According to a list maintained by the scientific International Organization for Standardization (ISO), as of January 1, 2014, there were approximately 250 currencies in the world being traded for goods and services and financial transactions. Many have names that you would recognize, such as the United States Dollar, the Canadian Dollar, the Euro (a transnational currency used by some but not all of the member nations of the European Union, plus five nations that do not belong to the European Union), the Mexican Peso, the Japanese Yen, and the Swiss Franc, and the Chinese Yuan (also called the Renminbi). But there are also many that you may never have heard of (unless you have been a recent visitor), such as the Azerbaijani Manat, the Moldovan Leu, or the Peruvian Nuevo Sol.

These currencies are all exchanged - that is, traded with each other - in the huge, global, decentralized foreign exchange market, which is explained in detail in this chapter. Let's explore that market.

1. What are exchange rates?

In a world where there are many national and regional currencies, such as those named above plus the other 250 currencies (more or less) on the ISO 4217 list, exchange rates define the rate or ratio of which one of these currencies can be exchanged for any other at any given point in time. For example, a quotation of the exchange rate of the Euro to the U.S. Dollar might tell us that the exchange rate is 1.35, which implies that a single Euro can be exchanged for $1.35. Anyone with any experience trading exchange rates knows that ratio is only temporary, at least for major currencies, because these rates are market-determined in what is the largest financial market in the world, as measured by the value of daily transactions. As will be explained below, supply and demand forces cause these exchange rates to fluctuate endlessly.

Normally the ratio is expressed as the price in one currency of one unit of the other currency, such as the example above, where it was stated that one Euro is worth 1.35 U.S. Dollars. In the finance markets quotations usually price other currencies in U.S. Dollars (hereafter only the term Dollars will be used in reference to U.S. Dollars whereas the full name will be used for other currencies with the same name, such as the Canadian Dollar).

The world's seven most actively traded currencies are called majors, and the value of the other six relative to the Dollar is shown for the time indicated in Figure 1 - Exchange Rates of the Majors. The left column shows the cost of one unit of the currency in question in Dollars. As can be seen, the currencies are typically quoted in four decimal points, although the Japanese Yen is quoted in six decimal points, as shown (because a single Yen is worth so little in Dollars).

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1 Approximately? There are a number of borderline cases that make an exact tally difficult. For example, Cuba uses the Cuban Peso, but should one also count their special convertible currency, the Peso Convertible, which has very restricted circulation? Also some smaller countries use the currencies of larger countries, like Panama, which technically uses a currency called the Balboa, but you will never see one while in Panama, because they also use the U.S. Dollar. The International Organization for Standardization (ISO) maintains the ISO 4217, which is a list of currency codes and, when they exist, their special symbols. See http://www.iso.org/iso/home/standards/currency_codes.htm
Obviously a ratio can be expressed from either perspective, so the right column, which is simply the inverse of the left column, tells you the price of a single Dollar in terms of the other currency. The Yen quotation is easier to read, grasp and remember when it is a value like 95.364 or 100.13 (as opposed to 0.009432) so the media can be rather arbitrary when reporting the exchange rate - sometimes it is the Dollar price of another currency (like the Euro in the left column) or the other way around (like the Yen in the right column). Therefore to help alleviate confusion, unless otherwise clearly indicated, the convention used in this chapter will be the same as that used by the finance markets - the quotation will be the Dollar value of a single unit of some other currency (like the left column above). It should be noted that when this convention is used in the finance markets, the exchange rate symbol will list the Dollar second. For example, the symbol EUR/USD (also shown using ISO currency symbols €/$) and JPY/USD (also shown as ¥/$) refers to the Dollar price of the Euro and Yen respectively, the values on the left column of Figure 1. Just to be clear and avoid confusion below, the inverse value of the Yen - the number closer to 100, would be referred to as USD/JPY or $/¥.

In today's global economy nearly all exchange rates for major currencies are floating exchange rates, which implies that the ratio is fluid and determined by supply and demand forces in the huge global market for currencies. This has not always been true. Floating exchange rates are a relatively modern phenomenon. Prior to World War II governments used a chaotic system to determine exchange rates. Each major country would define the relative value of their currency in the price of gold. For example, when Sir Isaac Newton was master of the mint of the United Kingdom in 1717, he set the price of gold at 77sh (shillings) 10½d (pence) per troy ounce, a value that effectively held for four centuries. All other countries set their price of gold accordingly, which then effectively linked their exchange rates to the British Pound. By 1925 this gold-pricing arrangement had effectively linked the Pound to the Dollar at an exchange rate of £1 = $4.86. At that time the Dollar price of gold equaled $20.67 per troy ounce. During the Great Depression President Roosevelt raised this value by proclamation to $35 per ounce, where it remained until 1972.

This system was almost doomed from its inception because fluctuations in trade and financial flows plus the relentless aggressive assault of speculators made it difficult for central banks to intervene on a scale large enough to maintain stable exchange rates. Fixing the Dollar and hence everything else to gold didn't help either. Gold is an industrial commodity with fluctuations in production, inventory, and non-monetary usage (like jewelry and electronics), so with a fixed price there were bound to be chronic surpluses and shortages of this precious commodity, which insures the presence of a robust black market, which in turn always undermines the "official" price of anything.

