket included important U.S. trading partners (such as China) that maintained fixed or tightly managed exchange rates against the dollar. These trends only briefly reversed during the global financial crisis of 2008 before continuing up to 2015.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Example: Using Exchange Rates to Compare Prices in a Common Currency

TABLE 2-2

Using the Exchange Rate to Compare Prices in a Common Currency Now pay attention, 007! This table shows how the hypothetical cost of James Bond's next tuxedo in different locations depends on the exchange rates that prevail.

Scenario		1	2	3	4
Cost of the tuxedo in local currency	London	£2,000	£2,000	£2,000	£2,000
	Hong Kong	HK$30,000	HK$30,000	HK$30,000	HK$30,000
	New York	$4,000	$4,000	$4,000	$4,000
Exchange rates	HK$/£	15	16	14	14
	$/£	2.0	1.9	2.1	1.9
Cost of the tuxedo in pounds	London	£2,000	£2,000	£2,000	£2,000
	Hong Kong	£2,000	£1,875	£2,143	£2,143
	New York	£2,000	£2,105	£1,905	£2,105

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Exchange Rate Regimes: Fixed Versus Floating

There are two major types of **exchange rate regimes**—fixed and floating:

- A **fixed** (or **pegged**) **exchange rate** fluctuates in a narrow range (or not at all) against some *base currency* over a sustained period. The exchange rate can remain fixed for long periods only if the government intervenes in the foreign exchange market in one or both countries.
- A **floating** (or **flexible**) **exchange rate** fluctuates in a wider range, and the government makes no attempt to fix it against any base currency. Appreciations and depreciations may occur yearly, monthly, by the day, or even every minute.

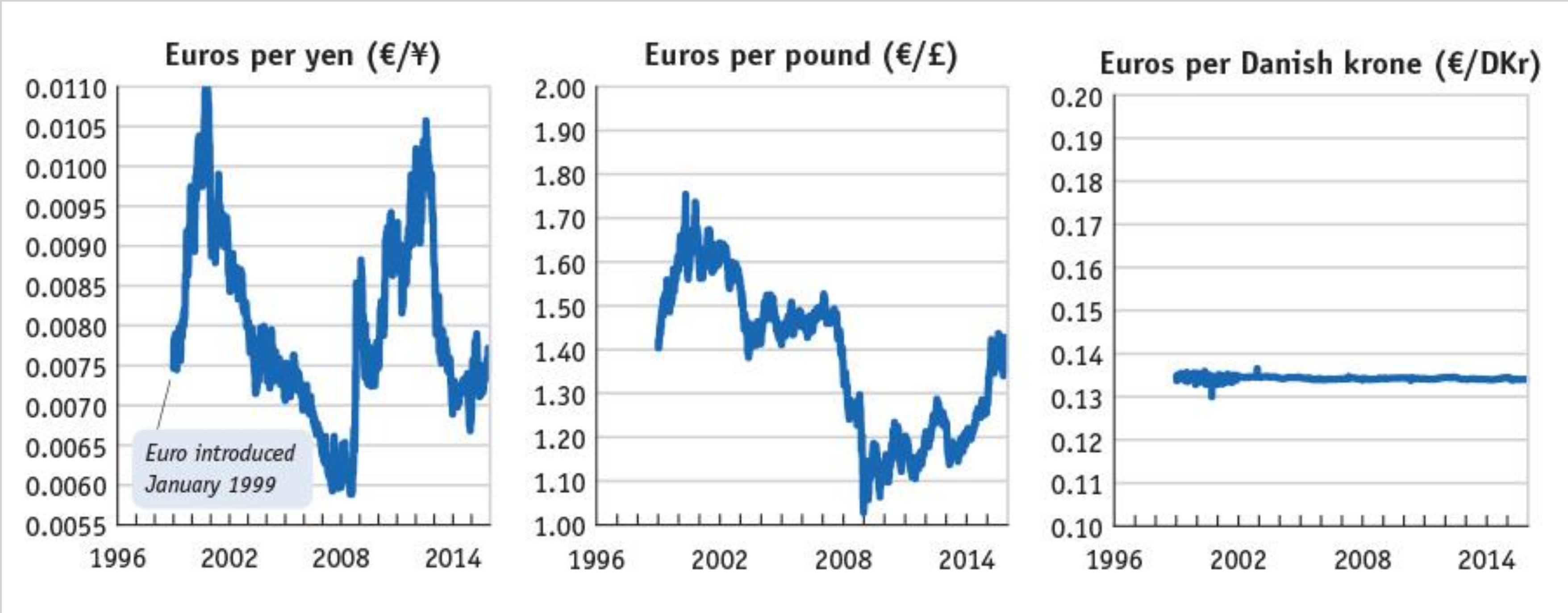
© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

FIGURE 2-2 (1 of 2) Exchange Rate Behavior: Selected Developed Countries, 1996–2015

This figure shows the exchange rates of three currencies against the U.S. dollar. The U.S. dollar is in a floating relationship with the yen, the pound, and the Canadian dollar (or *loonie*). The U.S. dollar is subject to a great deal of volatility because it is in a floating regime, or **free float**.

APPLICATION

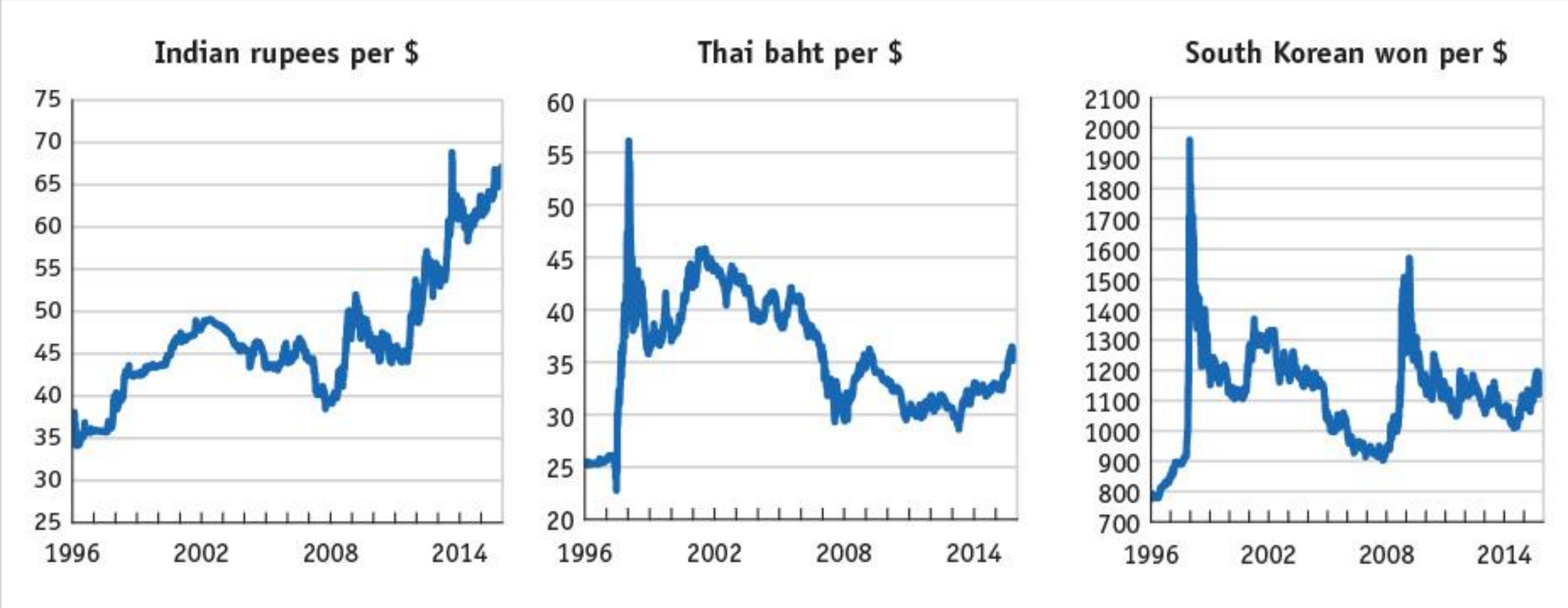
FIGURE 2-2 (2 of 2) Exchange Rate Behavior: Selected Developed Countries, 1996–2015 (cont.)



This figure shows exchange rates of three currencies against the euro, which was introduced in 1999. The pound and the yen float against the euro. The Danish krone provides an example of a fixed exchange rate. There is only a tiny variation around this rate, no more than plus or minus 2%. This type of fixed regime is known as a **band**.

APPLICATION

FIGURE 2-3 (1 of 2) Exchange Rate Behavior: Selected Developing Countries, 1996–2015

