Exchange Rates

by Professor Gary R. Evans
First edition July 10, 2014, this edition March 12, 2018

According to a list maintained by the scientific **International Organization for Standardization** (**ISO**), as of January 1, 2018, there were approximately 272 currencies in the world being traded for goods and services and financial transactions.[1] 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 to the countries who trade them), such as the Azerbaijanian 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 270 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 1.23, which implies that a single *Euro* can be exchanged for $1.23. 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.

Figure 1 – Exchange rates of the majors to the U.S. Dollar

U.S. Dollar Exchange Rates
March 11 2018

		Cost of one unit in $	Inverse
EU Euro	EUR	1.231	0.813
British Pound	GBP	1.385	0.722
Australian Dollar	AUD	0.785	1.273
Canadian Dollar	CAD	0.780	1.282
Chinese Yuan	CNY	0.157	6.334
Japanese Yen	JPY	0.00936	106.85
Swedish Krona	SEK	0.12131	8.243
Swiss Franc	CHF	1.051	0.951

Source: XE.com

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 1.23 *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 seven relative to the *Dollar*, plus the *Chinese Yuan*, which is not in the seven, is shown for the time indicated in **Figure 1 - U.S. Dollar Exchange Rates**. 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*).

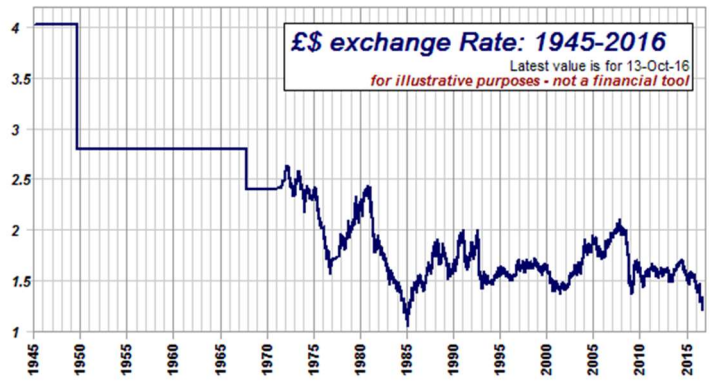
[1] Approximately? There are a number of borderline cases that make an exact tally difficult. For example, Cuba uses the Cuban Peso, but should one also count their special convertible currency, the Peso Convertible, which has very restricted circulation? Also some smaller countries use the currencies 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 106.85 (as opposed to 0.00936) 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 gold-based system could not survive the strains of the Great Depression and World War II, so in July 1944 the allies during World War II agreed to the ***Bretton Woods System*** of currency exchange and they were joined by their former enemies not long after. That system ultimately consisted of two components: (1) gold was priced in terms of the *U.S. Dollar* at $35 per ounce, and (2) all other currencies were convertible to *U.S. Dollars* at a ***fixed exchange rate***, also referred to then as a ***pegged exchange rate***. The "peg" was not fixed at an exact ratio - central banks were required to attempt to maintain the exchange rate within a 1% range. For example, this system initially linked the *Pound* to the *Dollar* at an exchange rate of 1£ = $4.03.[2]

Figure 2 – The £/S exchange rate 1945-2016



Source: http://www.miketodd.net/encyc/dollhist-graph.htm

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.[3] 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.[4]

[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. You could buy as many coffins as you wanted - after all, they were jewelry.

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 world currencies were delinked from gold and effectively from each other, clearly the way for the modern era of *floating exchange rates*.[5]

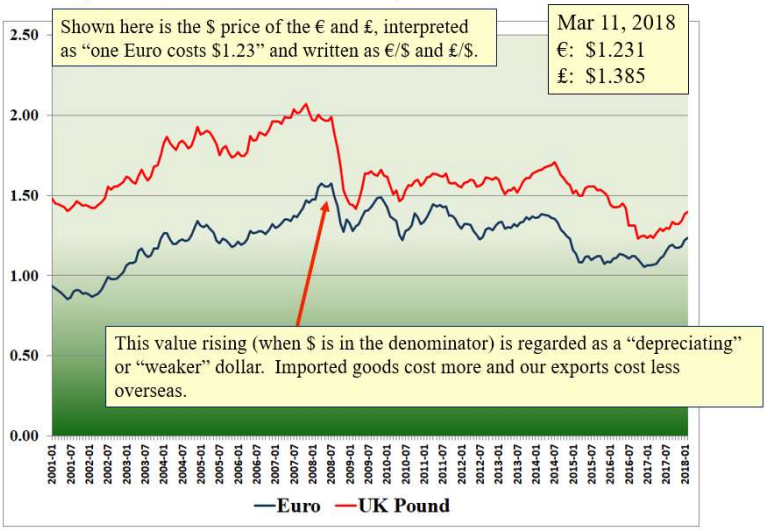
The impact of the transition can hardly be overstated. Refer to **Figure 2 - The £/$ Exchange Rate 1945-2016** copied from the miketodd.net research site to see the difference between the period prior to 1971 (the Bretton Woods era) and the modern era.