By 1971 the world's leaders concluded that the regime of fixed exchange rates was done, and in August of that year the United States suspended convertibility of the Dollar to gold, then devalued the Dollar to gold at $38 an ounce in May, 1972, then again to $42.22 in 1973. Finally on New Year's day 1975 all restrictions on gold trading were lifted and all

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2 The interested student can read a fascinating history of this troubled period in "The Battle of Bretton Woods: John Maynard Keynes, Harry Dexter White, and the Making of a New World Order," by Benn Steil, 2013, Princeton University Press.

3 This problem - why fixed exchange rates cannot work over time - is explained in more detail in the modeling portion of this chapter.

4 Your teacher was stationed in the Republic of Panama in the late 1960s when the price of gold was still fixed at $35 per ounce and buying gold directly for speculation was illegal. But one could go to a Panamanian "jewelry" trader and buy a little ingot of exactly one ounce of gold, nestled into a tiny black balsawood coffin, for about $60 per ounce if my memory serves me right. You could buy as many coffins as you wanted - after all, they were jewelry.
world currencies were delinked from gold and effectively from each other, clearly the way for the modern era of floating exchange rates.\footnote{A good chronology of the role of gold (from 1717) is published by the World Gold Council at \url{https://www.gold.org/government_affairs/gold_as_a_monetary_asset/additional_information/chronology/}}

The impact of the transition can hardly be overstated. Refer to Figure 2 - The £/$ Exchange Rate 1945-2013 copied from the miktodd.net research site to see the difference between the period prior to 1971 (the Bretton Woods era) and the modern era.

But not all exchange rates today are freely floating. Many of the currencies of small countries are linked to a major currency, typically the Dollar. And there is still one currency for a major trading country, the People's Republic of China, that uses a managed exchange rate. The Chinese government does not let the Chinese Yuan, also called the Renminbi, float free. Instead the government sets and resets the exchange rate formally, basically a fixed exchange rate that is re-fixed frequently. This unusual arrangement is discussed more later in this chapter.

2. Examples of exchange rate movement.

It should be obvious about why exchange rates matter in the world of economics and finance. In a the modern era of global trade, when in the United States we drive cars made in Japan or Canada (or both!), watch televisions made in South Korea, wear shoes made in China and drink French wine, intuition tells us that exchange rates are going to have a major impact upon the prices we pay for our imports and what we can earn for our exports.

Consider the example of a South Korean television made by Samsung. Samsung's employees must be paid in their domestic currency, the Won (symbol KRW or ₩), which in early 2014 had an exchange rate of slightly more than 1,000 Won to the Dollar \([\text{KRW/USD} = \text{₩/}$ = 0.000950]\). Samsung's auto dealers in Southern California will be paid in Dollars, so somewhere along the line those Dollars must be converted to Won so the South Korean workers can be paid and Samsung can cover its other domestic expenses. This conversion will typically be done through a bank.

So what is a Samsung television worth in Won? The popular electronics site Newegg listed a Samsung model 50" 1080p 120Hz 3D LED TV (model UN50F6400AFXZA) television for the retail price of $1,097.99 on January 3, 2014. On that same day the Won exchange rate was that shown above, 0.000950, which inverts to 1052.63. Therefore that television was worth ₩1,155,779. But earlier in the year, around June, the same exchange rate was only 0.00086, which inverts to 1162.79, which would make the same television worth ₩1,276,732. From the perspective of Samsung, the television at a given Dollar price was generating less revenue later in the year, which leaves Samsung with less cash to pay expenses or forces them to raise the Dollar price of their products in the United States in a very competitive market. And Samsung's hard choice had nothing to do with manufacturing costs or engineering and labor costs or the demand by Americans for electronics.

It is very clear that exchange rates matter.
To get a better perspective on this we are going to look at a couple of different exchange rates relative to the Dollar and then relative to each other. From these examples we will learn a very important principle about exchange rates: floating exchange rates must be in complete alignment with each other.

Refer to Figure 3 - €/$ and £/$ Exchange Rates. Although the United Kingdom is part of the European Union, the British government decided that they wanted to maintain their own traditional currency, the Pound (symbol GBP or £). The Euro (symbol EUR or €) was phased into use in the late 1990s for the nations that use the Euro and by January 1, 1999 Eurozone governments had fully converted to the Euro, and by January 1, 2002, the Euro had fully replaced traditional European currencies like the French Franc and the German Mark.6

The original exchange rate for the Euro and the Dollar (€/$) was (probably - sources conflict) $1.19 per Euro.7 You can see in Figure 3 that by the time the other European currencies had been withdrawn from use (January 2002) the Euro was trading for less than a Dollar. Since then, though, the Euro has climbed erratically, rising above $1.50 in 2008, then stabilizing around $1.35 since. This behavior, a rise in the Dollar price of a foreign currency, is referred to as a relative revaluation of that currency and a relative devaluation of the Dollar.8

As has already been made obvious, such systematic currency fluctuations can have a major impact upon international trade. Consider the case of the Euro revaluation shown in Figure 3. It should be clear that this revaluation would put upward pressure on the price of French wine and German automobiles imported into the United States. Consider two examples shown in Figure 4 - Examples of Euro Revaluation Impact. In that example, two exchange rates to the Euro are considered, $1.00 in 2002 and $1.50 in 2008. Then we identify two products being imported from Europe, and Audi auto that might sell in Europe for around €30,000 before taxes, and a €25 bottle of French wine. For those two we show their Dollar import prices for the two years in question.9 Both the Dollar cost of the Audi and the bottle of French wine rise by 50% because the Dollar devalued by that amount. In the right-hand columns we see two possible examples of U.S. - made exports, a John Deere lawn tractor selling for $4,000 domestically and a bottle of California wine selling for $25. In those examples the Euro prices plunge by 33%, again because of the same Dollar devaluation / Euro revaluation.