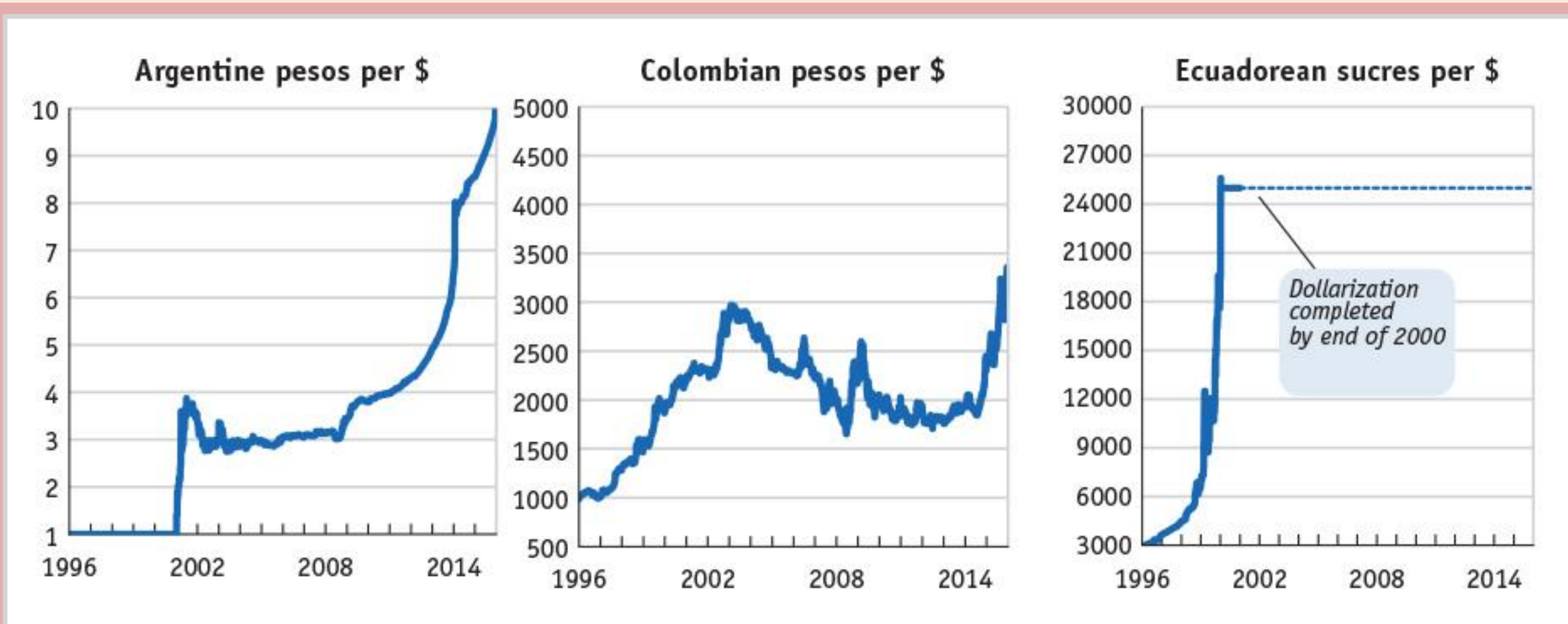


Selected Developing Countries, 1996–2015 Exchange rates in developing countries show a wide variety of experiences and greater volatility. Pegging is common but is punctuated by periodic crises (you can see the effects of these crises in graphs for Thailand, South Korea, and India). India is an example of a middle ground, somewhere between a fixed rate and a free float, called a **managed float**.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

APPLICATION

FIGURE 2-3 (2 of 2) Exchange Rate Behavior: Selected Developing Countries, 1996–2015 (cont.)



Colombia is an example of a **crawling peg**. The Colombian peso is allowed to crawl gradually, and it steadily depreciated at an almost constant rate for several years from 1996 to 2002. **Dollarization** occurred in Ecuador in 2000, a process that occurs when a country unilaterally adopts the currency of another country.

APPLICATION

Recent Exchange Rate Experiences

Exchange Rate Regimes of the World

- Figure 2-4 (on the next slide) shows an IMF classification of exchange rate regimes around the world, which allows us to see the prevalence of different regime types across the whole spectrum, from fixed to floating.
- The classification covers 182 economies for the year 2010, and regimes are ordered from the most rigidly fixed to the most freely floating.
- Six of these countries have a **currency board**, a type of fixed regime that has special legal and procedural rules designed to make the peg “harder”—that is, more durable.

APPLICATION

FIGURE 2-4 A Spectrum of Exchange Rate Regimes

Increasingly fixed

Increasingly floating

No separate legal tender (52 countries)	*Another currency as legal tender*: (13): Ecuador, El Salvador, Kiribati, Liechtenstein, Marshall Islands, Micronesia, Monaco, Montenegro, Palau, Panama, San Marino, West Bank & Gaza, Zimbabwe *Eurozone*: (19): Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain *Eastern Caribbean Currency Union*: (6): Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines *West African CFA Franc Zone*: (8): Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, Togo *Central African CFA Franc Zone*: (6): Cameroon, Central African Rep., Chad, Rep. of Congo, Equatorial Guinea, Gabon
Currency boards (6)	Bosnia and Herzegovina, Brunei, Bulgaria, Djibouti, Hong Kong, Macao
Other pegs (35)	Anguilla, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belize, Bhutan, Bolivia, China, Comoros, Costa Rica, Denmark, Eritrea, Honduras, Iran, Jordan, Kuwait, Lebanon, Lesotho, Maldives, Morocco, Namibia, Nepal, Netherlands Antilles, Oman, Paraguay, Qatar, Saudi Arabia, Solomon Islands, Suriname, Swaziland, Ukraine, United Arab Emirates, Venezuela

This figure shows IMF classification of exchange rate regimes around the world for 182 economies in 2010. Regimes are ordered from the most rigidly fixed to the most freely floating. Six countries use an ultra-hard peg called a currency board, while 35 others have a hard peg.

APPLICATION

FIGURE 2-4 A Spectrum of Exchange Rate Regimes (continued)

Increasingly fixed

Increasingly floating

Bands, crawling pegs, crawling bands (43)	Algeria, Angola, Argentina, Botswana, Burundi, Cambodia, Cape Verde, Croatia, Dominican Republic, Egypt, Gambia, Georgia, Ghana, Guatemala, Guinea, Guyana, India, Iraq, Jamaica, Kazakhstan, Kyrgyz Republic, Malawi, Mauritius, Moldova, Mongolia, Nicaragua, Nigeria, Pakistan, Papua New Guinea, Peru, Rwanda, São Tomé and Príncipe, Sierra Leone, Sri Lanka, Sudan, Tajikistan, Tanzania, Tonga, Trinidad and Tobago, Tunisia, Uganda, Vietnam, Yemen
Wide bands, managed floating, free floating (46)	Afghanistan, Albania, Armenia, Australia, Belarus, Brazil, Canada, Chile, Colombia, Czech Republic, Haiti, Hungary, Iceland, Indonesia, Israel, Japan, Kenya, Korea, Liberia, Macedonia FYR, Madagascar, Malaysia, Mauritania, Mexico, Mozambique, New Zealand, Norway, Philippines, Poland, Romania, Russia, Samoa, Serbia, Seychelles, Singapore, South Africa, Sweden, Switzerland, Thailand, Turkey, United Kingdom, United States, Uruguay, Uzbekistan, Vanuatu, Zambia

An additional 43 counties have bands, crawling pegs, or crawling bands, while 46 countries have exchange rates that either float freely, are managed floats, or are allowed to float within wide bands.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

3 The Market for Foreign Exchange

Exchange rates the world over are set in the **foreign exchange market** (or **forex** or **FX market**).

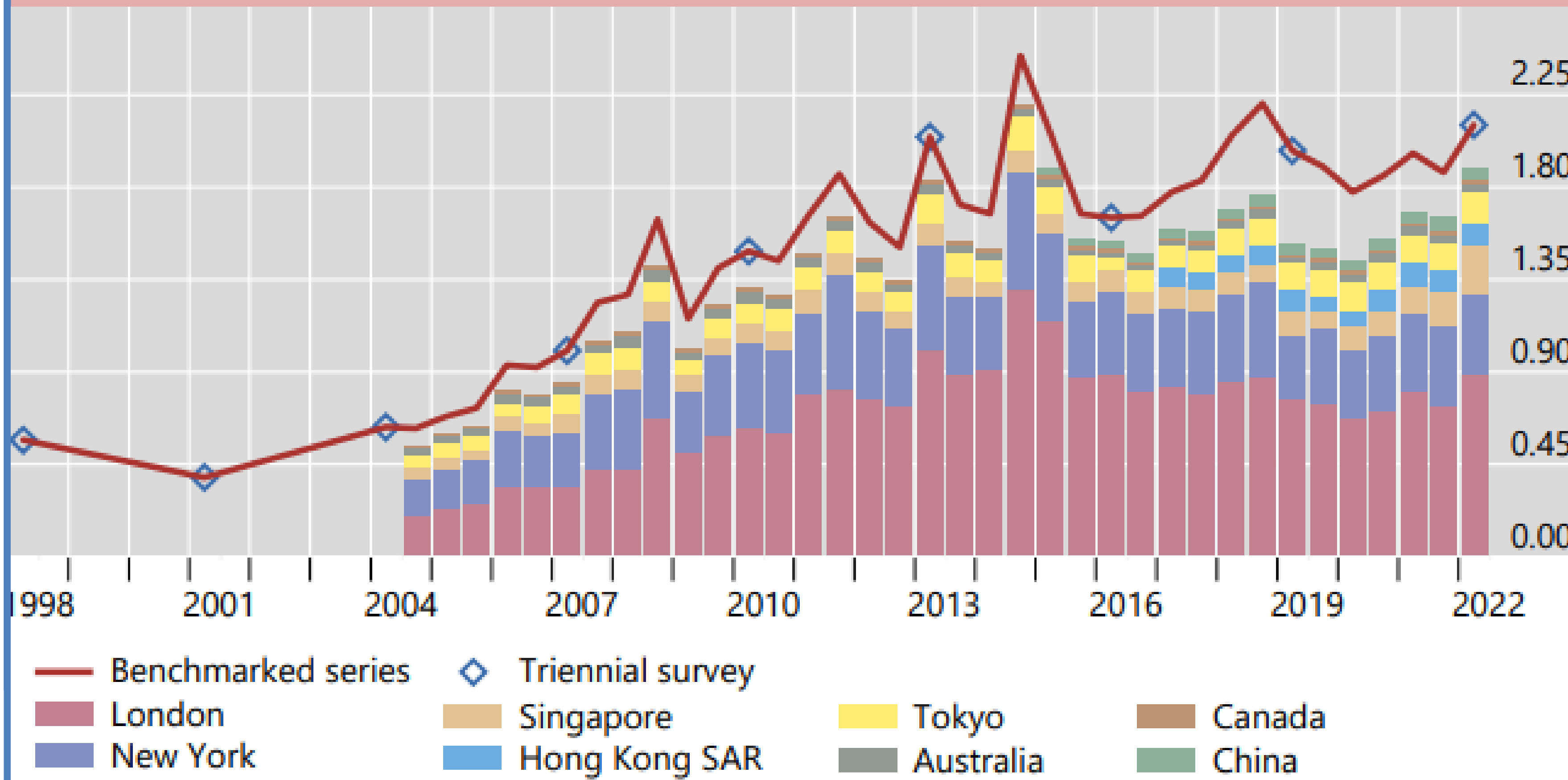
- The forex market is not an organized exchange: Trade is conducted "over the counter."
- According to the latest Triennial, daily trading volume in the global spot FX market averaged $2.11 trillion in April 2022.
- The three major foreign exchange centers are located in the United Kingdom, the United States, and Japan.
- Other important centers for forex trade include Hong Kong, Paris, Singapore, Sydney, and Zurich.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