From this example, the following axiom should be very clear:

A domestic currency devaluation has a tendency to raise the prices of exported products and lower the prices of imported products, thus generally discouraging exports and encouraging imports.

In the example provided, it is the U.S. currency that had this status, so this would have helped the U.S. economy somewhat and hindered the Eurozone economy.

A complete reversal of the axiom above applies, of course, to a revalued currency, which in this case is the Euro.

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6 Your teacher worked in Cannes, France in summer 1998 and 1999 and remembers that stores priced goods in both the Euro and the Franc, a rather charming enterprise. The Franc by 2002, but not from his personal collection.
7 This seems to have been the price of the Euro at market close on the first day of trading, on January 5, 1999.
8 Some scholars only use these terms if the currency movement reflects official policy. We won't make such a distinction because our primary concern is the effect of the currency movement, not its cause.
9 That is, imports from the U.S. perspective, which are obviously classified as exports in Europe. These examples assume somewhat unrealistically that there is no domestic inflation in either country over this period - an Audi worth €30,000 in 2002 still costs €30,000 in 2008. But throwing in an inflation assumption would only confuse the example without changing the results unless there was a substantial difference in the two inflation rates, but that was not the case for the United States and the Eurozone between 2002 and 2008.
As stated earlier, not all members of the European Union decided to adopt the Euro, and among those that did not was Great Britain and their Pound. Figure 3 also showed the exchange rate of the British Pound (£/S) over the same period, which was more stable end-to-end than the Euro but revalued considerably between 2001 and 2007, then sharply devalued in 2008 with the Euro and has been stable since 2009.

Now refer to Figure 5, which shows the Dollar/Yen ($/¥) exchange rate. Notice right away that we have reversed the convention of describing a currency in its Dollar value - in this case the figure shows the Yen value of one Dollar, rather than the other way around. The reason for doing this was explained earlier - one Yen is worth so little in Dollar terms that the quote is hard to read or remember. And of course we could map it consistently with the Euro and Pound example by simply inverting the data (dividing one by each observation).

But when it is reversed as shown, then the interpretation of the direction of the exchange rate is also reversed. The general decline (with many short-run exceptions) in the $/¥ exchange rate reflect a Dollar devaluation and a Yen revaluation (which is consistent with the pattern seen in the two European currencies). This Yen revaluation was relentless and substantial between 1985, when the exchange rate was 285, as is stated in Figure 5, to 2007, when it fell below 80.

Consistent with the lesson from Figure 4, this would imply that Japanese exports faced relentless upward pricing pressures in the U.S., whereas U.S. exports to Japan were actually deflationary (fell in absolute prices) over the decades.

That Japan's export industry managed to survive implies that maybe Figure 4 is a little simplistic in what it implies about the impact of exchange upon prices. Japan, in fact, has kept their export market alive by a combination of remedies, including relentless cost-cutting through capable engineering (that would be like reducing the Euro cost of our Audi in Figure 4 through German engineering), absorbing narrower profit margins (making less Yen profit per Dollar) and wisely exporting at least some of their manufacturing to their markets. For example, the Toyota Prius is still largely made in Japan, but the Toyota Corolla, also manufactured in Japan for their domestic market, also has major assembly plants in the United States and Canada and elsewhere in the world.

Nonetheless, the relentless revaluation of the Yen was having a very damaging effect upon the economy after the 2008 global crisis, so the newly-elected government of Prime Minister Shinzo Abe intentionally devalued the Yen in late 2012, ultimately pushing its value up well above 100 (which can be seen as the right-side spike in Figure 5). That story is sufficiently interesting and revealing that it will be told at the end of this chapter, in the case studies.

We remember from Figure 1, which identified the seven currencies (including the U.S. Dollar in which they are priced) that are classified as majors, that the three other currencies discussed in this section are all majors. We also know that a great deal of trade takes place between the Eurozone and Japan without any involvement by the United States, so obviously there is going to be a market exchange rate between the Euro and the Yen. The exchange rates between the other majors that do not involve the U.S. Dollar are called crosses.

A quick analysis of the crosses allows us to make an important generalization about exchange rates: in a competitive market for foreign exchange, the diverse exchange rates between currencies must be compatible with each other.

10 Often this term is applied to any non-Dollar exchange rate, whether among the majors or not.
What exactly does this mean? It means that all exchange rates must be mathematically compatible, at least approximately. This is best explained by example. Refer to Figure 6 - Exchange Rate Compatibility.

<table>
<thead>
<tr>
<th>Figure 6 - Exchange Rate Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>€/$</td>
</tr>
<tr>
<td>1.386</td>
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</table>

Basically, if one major exchange rate equals value $\alpha$ and another major exchange rate equals $\mu$, then the product of those two exchange rates, which by definition equals an actual cross exchange rate, must equal $\alpha \times \mu$. A numerical example is shown using three currencies, the Euro, the Dollar, and the Yen.

This relationship will always apply to majors and their crosses, but it may not always apply to lesser currencies. Generally this condition requires a very active, liquid, global market.

A process called currency arbitrage guarantees this result. If the values of the currencies are misaligned then speculative traders can buy a batch of the relatively undervalued currency and sell a batch of the relatively overvalued currency and profit as they converge to their proper levels. Further, this will happen because the surge in demand raises the value of the undervalued currency and the surge in supply lowers the value of the overvalued currency until they are in alignment. To explain this in more detail requires use of a model, which is yet to be developed in this chapter, so we will return to currency arbitrage in an appendix.

3. The global market for foreign exchange (FX)

If you have ever used the foreign exchange (typically labeled FX) market (and you are not a professional trader), it is likely that you did it in one of three ways: (1) you used a foreign exchange booth at an international airport (and if you did, you are probably aware that you were completely ripped off), (2) you swapped currencies or Travelers Checks for traveling at your bank, and still paid a pretty stiff fee, or (3) you simply used your debit card or credit card while traveling overseas and expenditures there were booked in the appropriate currency and debited to your Dollar-based debit or credit account at a reasonable exchange rate. So at least you know from that experience that exchange rates really matter when it comes to costing out travel.

The market for foreign exchange traded today at today's exchange rate is called the spot market for foreign exchange, in contrast to the three huge market designed to facilitate future trades of foreign exchange at a price agreed to today, which are called the forward markets, futures markets and swap markets for foreign exchange.11

The decentralized spot foreign exchange market is one of the oldest finance markets in the world. The Egyptians, Greeks, and Romans all had coin- and bullion-based foreign exchange markets.

The FX market is also the largest finance market in the world. Global FX market activity averaged (in converted Dollar value) $5.3 trillion per day in early 2013.12 Spot market trading alone represented about $2 trillion of this amount (another $2 trillion was represented by the swap market, which is not explained in this introductory essay).

The majority of private (as opposed to government) spot market transactions are undertaken by global banks either for their own account or on behalf of their clients, and it is there supply and demand activity for foreign exchange that strongly influences prices - the actual quoted exchange rates - in the spot market. Hedge funds, large pension funds, and proprietary (quant) trading firms (who trade huge amounts for their own account) are extremely active in the FX market.

11 These markets are difficult to explain and require at least a minimal background in finance, so no attempt will be made to explain them here. The interested student can read a chapter from the material written for Economics 104, Chapter 10 Futures Contracts if you want to understand how the futures contracts work. The BIS reference that follows this note provides a detailed albeit highly technical description about forward and swap foreign exchange markets.

Refer to Figure 7 - Bank of International Settlement Relative Market Share, April 2013, which shows the percentage of this exchange represented by the majors and other currencies. The numbers shown are for percentage of market share, so the 87% in the upper left bar chart means that the U.S. Dollar was represented as one half the traded pair in 87% of all FX transactions in April 2013! The U.S. Dollar is clearly still the dominant world currency. The upper left hand bar chart makes it clear that the USD/EUR trade takes nearly a quarter of the FX market.

**Figure 7 - Bank of International Settlement Relative Market Share, April 2013**

![Bar chart showing foreign exchange market turnover by currency and currency pairs.](image)

It is relatively easy to buy and sell foreign exchange, especially if done on a large scale. As one might guess, dedicated online sites allow exchange transactions to be conducted easily a current spot rates with relatively low transactions fees. Figure 8 - Currenex Graphical User Interface shows the user interface for Currenex, one of the more popular sites. Refer to the upper left hand currency quotation in Figure 8, which shows a quotation for the EUR/USD exchange rate, which we remember from above reflects the Dollar value of a Euro. Both quotations shown are shown in five decimals, one at 1.44310 and the other at 1.44323 (look carefully at the information within the square to understand the quoting convention). The difference in these two prices is called the spread, which in this example equals 0.013 cents. The minimum transaction size is for $1 million worth of Euros, and if you are buying Euros (by hitting the *Buy 1m* button) you will pay the higher price, $1.44323, but if you are selling (by hitting the *Sell 1m* button) you will earn the lower price, $1.44310. As you might guess, this tiny spread ($130) goes to the host, in this case Currenex. This spread, plus transactions fees, is how the middleman makes money.
As can be seen, many of the other major and some crosses are well represented. As supply and demand conditions change throughout the day, the prices rise and fall in synchronization, with the spread remaining about the same.

**Figure 8 – Currenex Graphical User Interface**

Day traders and other currency speculators, even those speculating on a very small scale, have in recent years been attracted to spot currency speculation **FOREX** websites where the traders can bet on the direction of an exchange rate movements. **Figure 9 FXCM Trading Interface** show a portion of the interface of one of the more popular trading sites, fxcm.com. The interpretation of the trading interface is more or less the same as it was for the Currenex site, spread and all. Again the upper left screen represent the EUR/USD exchange rate, at 1.23408 on the sell side and 1.23435, a 0.027 cent spread. Compared to the large professional trading sites like Currenex, where million-Dollar trades are typical, the retail **FOREX** sites always allow trades as small as $10,000 and some allow micro lots as small as $1,000. Far more important, the **FOREX** sites allow leverage of 50 to 1! This means that the cash requirement to buy or sell a $10,000 contract is only $200, which is why these sites are so popular with young day-traders.