3 The Market for Foreign Exchange

Size of the Market

FIGURE 2-5 Daily FX spot trading volume, in $ trillions

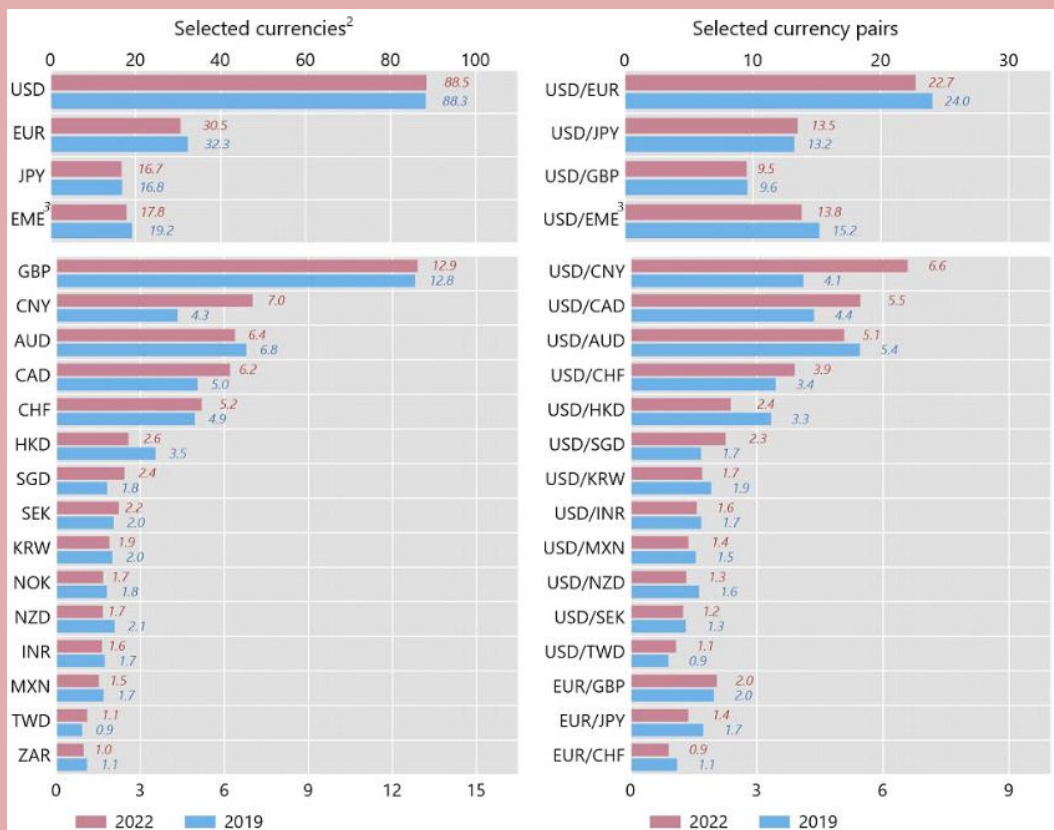


Source: BIS Working Papers No 1094 The foreign exchange market by Alain Chaboud, Dagfinn Rime and Vladyslav Sushko https://www.bis.org/publ/work1094.pdf

3 The Market for Foreign Exchange

FIGURE 2-6 Size of the Market

Foreign exchange market turnover by currency and currency pairs
Net-net basis, daily averages in April 2022 as percentage of total turnover



[1] Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis. [2] As two currencies are involved in each transaction, the sum of shares in individual currencies will total 200%. [3] Emerging market economy currencies excluding the Chinese renminbi and Russian rouble: AED, ARS, BGN, BHD, BRL, CLP, COP, CZK, HKD, HUF, IDR, ILS, INR, KRW, MXN, MYR, PEN, PHP, PLN, RON, SAR, SGD, THB, TRY, TWD and ZAR.

Source: BIS Triennial Central Bank Survey. For additional data by currency and currency pairs, see Tables 4 and 5. See our Statistics Explorer for access to the full set of published data.

© Bank for International Settlements

- The US dollar remained the world's dominant vehicle currency
- The next three most traded currencies – the euro, the Japanese yen and the pound sterling
- The euro continued to be the world's second most traded currency, on one side of 30.5% of all trades in April 2022
- The Chinese renminbi exhibited the biggest increase in market share since the 2019 survey, being on one side of 7% of all trades in 2022

Source: https://www.bis.org/statistics/rpfx22.htm

Size of the Market

FIGURE 2-3

OTC foreign exchange turnover by country and currency

''Net-gross'' basis[1], daily averages in April 2022 in millions of US dollars

	TOT	Specified currency against all other currencies[2]					
		EUR	GBP	JPY	CHF	CNY	USD
Total	**9 788 365**	**2 994 871**	**1 232 241**	**1 639 315**	**518 285**	**678 314**	**8 703 835**
Top 9 traders market, of which:	**8 391 792**	**2 432 496**	**1 103 145**	**1 550 833**	**473 095**	**655 046**	**7 523 886**
	86%	**81%**	**90%**	**95%**	**91%**	**97%**	**86%**
China	152 688	18 135	1 362	10 086	994	118 081	149 290
Hong Kong SAR	694 359	105 962	28 908	94 840	7 812	**191 227**	669 342
Japan	432 527	60 313	20 100	353 421	4 466	5 161	348 418
Luxembourg	91 867	54 572	13 358	22 656	8 538	558	53 387
Netherlands	74 137	50 344	6 790	3 956	3 050	971	68 409
Singapore	929 460	149 366	55 908	235 783	19 884	101 094	842 730
Switzerland	349 742	148 829	38 549	33 664	118 407	5 081	284 066
United Kingdom	**3 754 661**	**1 273 224**	**700 926**	**515 021**	**203 569**	**148 831**	**3 396 113**
United States	**1 912 350**	**571 750**	**237 243**	**281 407**	**106 374**	84 042	**1 712 132**

Source: https://www.bis.org/statistics/rpfx22.htm

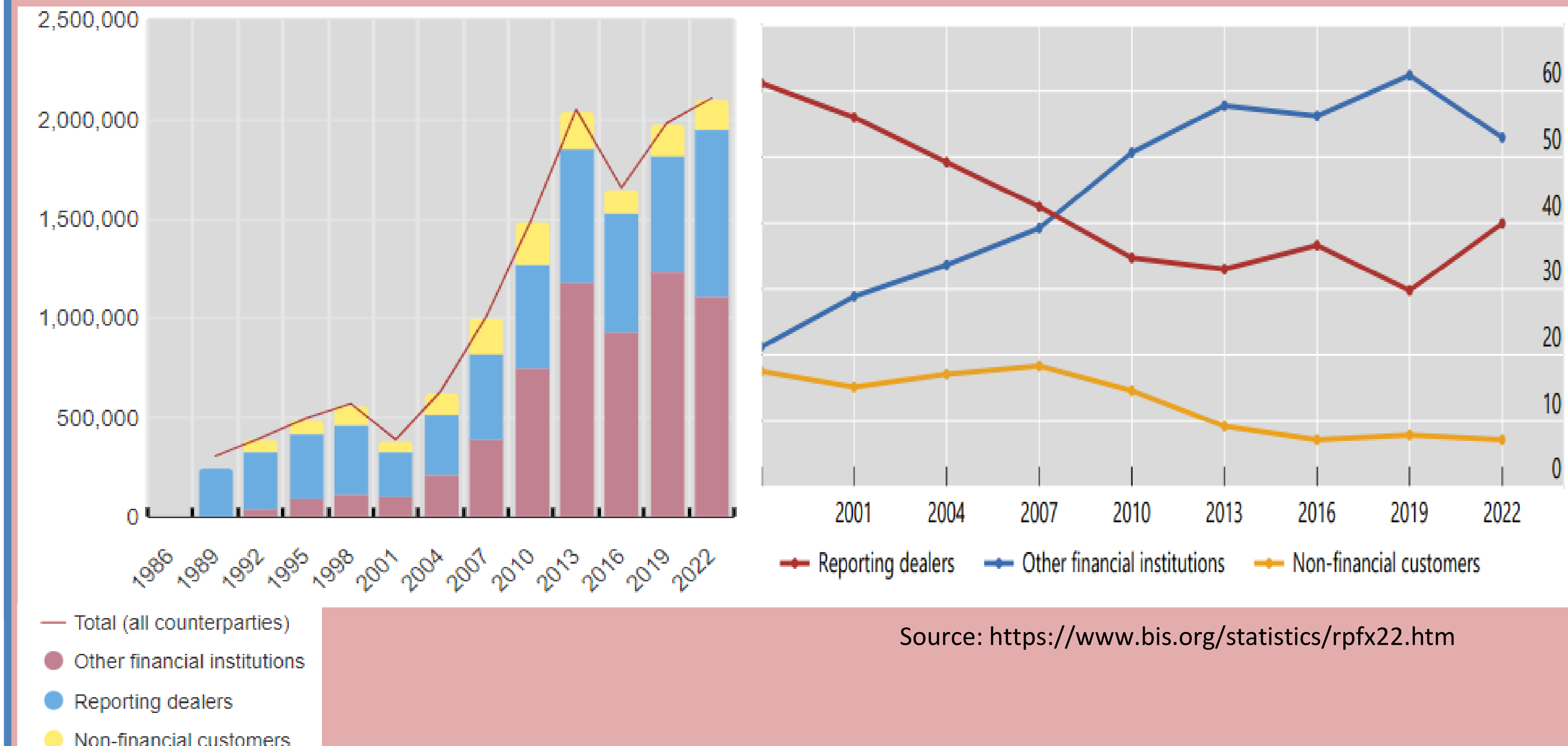
[1] Spot transactions, outright forwards, foreign exchange swaps, currency swaps, options and other products. Adjusted for local inter-dealer double-counting. Data may differ slightly from national survey data owing to differences in aggregation procedures and rounding. See annex for abbreviations. [2] Because two currencies are involved in each transaction, the sum of transactions in individual currencies comes to twice the total reported turnover. In this and all other tables by country the United Arab Emirates in 2022 include the Dubai International Financial Centre data.

Size of the Market

FIGURE 2-7 **OTC foreign exchange turnover by country and currency**

"Net-gross" basis[1], daily averages in April 2022 in millions of US dollars

FX spot trading: percent shares by type of counterparty

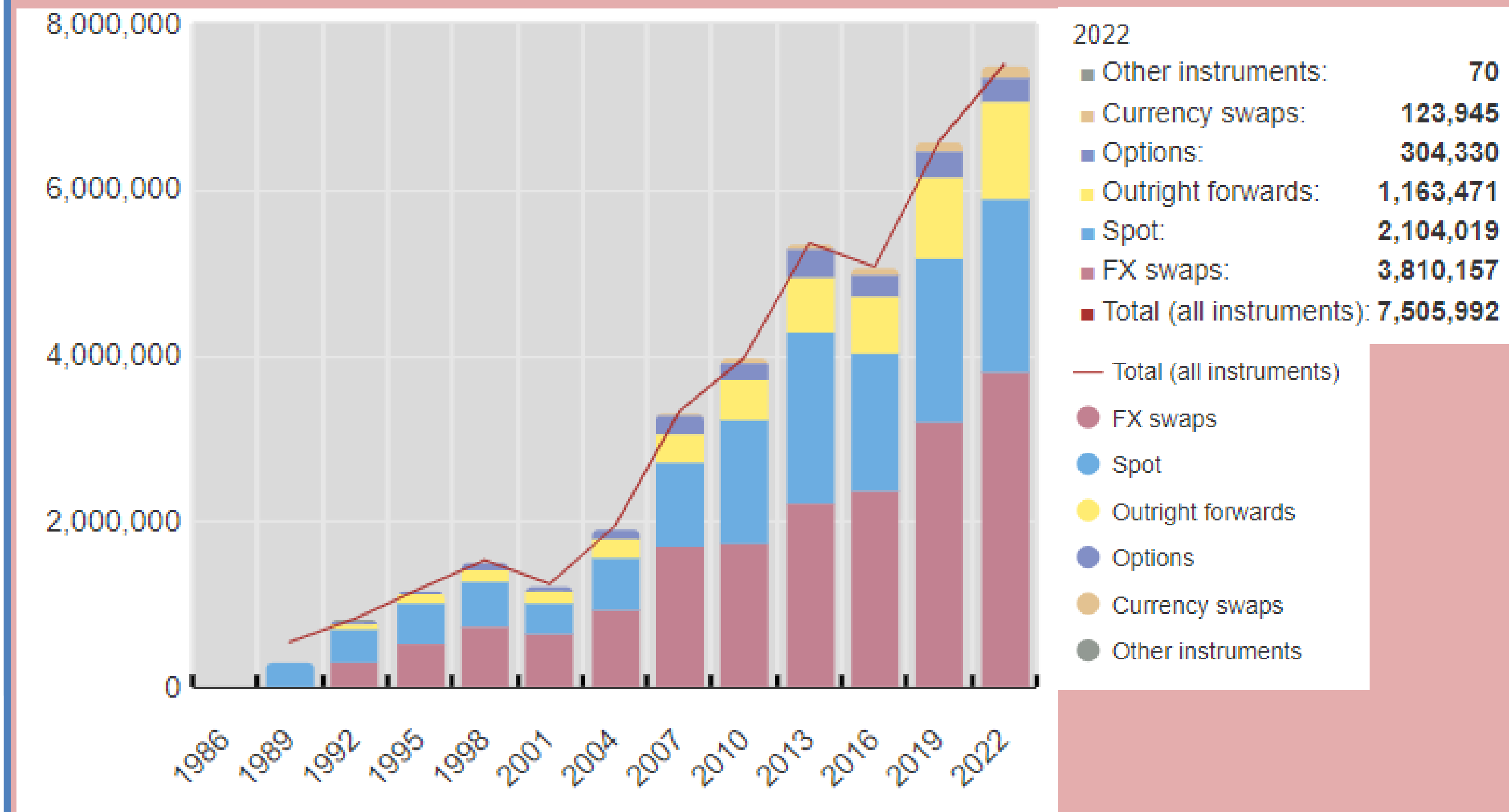


Source: https://www.bis.org/statistics/rpfx22.htm

Size of the Market

FIGURE 2-8 **Global foreign exchange market turnover**

Net-net basis; Daily averages, in millions of US dollars



The Spot Contract

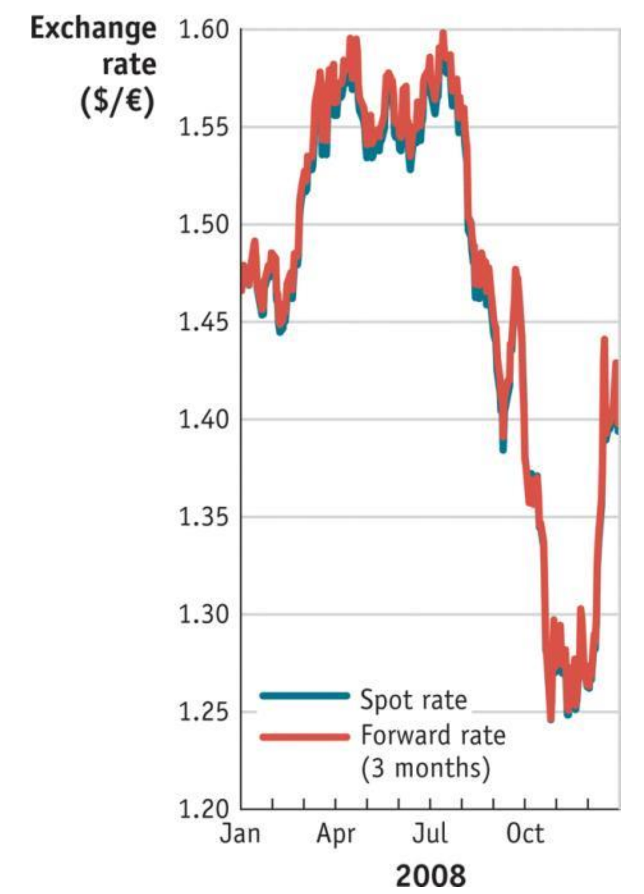
- The simplest forex transaction is a contract for the immediate exchange ("on the spot") of one currency for another between two parties. This is known as a **spot contract**.
- The exchange rate for this transaction is referred to as the **spot exchange rate**.
- The use of the term "exchange rate" always refers to the spot rate for our purposes, unless otherwise noted.
- The spot contract is the most common type of trade and appears in almost 30% of all forex transactions (in 2019).

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Derivatives

- In addition to the spot contracts other forex contracts include **forwards, swaps, futures**, and **options.**
- Collectively, all these related forex contracts are termed **derivatives.**
- The spot and forward rates closely track each other.

FIGURE 2-9



© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

APPLICATION

Foreign Exchange Derivatives

Forwards

A forward contract differs from a spot contract in that the two parties make the contract today, but the *settlement date* for the delivery of the currencies is in the future, or forward. The time to delivery, or *maturity*, varies. However, because the price is fixed as of today, the contract carries no **risk**.

Swaps

A swap contract combines a spot sale of foreign currency with a forward repurchase of the same currency. This is a common contract for counterparties dealing in the same currency pair over and over again. Combining two transactions reduces **transactions costs**.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

APPLICATION

Foreign Exchange Derivatives

Futures

A futures contract is a promise that the two parties holding the contract will deliver currencies to each other at some future date at a prespecified exchange rate, just like a forward contract. Unlike the forward contract, futures contracts are standardized, mature at certain regular dates, and can be traded on an organized futures exchange.

Options

An option provides one party, the buyer, with **the right to buy** (*call*) **or sell** (*put*) a currency in exchange for another at a prespecified exchange rate at a future date. The buyer is under no obligation to trade and will not exercise the option if the spot price on the expiration date turns out to be more favorable.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Private Actors

- Most forex traders work for **commercial banks.** About 75% of all forex transactions globally are handled by just 10 banks.
- The exchange rates for these trades underlie quoted market exchange rates.
- Some corporations may trade in the market if they are engaged in extensive transactions in foreign markets.