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13 To some extent on the **FOREX** sites smaller traders are at the mercy of large currency traders when using these popular sites and most small traders end up with losses. The spreads quoted are not the actual current spot prices in the markets in question - they are prices offered by larger trading intermediaries who are able to trade directly at actual spot and futures prices, and reflect a small bias that gives a disadvantage to the small trader. For example, when there are sudden spot market movements, the newly-realigned prices are not offered to small traders until a few seconds after the sponsoring traders have taken their own positions. Consequently, trading on leveraged **FOREX** sites is **not** recommended to readers.

14 Day-traders, almost all young men, trader currencies on leverage (50 to 1) buying and selling throughout the day, holding positions for only a short time. Many rely upon "technical" trading, which imagines that you can see clear trading patterns by looking at prices alone. Nearly all lose everything invested, get discouraged, and drop out. Numerical patterns mean something only in the movie **Π**.
Foreign exchange trading is also popular and healthy on the enormous global futures market, where traders can speculate or hedge their currency positions contracting for prices today on exchange rates months into the future.15

Figure 9 – FXCM Trading Interface

4. An elementary exchange rate model

The exchange rate market is the largest market of any kind in the world and exchange rates are fluid and volatile. The rates themselves are clearly impacted by general economic conditions, a host of economic variables like relative inflation and interest rates, and obviously by general supply and demand conditions for the currencies themselves. At this point, developing a model will help to make some sense of all of this and allows us to systematically sort out and analyze the impact of key variables upon exchange rates.

Refer to Figure 10 - An elementary model of the EUR/USD exchange rate. This example is set up to produce a special price, the Dollar price of a Euro (rather than the other way around) because this is how this exchange rate is typically quoted in the foreign exchange markets. The model treats the Euro as though it is a commodity to be traded which is priced in Dollars. From this perspective - treating the Euro as a commodity priced in Dollars - the demand curve shown represents the demand for the Euro priced in Dollars. Think of it as the equivalent of the demand for oil priced in Dollars.16

The negative slope of the demand curve implies that the higher the Dollar price of the Euro, the less the demand for the Euro.

But why? We can't say that the slope of the demand curve is negative simply because slopes of demand curves usually are negative. This is clearly a special kind of market.

15 Explaining the complicated futures market for exchange rates is far beyond the scope of this chapter, but the curious student can explore further by reading your teacher’s chapter Futures Contracts in the course material for Economics 104, most likely found at http://www2.hmc.edu/~evans/e104ls.htm.

16 The demand and supply curves in this section are drawn as straight lines just for convenience and to make the graph easier to read. The true relationship would actually be non-linear.
Consider that a buyer who had Dollars would demand a Euro (would want to trade Dollars for Euros) because she would want to use the Euro to buy something else, such a trip to Munich or a nice bottle of French wine. But the higher the Dollar price of the Euro, the higher the effective cost of the trip to Munich or the bottle of French wine. Examples earlier would remind us that a liter of wine costing 10 Euros would cost $13.50 at an exchange rate of 1.35 (our default value in Figure 10) but would cost $15.00 at a higher exchange rate of 1.50. Assuming that the demand for wine has a traditional negatively-sloped demand curve, then so would any currency that enables a foreigner to buy that wine. Basically, the downward slope of the currency demand curve exists because all of the commodities and services that one might buy after currency exchange have negatively-sloped demand curves.

The supply curve will have a similar interpretation - the curve represents the amount of Euros supplied to the market given different Dollar prices and that would be expected to have a positive slope. Who "supplies" Euros in the context of this perspective? Those who already have Euros and want Dollars, such as European buyers of American exports or Europeans who want to vacation in Florida. Using the latter for an example, the higher the exchange rate in Figure 10, the more Dollars a tourist will get per Euro, which will lower the cost of the Florida vacation, hence raising the demand for such vacations while explaining the slope of the supply curve.

These examples show why the foreign exchange market is fundamentally different from an ordinary international commodity market, like the market for oil. Whereas we can comfortably refer to the Dollar price of oil, we will never refer to the oil price of the Dollar or the wine price of Euros. But the foreign exchange market is a swap market where neither currency is a true commodity. Therefore Figure 10 could have just as easily been set up as an USD/EUR example, with complete validity, where the perspective treated the Dollar as a commodity priced in Euros. The demand and supply curves would have been for Dollars and the price would have been inverse (with the default at 1/$1.35 = €0.74). For that reason the line labeled Demand for Euro is also labeled in parenthesis Supply of Dollar, because it is the same thing. In this market, by definition to demand Euros is to supply Dollars, because you are offering to swap Dollars for Euros.

Sometimes, though the convention stresses the mirror image. Consider the case of Figure 11 - The USD/JPY exchange rate, for example, which will be used to model the USD/JPY exchange rate. This mirrored convention is often used because the Dollar price of the Yen is so low, around a penny. It is easier to remember the Yen price of the Dollar. So Figure 11 treats the Dollar as a commodity priced in Yen, and the supply and demand curves represent the supply of and demand for the Dollar. But again, logic tells us that the demand for the Dollar is, by definition in this market, also the supply of Yen (you can't ask for a Dollar without offering, say, 100 Yen).