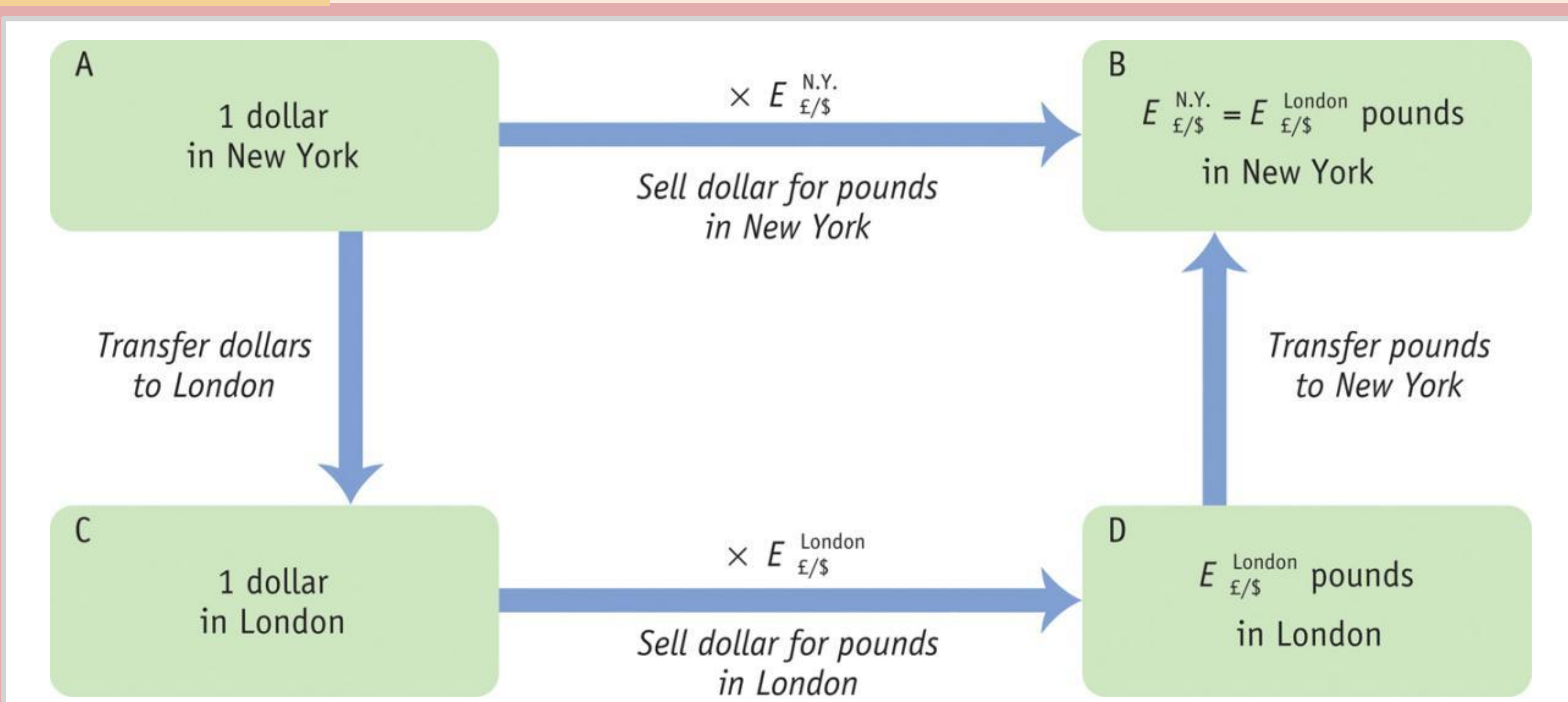
Government Actions

- Some governments engage in policies that restrict trading, movement of forex, or cross-border financial transactions. These are called a form of **capital control.**
- In line with capital controls, the central bank must stand ready to buy or sell its own currency to maintain a fixed exchange rate.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

4 Arbitrage and Spot Exchange Rates

FIGURE 2-10



Arbitrage and Spot Rates Arbitrage ensures that the trade of currencies in New York along the path AB occurs at the same exchange rate as via London along path ACDB. At B the pounds received must be the same, regardless of the route taken to get to B:

$$E_{£/\$}^{N.Y.} = E_{£/\$}^{London}$$

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Arbitrage with Three Currencies

In general, three outcomes are again possible.

1. The direct trade from dollars to pounds has a better rate:
   $E_{£/\$} > E_{£/€}\, E_{€/\$}$

2. The indirect trade has a better rate: $E_{£/\$} < E_{£/€}\, E_{€/\$}$

3. The two trades have the same rate and yield the same result:
   $E_{£/\$} = E_{£/€}\, E_{€/\$}$. Only in the last case are there no profit opportunities.
   This is the **no-arbitrage condition**:

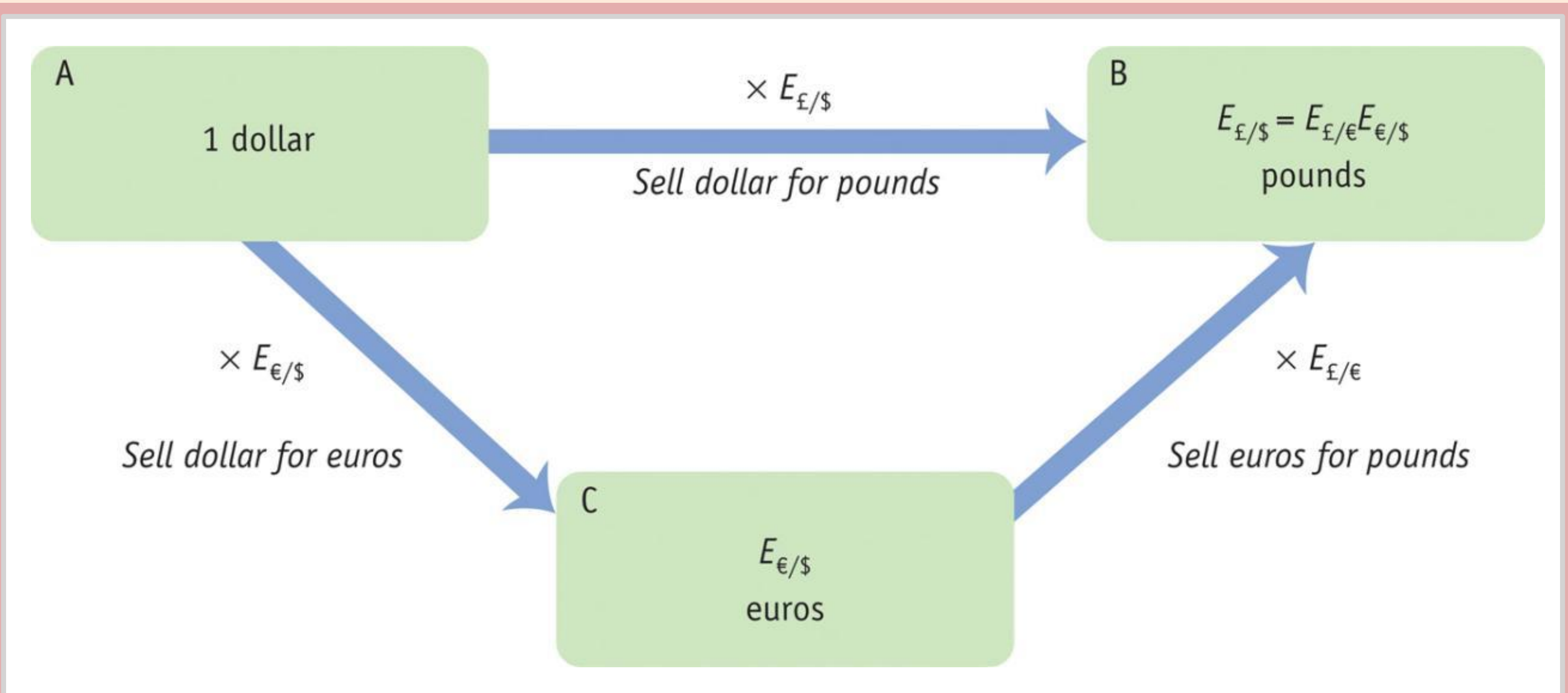
$$\underbrace{E_{£/\$}}_{\substack{\text{Direct}\\ \text{exchange rate}}} = E_{£/€}\, E_{€/\$} = \underbrace{\frac{E_{£/€}}{E_{\$/€}}}_{\text{Cross rate}}$$

The right-hand expression, a ratio of two exchange rates, is called a **cross rate**.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

4 Arbitrage and Spot Exchange Rates

FIGURE 2-11



Arbitrage and Cross Rates Triangular arbitrage ensures that the direct trade of currencies along the path AB occurs at the same exchange rate as via a third currency along path ACB. The pounds received at B must be the same on both paths:

$$E_{£/\$} = E_{£/€}\, E_{€/\$}$$

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

4 Arbitrage and Spot Exchange Rates

Bid/Ask Spread of Banks

- Commercial banks charge fees for conducting foreign exchange transactions;
- There is price differences: a bank's **bid price** (buy quote) for a foreign currency will always be less than its **ask price** (sell quote). T
- The difference between the bid and ask prices is known as the bid/ask **spread**
- A larger bid/ ask spread generates more revenue for commercial banks but represents a higher cost to individuals or MNCs that engage in foreign exchange transactions.
- The bid/ask spread is normally expressed as a percentage of the ask quote.

$$\text{Bid/ask spread} = \frac{\text{Ask rate} - \text{Bid rate}}{\text{Ask rate}}$$

Example: Let us assume you have \$1,000 and plan to travel from the United States to the United Kingdom. Assume further that the bank's bid rate for the British pound is \$1.52 and its ask rate is \$1.60. Before leaving on your trip, you go to this bank to exchange dollars for pounds. Your \$1,000 will be converted to 625 pounds (£), as follows:

$$\frac{\text{Amount of \$ to be converted}}{\text{Price charged by bank £}} = \frac{\$1{,}000}{\$1.60} = £625$$

Now suppose that an emergency prevents you from taking the trip and so you now want to convert the £625 back into U.S. dollars. If the exchange rate has not changed, then you will receive only

£625=(Bank's bid rate of \$1.52/£) = \$950

Because of the bid/ask spread, you have \$50 (**5 percent**) less than when you started. Of course, the dolar amount of your loss would be greater if you had originally converted more than \$1,000 into pounds.

4 Arbitrage and Spot Exchange Rates

Bid/Ask Spread of Banks

- Interbank FX traders buy currency for inventory at the **bid price**
- sell from inventory at the higher **offer** or **ask price**

The following table summarizes the reciprocal relationship between American and European bid and ask quotations.

	BID	ASK
$E_{£/\$}$	1.52	1.60
$E_{\$/£}$	0.65	0,63

Factors That Affect the Spread

The spread on currency quotations is influenced by the following factors:

Spread=f(	**Order costs,**	**Inventory costs,**	**Competitions**	**Volume**	**Currency risk)**
	+	+	-	-	+

Cross Rates and Vehicle Currencies

- The majority of the world's currencies trade directly with only one or four of the major currencies, such as the dollar, euro, yen, or pound.
- Many countries do a lot of business in major currencies such as the U.S. dollar, so individuals always have the option to engage in a triangular trade at the cross rate.
- When a third currency, such as the U.S. dollar, is used in these transactions, it is called a **vehicle currency** because it is not the home currency of either of the parties involved in the trade and is just used for intermediation.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

5 Arbitrage and Interest Rates

An important question for investors is in which currency they should hold their liquid cash balances.

- Would selling euro deposits and buying dollar deposits make a profit for a banker?
- These decisions drive demand for dollars versus euros and the exchange rate between the two currencies.

The Problem of Risk

A trader in New York cares about returns in U.S. dollars. A dollar deposit pays a known return, in dollars. But a euro deposit pays a return in euros, and one year from now we cannot know for sure what the dollar–euro exchange rate will be.

- *Riskless arbitrage* and *risky arbitrage* lead to two important implications, called *parity conditions*.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Riskless Arbitrage: Covered Interest Parity

Contracts to exchange euros for dollars in one year's time carry an exchange rate of $F_{\$/€}$ dollars per euro. This is known as the **forward exchange rate**.

- If you invest in a dollar deposit, your \$1 placed in a U.S. bank account will be worth $(1 + i_\$)$ dollars in one year's time. The dollar value of principal and interest for the U.S. dollar bank deposit is called the *dollar return.*

- If you invest in a euro deposit, you first need to convert the dollar to euros. Using the spot exchange rate, \$1 buys $1/E_{\$/€}$ euros today.

- These $1/E_{\$/€}$ euros would be placed in a euro account earning $i_€$, so in a year's time they would be worth $(1 + i_€)/E_{\$/€}$ euros.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Riskless Arbitrage: Covered Interest Parity / covered interest arbitrage

To avoid that risk, you engage in a forward contract today to make the future transaction at a forward rate $F_{\$/€}$.

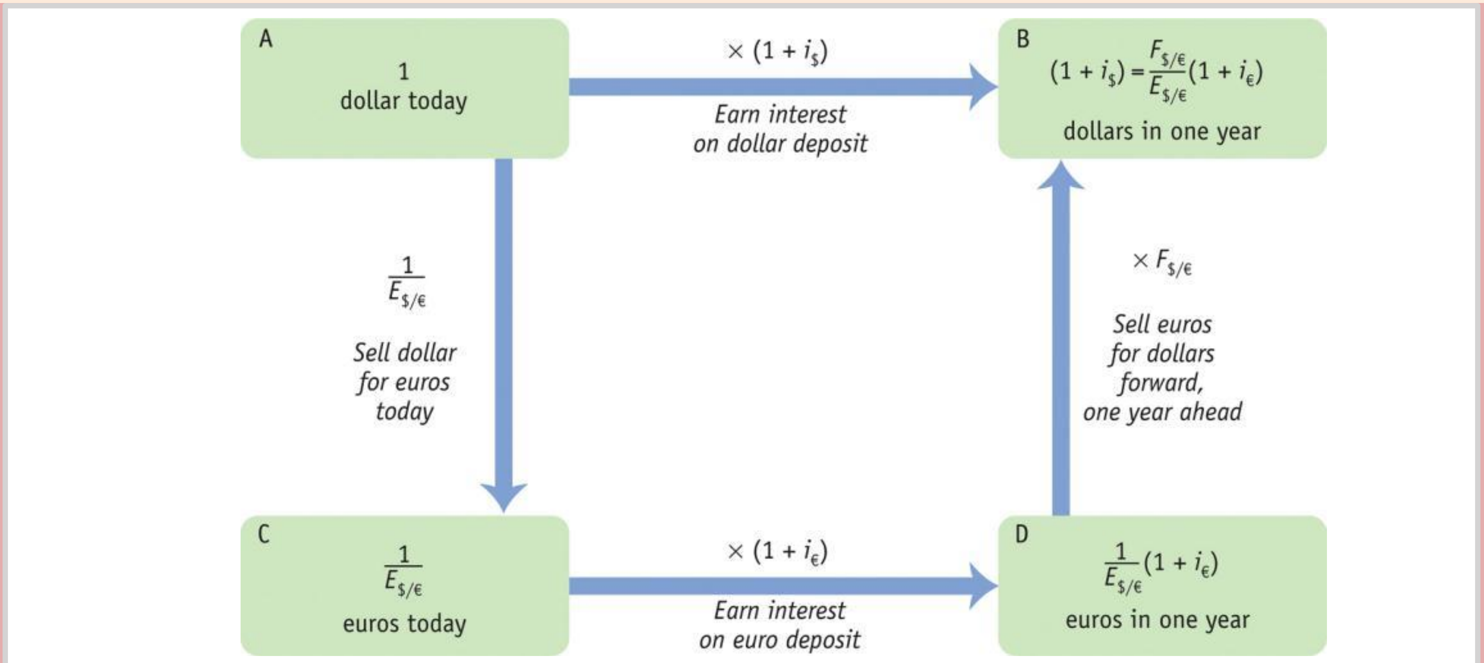
- The $(1 + i_€)/E_{\$/€}$ euros you will have in one year's time can then be exchanged for $(1 + i_€)F_{\$/€}/E_{\$/€}$ dollars, or the dollar return on the euro bank deposit.

$$\underbrace{(1+i_\$)}_{\text{Dollar return on dollar deposits}} = \underbrace{(1+i_€)\frac{F_{\$/€}}{E_{\$/€}}}_{\text{Dollar return on euro deposits}} \cong \left[\frac{F_{\$/€}-E_{\$/€}}{E_{\$/€}}\right]$$

- This is called **covered interest parity (CIP/CIA)** because all exchange rate risk on the euro side has been "covered" by use of the forward contract.

5 Arbitrage and Interest Rates

FIGURE 2-12



Arbitrage and Covered Interest Parity Under CIP, returns to holding dollar deposits accruing interest going along the path AB must equal the returns from investing in euros going along the path ACDB with risk removed by use of a forward contract. Hence, at B, the riskless payoff must be the same on both paths:

$$(1 + i_\$) = \frac{F_{\$/€}}{E_{\$/€}}(1 + i_€)$$

EXAPLE: **Covered Interest Parity / covered interest arbitrage**

- Suppose that the annual interest rate ($i_{\$}$) is 5 percent in the United States and 8 percent in the EU. ($i_{€}$), and that the spot exchange rate ($E_{\$/€}$) is \$1.80/ € and the forward exchange rate ($F_{\$/€}$), with one-year maturity, is \$1.78/ €.
- Assume that the arbitrager can borrow up to \$1,000,000 or € 555,556, which is equivalent to \$1,000,000 at the current spot exchange rate.

Check if IRP is holding:

$$(1+i_{€})\frac{F_{\$/€}}{E_{\$/€}} = \left[\frac{1.78_{\$/€}}{1.80_{\$/€}}\right](1.08)=1.068$$

- which is not exactly equal to $(1+i_{€})$ = 1.05

$$(1+i_{\$}) < (1+i_{€})\frac{F_{\$/€}}{E_{\$/€}}$$

Clearly, IRP is not holding => implying that a profitdable arbitrage opportunity exists. Since the interest rate is lower in the United States than in the EU after adjusting for the exchange rates (F/S), an arbitrage transaction should involve borrowing in the United States and lending in the EU

EXAPLE: Covered Interest Parity / covered interest arbitrage

The arbitrager can carry out the following transactions:

1. In the United States, borrow \$1,000,000. Repayment in one year will be \$1,050,000 = \$1,000,000 * 1.05.
2. Buy € 555,556 spot using \$1,000,000.
3. Invest £555,556 in the EU. The maturity value will be € 600,000= € 555,556 * 1.08.
4. Sell € 600,000 forward in exchange for \$1,068,000 5 (€ 600,000)(\$1.78/£).

The arbitrager then will deliver this EURO amount to the counterparty of the forward contract and receive \$1,068,000 in return. Out of this dollar amount, the maturity value of the dollar loan, \$1,050,000, will be paid. The arbitrager still has \$18,000 =(\$1,068,000 - \$1,050,000)

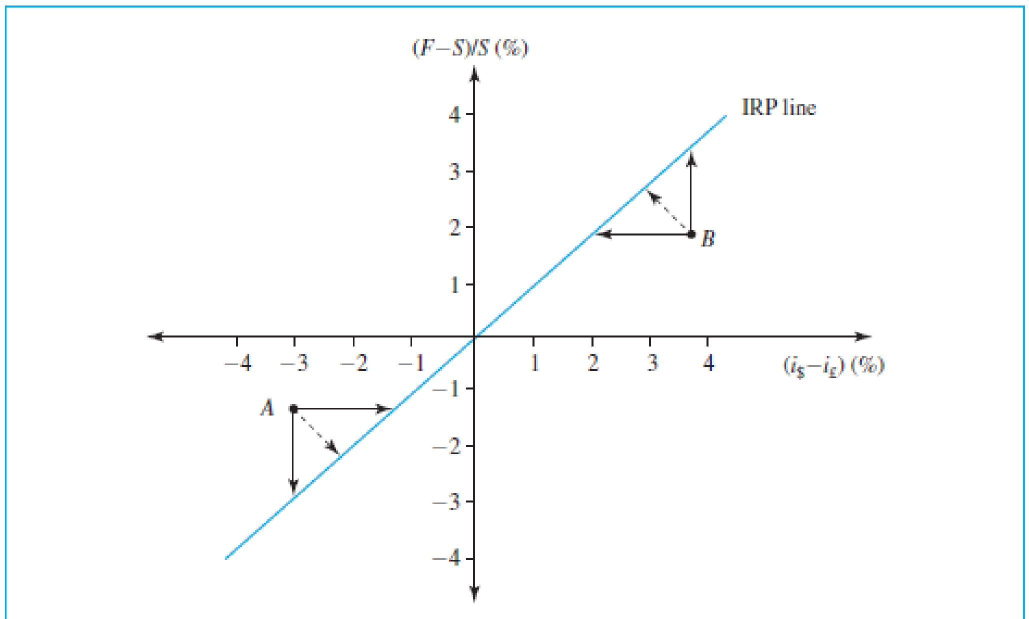
5 Arbitrage and Interest Rates

FIGURE 2-13 **EXAPLE:** **Covered Interest Parity / covered interest**

Covered Interest Arbitrage: Cash Flow Analysis

Transactions	CF_0	CF_1
1. Borrow \$1,000,000	\$1,000,000	−\$1,050,000
2. Buy £ spot	−\$1,000,000 £555,556	
3. Lend £555,556	−£555,556	£600,000
4. Sell £600,000 forward		−£600,000 \$1,068,000
Net cash flow	0	\$18,000