Figure 12 - Origins of Demand for and Supply of U.S. Dollars in Foreign Exchange should help in explaining why demand and supply curves shift in the foreign exchange market. It reminds us that the shifts in demand and supply are almost always the indirect effect of shifts in demand and supply for internationally traded goods and services, such as the wine, autos, and foreign travel used in examples above. Figure 12 refers to the U.S. perspective where the model is treating the foreign currency as the commodity priced in Dollars (such as in the EUR/USD example, but not the USD/JPY example).
Figure 12 also reminds us, though, that some of the demand for the Dollar may reflect the desire of foreign investors to invest in Dollar-denominated assets, like U.S. Treasury bonds, stocks listed on the American exchanges (such as the purchase of 1,000 shares of Intel common stock by someone living in Madrid) or even direct investment, such as the overseas purchase of a company located in the United States. Likewise the supply of the Dollar may be linked to the demand by U.S. investors for financial assets denominated in Euros. As we will see, these international investment financial flows are just as important as traditional imports and exports when evaluating exchange rate movements. In fact, in the modern era, they are probably far more important.

Although Figure 12 doesn’t list them, there are two more classes of activity that will affect the supply of and demand for currencies. First, currency speculators buy and sell these currencies to try to make capital gains on the movement of exchange rates, so obviously they will impact supply and demand. Also central banks like our Federal Reserve System will intentionally demand and supply currencies for policy purposes. That complicated part of the story deserves special treatment and will be explained later in the chapter.

Given the setup, it might be useful at this point to show how to use the elementary exchange rate model to explain a change in the equilibrium exchange rate. Suppose we start with the EUR/USD exchange rate originally represented in Figure 10, which begins with an equilibrium exchange rate of $1.20 (one Euro costs $1.20).

According to Figure 12, if there is an increase in investment assets in the United States by Europeans, that should increase the demand for the Dollar. There is some precedent for this example. In 2004 and 2005, there was a surge in demand for eastern U.S. real estate from Europeans looking for vacation or retirement homes (which would be classified as “foreign demand for U.S. investment assets” in Figure 12). The cause of this consisted of the dual attraction of low financing rates combined with easy qualification standards (too easy it eventually turned out) along with what was clearly a momentum market. Prices were rising fast and the investments were leveraged (because they were financed by borrowing) and capital gains were attractive to European small investors. The phenomenon was regional - areas like southern Florida had huge property booms that would later turn into a bubble and come crashing down. But it was real in 2005!

**Figure 13 - The impact of a surge in demand for real estate investments in the United States** shows the isolated effect of this kind of phenomenon. In this example, the Euro supply curve (which, remember, also represents demand for the Dollar) curve shifts out as shown. In other words, in order to enable Europeans to buy Florida real estate, which is
priced in Dollars, they had to supply Euros to obtain those Dollars from the perspective of this model. This has a tendency to put downward pressure upon the exchange rate - in this case, to lower it to a level like $1.20, as shown. This is an example of a strengthening Dollar and a depreciating Euro.

Because we are using a comparative statics model, it should be stressed that this result shows only a tendency for the exchange rate to fall. In this example, the impact of only one factor is being evaluated and we know that exchange rates over time reflect the conflation of all variables that act upon them, not just this one. While this surge in real estate speculation was happening, other forces were also at work, including policy forces (explained later) that could cancel this effect out. Nonetheless we have reason to believe that this influence, considered in isolation, would tend to push the exchange rate downward.

In this simple example only the supply curve is being shifted. We will look at other examples where the trigger event that changes the equilibrium will clearly impact both the supply and demand curves in some predictable way.

It might already be apparent to the reader that we have a potential problem in sorting out cause and effect. Demand for investments, exports and tourist travel will clearly effect the exchange rate - we just showed a theoretical example of that - which implied that the shift in supply is the cause and the new exchange rate is the effect. But we also gave examples earlier (using wine and tourism) that implied that a changing exchange rate will shift the demand for exports and imports and tourism. That implies that exchange rates are the cause and shifting demand or supply is the effect! So which is it?

First, to some extent it is both. The relationship between changing exchange rates and shifting demand for commodities and financial assets is reciprocal - they feed back and forth on each other.

In the context of a modeled explanation though, the direction of causality is determined by whatever the model explains as the initial cause of the disturbance to the equilibrium. In our example in Figure 13 we were careful to say the initial shock was caused by a real estate boom triggered by lower interest rates and easy financing terms in the United States, to which exchange rates responded. In this example the increase in the exchange rate is the effect of the chain of events, which in turn will begin to cause other reactions.

Equally plausible, however, would be a story represented by Figure 14 The impact of a shift in the demand for Euros upon the exchange rate and the Florida real estate market. In this example the story begins with a shift in the demand of the Euro to the left. Let us say that this is due to a European government policy action that we have yet to explain (but will explain later). Here again the exchange rate rises from $1.35 to $1.50. So what effect does it have upon Florida real estate? Consider that before the exchange rate changed, €200,000 would exchange for $270,000 if a buyer from Spain was in the market to buy a Florida condo. After the exchange rate responded to government policy, the same €200,000 exchanges for $300,000 (or to put it another way, the $270,000 condo is now priced at only €180,000)! The condo is cheaper. So in this example, the exchange rate is the cause and the speculation is the effect.

In the former case (Figure 13) the supply curve shifted, causing a new equilibrium. In the latter case (Figure 14), the new equilibrium reflected a shift along a stable supply curve.
The analysis, therefore, depends upon a clear account of the initial cause.\(^{17}\)

5. Using the model to evaluate key variables that influence exchange rates

Now that we have a model to use, let's use it to explore the impact of other key variables upon exchange rates. We are going to explore four different scenarios, supported by historical examples.