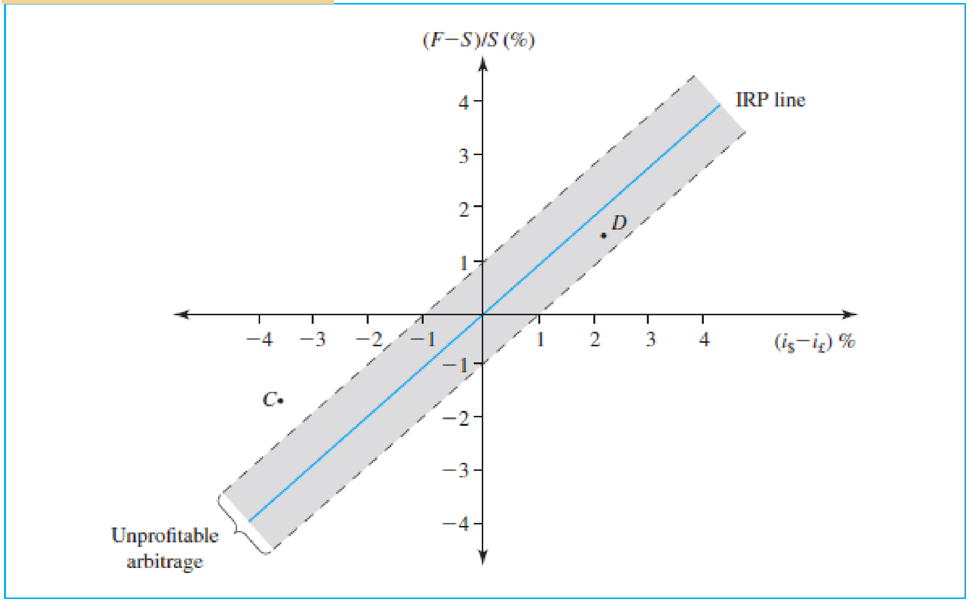
Interest rate parity diagram



Risky Arbitrage: Uncovered Interest Parity

- In our previous examples of CIP(CIA) transactions, we implicitly assumed, among other things, that no transaction costs existed.
- In reality, transaction costs do exist. The interest rate at which the arbitrager borrows,
- i_a , tends to be higher than the rate at which he lends, i_b , reflecting the bid-ask spread.
- Because of spreads, arbitrage profit from each dollar borrowed may become nonpositive: $\left(\frac{F^b}{S^a}\right)(1 + i_€^b) - (1 + i_\$^b) \leq 0$

FIGURE 2-14



APPLICATION

Evidence on Covered Interests Parity

FIGURE 2-15 (1 of 3) Financial Liberalization and Covered Interest Parity

Financial Liberalization and Covered Interest Parity: Arbitrage Between the United Kingdom and Germany The chart shows the difference in monthly pound returns on deposits in British pounds and German marks using forward cover from 1970 to 1995. In the 1970s, the difference was positive and often large: Traders would have profited from arbitrage by moving money from pound deposits to mark deposits, but capital controls prevented them from freely doing so.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

APPLICATION

Evidence on Covered Interest Parity

FIGURE 2-15 (2 of 3) Financial Liberalization and Covered Interest Parity (continued)

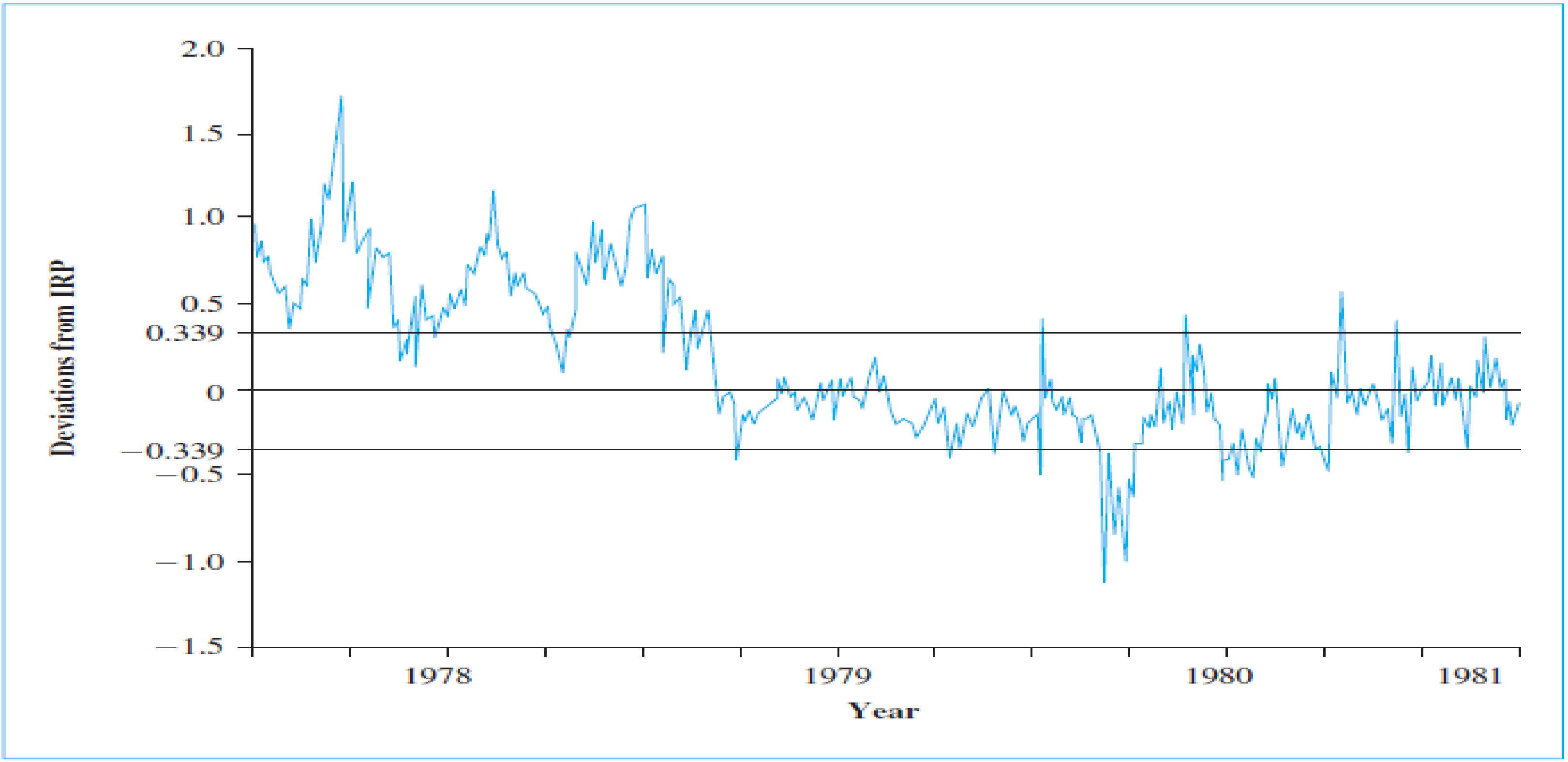
After financial liberalization, these profits essentially vanished, and no arbitrage opportunities remained. The CIP condition held, aside from small deviations resulting from transactions costs and measurement errors.

© 2017 Worth Publishers International
Economics, 4e | Feenstra/Taylor

APPLICATION

Evidence on Covered Interest Parity

FIGURE 2-15 (3 of 3) Deviations from Interest Rate arity: Japan, 1978–81 (in percent)

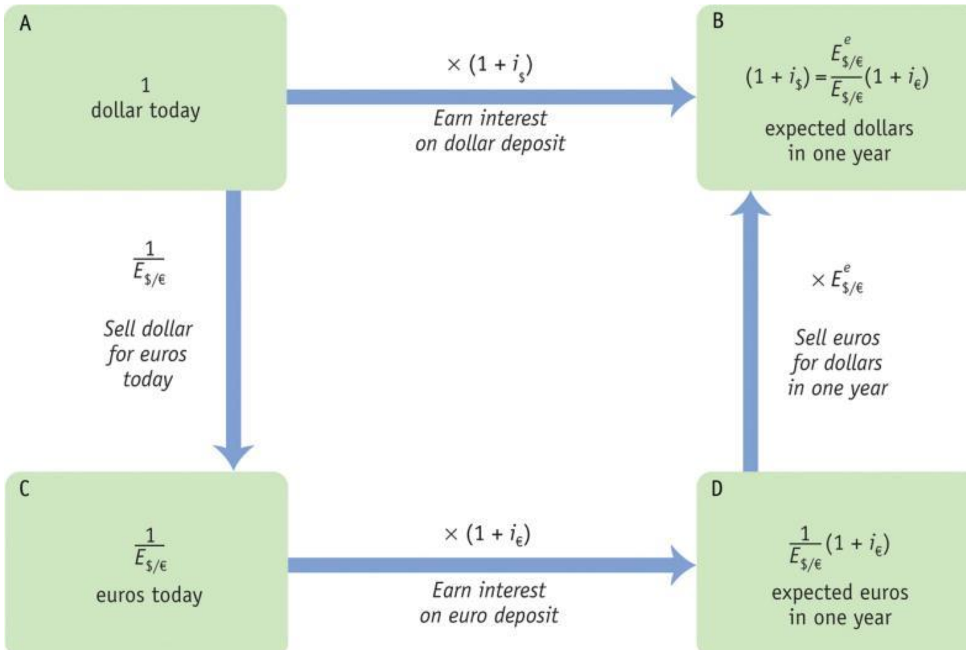


Note: Daily data were used in computing the deviations. The zone bounded by +0.339 and −0.339 represents the average width of the band around the IRP for the sample period.

Source: I. Otani and S. Tiwari, "Capital Controls and Interest Rate Parity: The Japanese Experience, 1978–81" *IMF Staff Papers* 28 (1981), pp. 793–816.

5 Arbitrage and Interest Rates

FIGURE 2-16



Arbitrage and Uncovered Interest Parity Under CIP, returns to holding dollar deposits accruing interest going along the path AB must equal returns from investing in euros going along the risky path ACDB. Hence, at B, the expected payoff must be the same on both paths:

$$(1 + i_{\$}) = \frac{E^{e}_{\$/€}}{E_{\$/€}}(1 + i_{€})$$

Risky Arbitrage : Uncovered Interest Parity

What Determines the Spot Rate?

- Uncovered interest parity is a no-arbitrage condition that describes an equilibrium in which investors are indifferent between the returns on unhedged interest-bearing bank deposits in two currencies.

- We can rearrange the terms in the uncovered interest parity expression to solve for the spot rate:

$$E_{\$/€} = E^{e}_{\$/€}\frac{1+i_{€}}{1+i_{\$}} \Rightarrow E^{e}_{\$/€} = E_{\$/€}\frac{1+i_{\$}}{1+i_{€}}$$

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Assets and Their Attributes

- An investor's entire portfolio of assets may include stocks, bonds, real estate, art, bank deposits in various currencies, and so on. All assets have three key attributes that influence demand: return, risk, and **liquidity**.
- An asset's **rate of return** is the total net increase in wealth resulting from holding the asset for a specified period of time, typically one year.
- The risk of an asset refers to the volatility of its rate of return.
- The liquidity of an asset refers to the ease and speed with which it can be liquidated, or sold.
- We refer to the forecast of the rate of return as the **expected rate of return**.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

APPLICATION

Evidence on Uncovered Interest Parity

- Dividing UIP by CIP, we obtain:

$$1 = E^e_{\$/€}/F_{\$/€} \quad \text{, or} \quad E^e_{\$/€} = F_{\$/€}$$

- Although the *expected future spot rate* and the *forward rate* are used in two different forms of arbitrage—risky and riskless, in equilibrium they should be exactly the same!

- If both covered interest parity and uncovered interest parity hold, the forward must equal the expected future spot rate.

- Risk-neutral investors have no reason to prefer to avoid risk by using the forward rate versus embracing risk by awaiting the future spot rate.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

APPLICATION

Evidence on Uncovered Interest Parity

- If the forward rate equals the expected spot rate, the **expected rate of depreciation** equals the **forward premium** (the proportional difference between the forward and spot rates):

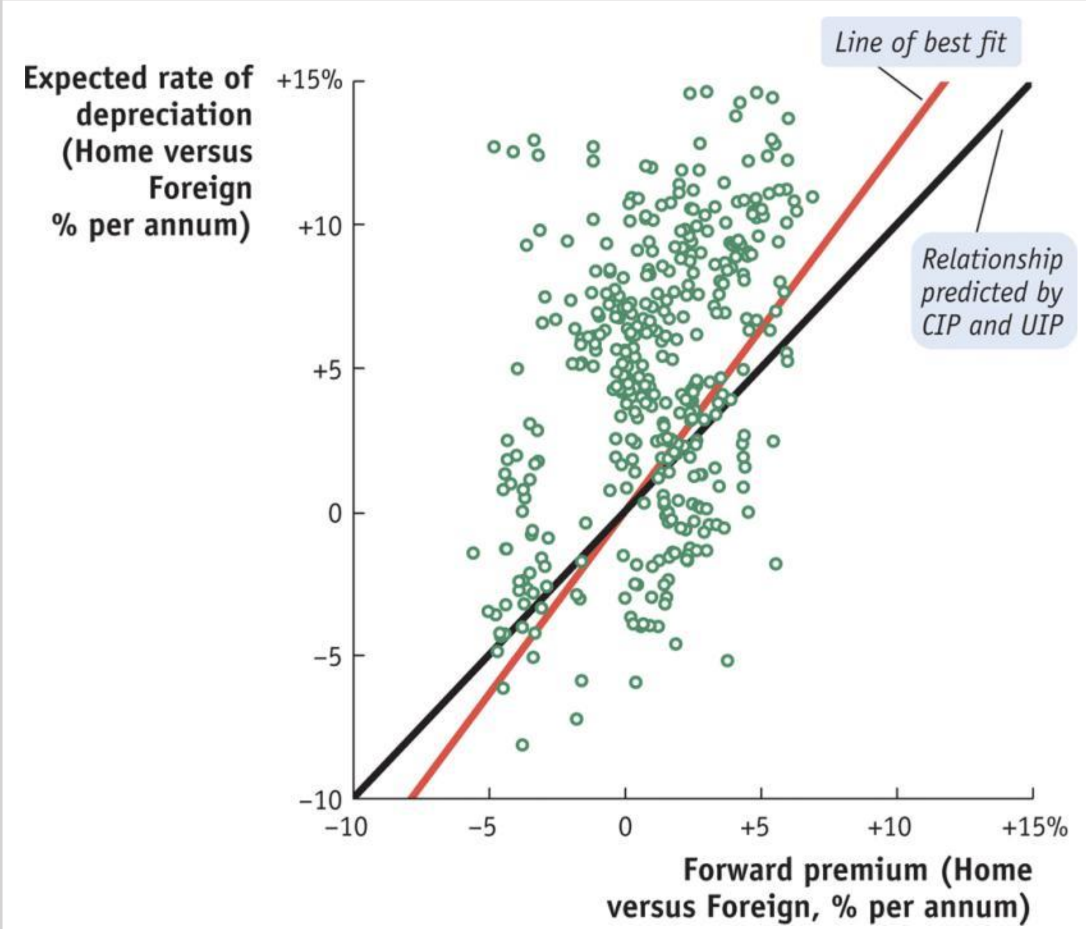
$$\underbrace{\frac{F_{\$/€}}{E_{\$/€}} - 1}_{\text{Forward Premium}} = \underbrace{\frac{E^e_{\$/€}}{E_{\$/€}} - 1}_{\text{Expected rate of depreciation}}$$

- A useful scale-free expression independent of currency, both sides typically measured in percent per year.
- While the left-hand side is easily observed, the expectations on the right-hand side are typically unobserved.

APPLICATION

Evidence on Uncovered Interest Parity

FIGURE 2-17



Evidence on Interest Parity

When UIP and CIP hold, the 12-month forward premium should equal the 12-month expected rate of depreciation. A scatterplot showing these two variables should be close to the diagonal 45-degree line.

Using evidence from surveys of individual forex traders' expectations over the period 1988 to 1993, UIP finds some support, as the line of best fit is close to the diagonal.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Uncovered Interest Parity: A Useful Approximation

$$\underbrace{i_\$}_{\substack{\text{Interest rate} \\ \text{on dollar deposits} \\ = \\ \text{Dollar rate of return} \\ \text{on dollar deposits}}} = \underbrace{\underbrace{i_€}_{\substack{\text{Interest rate} \\ \text{on euro deposits}}} + \underbrace{\frac{\Delta E^e_{\$/€}}{E_{\$/€}}}_{\substack{\text{Expected rate of depreciation} \\ \text{of the dollar}}}}_{\substack{\text{Expected dollar rate of return} \\ \text{on euro deposits}}}$$

- This approximate equation for UIP says that the home interest rate equals the foreign interest rate plus the expected rate of depreciation of the home currency.

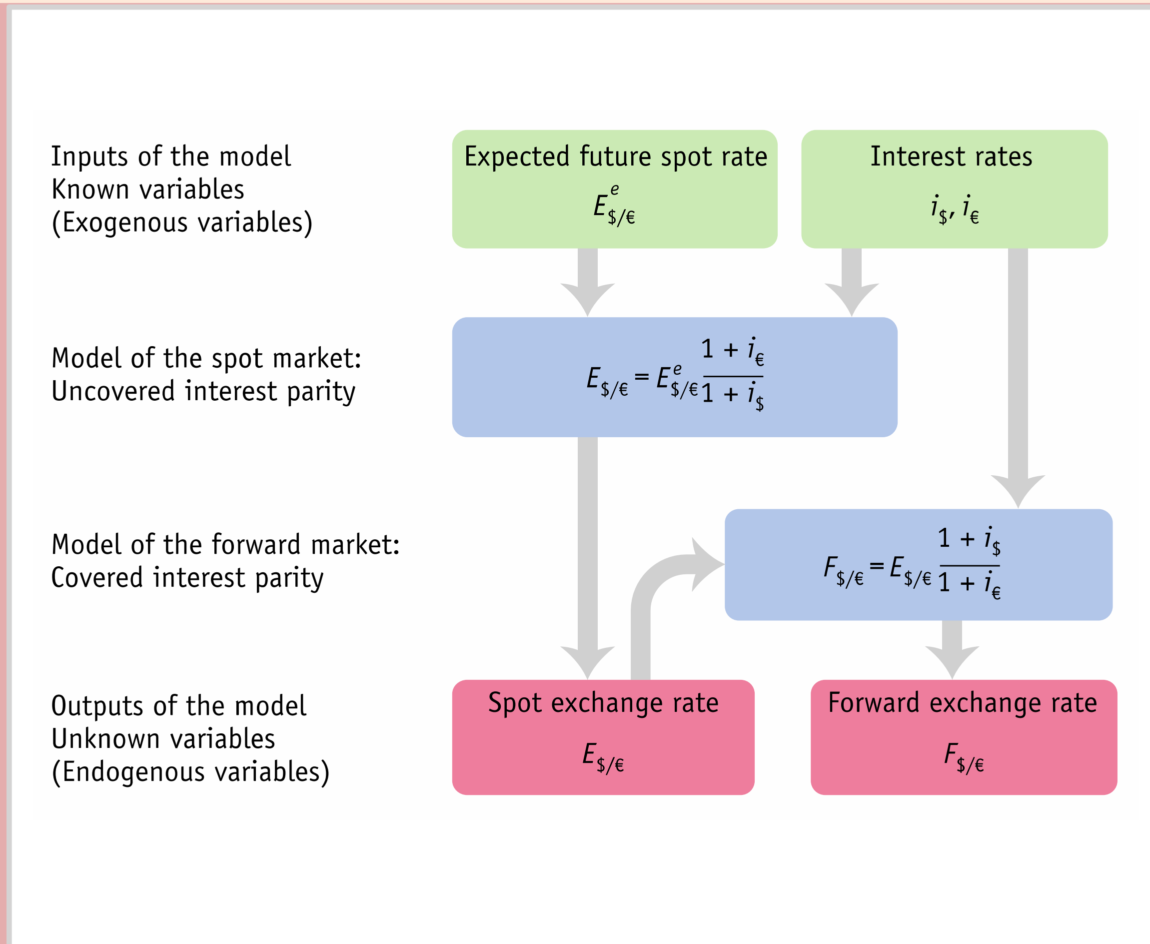
- Suppose the dollar interest rate is 4% per year and the euro 3%. If UIP is to hold, the expected rate of dollar depreciation over a year must be 1%. The total dollar return on the euro deposit is approximately equal to the 4% that is offered by dollar deposits.

© 2017 Worth Publishers International Economics, 4e | Feenstra/Taylor

Summary

FIGURE 2-18

How Interest Parity Relationships Explain Spot and Forward Rates In the spot market, UIP provides a model of how the spot exchange rate is determined. To use UIP to find the spot rate, we need to know the expected future spot rate and the prevailing interest rates for the two currencies. In the forward market, CIP provides a model of how the forward exchange rate is determined. When we use CIP, we derive the forward rate from the current spot rate (from UIP) and the interest rates for the two currencies.



Thank You for your attention!