5.1 The long-term impact upon exchange rates due to changes in consumer tastes

Refer to Figure 14 - The long-term devaluation of the Dollar relative to the Yen. This shows the annual average of this important exchange rate between 1881 and 2013 from the perspective of treating the Dollar as the commodity and the Yen as the price. Therefore the relevant demand and supply curves would be for the Dollar.

![Figure 14 - The long-term devaluation of the Dollar relative to the Yen](image)

The data shows a relentless devaluation of the Dollar relative to the Yen. By now it should be clear that this would have the tendency to raise the cost of imported Japanese goods, such as autos. Compare, for example, 1985 to 2011. In 1985 a single Dollar would buy 238 Yen, but in 2011 the same Dollar would buy only 80 Yen! Obviously over such a long time span the Yen-cost of manufacturing in Japan would be changing, but nonetheless this would put very heavy competitive pressure on Japanese manufacturing - the only way to remain competitive in the global economy would be to constantly slash the domestic manufacturing costs of autos, electronics, and other goods for which Japan is known.\(^{18}\)

![Figure 15 - The $/¥ exchange rate: surge in US import demand](image)

The dollar depreciates. This is an historical example.

It's 1985. Suppose car buyers in the U.S. begin to shift their demand for autos to Japanese imports because of perceived differences in quality control. In this market, the supply of Dollars (demand for Yen) would rise.

Figure 15 - The $/¥ exchange rate: surge in US import demand helps explain this long-term trend. Prior to the 1980s the United States was dominant in motor vehicle production, claiming more than 50% of the global market share in the 1970s. But in the early 1980s vehicle quality control began to seriously slip in the United States at the same time as Japanese quality control greatly improved.\(^{19}\) Consequently U.S. car and electronics (television, radios, etc.) began to shift their demand to Japanese imports, causing a relentless surge in market share for companies like Toyota, Datsun (now Nissan), Honda, Sony, and Panasonic.

This had the effect, as shown, of increasing the supply of the Dollar (to exchange for Yen) causing the supply curve to begin a secular, gradual, but relentless shift to the right as shown. For the same reason, Japanese consumers would be less

\(^{17}\) This is a little confusing, but this is characteristic of any comparative statics demand and supply model. Whether you are shifting a curve or moving along a static curve depends upon how the story started.

So what actually happened in Florida? A little bit of both probably. There was a bubble caused by fairly low interest rates and easy financing terms and at times shifting exchange rates actually dropped prices for buyers financing in Pounds and Euros while prices were rising for domestic buyers. There is a reason why there are so many Europeans are retired in Florida (and not so many Americans are retired in Europe).

\(^{18}\) And indeed Japanese engineering has largely succeeded at doing that over the decades, an economic story that is impressive by itself.

\(^{19}\) This phenomenon has been deeply documented. The interested student might read *The Reckoning* by David Halberstam
inclined to import U.S. autos (why buy an imported Buick if it was not made with the same quality as a Honda?) so the demand for the Dollar shifted left, as shown.

The net impact upon the exchange rate is clear.

Obviously this account is a little simplistic and other factors were at play, but this account nonetheless goes a long way toward explaining the long-term trend. This cause-and-effect scenario had largely vanished by 2000 and after that the exchange rate is fairly stable. U.S. companies improved their quality control and stabilized their market share as Japan had to worry about the competition provided by the new export juggernaut, China.

5.2 The effect of relative rising interest rates and other competitive global investment returns

Now consider the impact of global financial flows affected by relative rates of investment returns in competing countries. Figure 11 told us that international demand for investment assets in other countries will potentially impact the supply of and demand for currencies, and we have already seen a limited sample of that in our real estate example.

In today's global economy investment flows do not recognize international boundaries and are not much constrained by the need to swap currencies in order to invest in a foreign country. Studies of international capital flows have made it very clear that currency exchanges to finance investments now dominates trade flows. Generally, sophisticated managed investment pools will place their bets where the yields are highest (given risk considerations), and if yields in one country suddenly shift relative to another, then that can trigger sizeable currency flows. The reason is obvious. If yields suddenly rise on Euro-denominated bonds, for example, without a matching increase in yields in the United States, then investment money will leave the United States for Europe.

Figure 16 - The effect of a rise in European interest rates shows the effect of such a scenario. This example is not based upon historical precedent as was the previous, but it is an event that might happen in the near future as governments realign their enormous monetary and fiscal policies that were implemented in response to the global financial meltdown that began in 2007.

In Figure 16 it is assumed that the European Central Bank (ECB) decides to raise interest rates on Euro-denominated assets to an appreciable degree and there is no policy reaction in the United States, where interest rates remain unchanged. Because of this, the stable markets for bonds and notes and various risk levels are disturbed. Suddenly, yields are higher in Europe than they are in the United States for interest-bearing investment assets of similar maturities and risk profiles.

For example, assume that before the policy change, investment-grade (the safest risk profile) corporate notes with 10-year maturities are both yielding about 3% interest. Suppose that after the ECB raises rates in Europe, the European 10-year-note rate rises to 3.5%. Some money chasing higher yields will sell the Dollar-denominated notes and use the proceeds to buy the higher-yield European notes. To do this, the buyers have to swap Dollars for Euros. Simultaneously, some European investors already invested in the United States in Dollar-denominated assets, like U.S. Treasury notes, will
liquidate those to buy financial assets at home. The effect of these transactions is shown in Figure 16 as a shift in the demand curve for Euros to the right.

Likewise, European investors who might have bought Dollar-denominated assets change their minds, so the supply of Euros contracts, as is shown in the shift of the supply curve.

The net effect is unambiguous - the exchange rate rises, in this example from $1.35 to $1.50, devaluing the Dollar.

An important qualification has to be made to this example.

First, what matters are relative yields, not absolute yields. European yields have to be considered relative to yields in the United States and elsewhere, such as Japan, Canada, Australia, and so forth.

Far more important, investors respond to inflation-adjusted real yields rather than nominal yields. For example, a yield of 3.5% in Europe is considered higher than a yield of 3% in the United States only if inflation rates are about the same in both countries. On the other hand, if the inflation rate in the United States was only 1% and inflation rate in Europe was 2%, then in our example real yields in the United States would be higher than those in Europe. Generally the real rate of return is going to equal the nominal or market rate of return less the underlying inflation rate.

Finally, although this example draws upon relative interest rates from interest-earning assets like bonds, this analysis extends to all categories of yields for all classes of investment, including bond yields but also capital gains in stock markets, real estate investment gains (as in our earlier example) and even corporate profits for direct investment (for investors buying entire companies or portions of the same). So the general rule of thumb is this:

*A perceived increase in real (inflation-adjusted) investment returns in one nation relative to another will increase the relative value of the currency of the nation with the high investment returns.*

5.3 Central bank intervention intended to directly impact interest rates

From the examples already provided in this chapter, it is very clear that exchange rate movements can have a profound impact upon a domestic economy. One would expect, therefore, for governments to sometimes get directly involved in manipulating exchange rates, which they do.

Governments use the central banking authority to intervene in exchange rates. In the United States our central banking authority is the Federal Reserve System and all other nations have the equivalent of the Federal Reserve System, except in Europe this function is administered by a trans-national central bank called the European Central Bank. Central banks have the authority and ability to control the domestic money supply and can have a tremendous impact upon the general level of interest rates. Additionally they have the ability to buy and sell foreign currencies.

Over the years, central banks accumulate foreign reserves, largely as the consequence of international trade and international loans. Most foreign banks hold the bulk of their balances in U.S. Dollars, although some reserves are Euros and other currencies. U.S. Dollars were accumulated over the decades because of the huge balance of payments deficits the United States has run since the 1970s. Generally, we import more than we export and much of the difference ends up as cash accumulations in the form of Dollar reserve deposits.

This example of central bank intervention is based upon recent history in Japan. Refer to Figure 17 - The Bank of Japan Intervenes in the Foreign Exchange Market. This is a model of a central bank monetary intervention that began in Japan in December 1012 and continues at the time this was written. At the beginning of the policy intervention the $/¥ exchange rate was 79. By early 2014 the exchange rate had risen to 104.

This policy was initiated by newly-elected Japanese Prime Minister Shinzo Abe, who came to office promoting an aggressive monetary expansion (called "Abenomics" by the western media) designed to end deflation and trigger off a mild inflation. Abe's public campaign did not promise a Yen devaluation because Japan did not want to trigger a competitive trade war with, for example, South Korea, but economists and the business community understood that the real desired effect was a currency devaluation for the Yen.
The relentless Dollar devaluation relative to the Yen described earlier was damaging the Japanese economy. Large Japanese corporations still manufacturing in Japan, like Sony, Canon, Mitsubishi, and to a lesser extent the auto manufacturers (most of whom had shipped most production overseas) were losing large amounts of money. They couldn't compete on price with the exchange rate falling (when represented as $/¥, as in Figure 17) seemingly every day.

If Sony tried to sell a camera in California for $250, then at an exchange rate of 90, the company would receive ¥22,500. If a few months later the exchange rate had slipped to 80, then Sony would get only ¥20,000. This forced them to either take a cut on profit margins or raise the Dollar price of cameras in a competitive market.

Abe instructed the Bank of Japan, the Japanese central bank, to begin an immediate, aggressive monetary policy to stop deflation. Figure 17 shows a shift outward in the demand for Dollars between December 2012 and January 2014. This is partly because the Bank of Japan was actually buying Dollars, but also because the policy was lowering interest rates and making Dollar-denominated investments more attractive to Japanese investors. The supply of Dollars (demand for Yen) shifted left for the same reason.

Figure 18 - The Bank of Japan succeeds at devaluing the Yen

The policy officially begins

Shinzo Abe is elected Prime Minister of Japan in September 2012. He initiates “Abenomics,” which aggressively increases the money supply and has immediate effect of devaluing the Yen.

Such interventionist policies can clearly be very effective. However they can also be dangerous because they anger trading partners and competitors. South Korea, Taiwan, China, and Vietnam all compete with Japan for the American Dollar so they might at some point react by attempting their own devaluations, which could set off a trade war.

Also in Japan the effects of the devaluation are inflationary - an import costing a Dollar only cost 79 Yen in December 2012, but by April cost 104 Yen. One immediate impact is felt on gasoline, all of which Japan must import and all of which is priced in Dollars. Of course provoking inflation was the officially stated objective of the policy, but the Abe
administration may discover that you have to be careful about what you wish for. Japanese voters may not like paying a lot more for gasoline.

There is certainly more that can be said about exchange rates and their effects, but this chapter will conclude here. This gives us a foundation to explore more case studies and topical events in the lectures.