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 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 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.

Figure 3 - €/$ and £/$ Exchange Rates
Monthly data, Jan 2001 – February 2018



Source: Federal Reserve System G5/H10 data Foreign Exchange Rates

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 March 2018 had an exchange rate of slightly more than 1,128 *Won* to the *Dollar* [*KRW/USD* = ₩/$ = 0.000886]. Samsung's 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 online site *Amazon* listed a Samsung model 65" 4K Ultra HD TV (2017 model UN65MU8000) television for the retail price of $1,089.72 on March 11, 2018. On that same day the *Won* exchange rate was 0.000939407, which inverts to 1,064.43 Therefore, that television was worth ₩1,159,931. But only six months earlier, on October 6, 2017, the same exchange rate was only 0.000873, which inverted to 1,145,48, which would have made the same television worth ₩1,248,252. From the perspective of Samsung, the television at a given *Dollar* price was generating more *Won* revenue over the six months, which gave Samsung with more cash to pay expenses or allowed them to lower the *Dollar* price of their products in the United States in a very competitive market. And Samsung's changing choices 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.

[5] A good chronology of the role of gold (from 1717) is published by the *World Gold Council* at https://www.gold.org/government_affairs/gold_as_a_monetary_asset/additional_information/chronology/

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 was 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* (€/S) 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, then plunging in 2014, rising slightly since then. The behavior between 2001 and 2007, 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] In jargon, that phenomenon is also referred to as evidence of a "***weaker***" dollar and a "***stronger***" Euro. The situation reversed after 2008, ushering in a period of a "***stronger***" *Dollar* and a "***weaker***" *Euro* and *Pound*.

Figure 4 - Examples of € Revaluation - $ Devaluation Impact

		Impact upon U.S. Dollar **import** prices		Impact upon U.S. Dollar **export** prices	
Exchange rate in:		Audi worth €30,000	French wine worth €25	Deere lawn tractor worth $4,000	California wine worth $25
2002	$1.00	$30,000	$25.00	€ 4,000	€ 25.00
2007	$1.50	$45,000	$37.50	€ 2,667	€ 16.67

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** (before 2008). 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 € Revaluation-$ Devaluation Impact.** In that example, two exchange rates to the Euro are considered, $1.00 in 2002 and $1.50 in 2007. Then we identify two products being imported from Europe, an 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 **lower the prices of exported products** and **raise the prices of imported products**, thus **generally encouraging exports** and **discouraging imports**.

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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 had disappeared 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 2007. 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 2007.

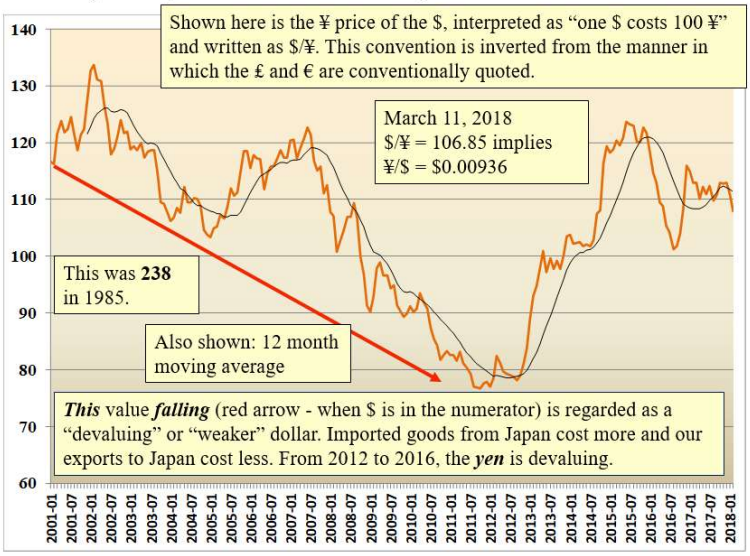
In the example provided, it is the U.S. currency that had this status, so this would have helped the U.S. economy somewhat and hindered the Eurozone economy.

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

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*, was stable between 2009 and 2014, devalued more, then with the *Euro*, strengthened against the *Dollar* in 2017. Although there were some concerns that the *Pound* would devalue after the 2016 British vote to leave the European Union (called the "Brexit") that fear has not yet materialized.

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.

Figure 5 - $ /¥ (Yen) Exchange Rate
Monthly data , Jan 2001 – February 2018



Source: Federal Reserve System G5/H10 data Foreign Exchange Rates

When it is reversed as shown, then the interpretation of the direction of the exchange rate is also reversed. The general ***decline*** 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 238, 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, Canada and Mexico.

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 120. 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***.[10]

[10] Often this term is applied to any non-Dollar exchange rate, whether among the majors or not.

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.*

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**, which is based upon actual values for these three exchange rates on March 11, 2018.

Figure 6 - Exchange Rate Compatibility		
€/$	$/¥	€/¥
1.231	106.85	131.53

€/$ X $/¥ = €/¥

Basically, if one major exchange rate equals value **α** and another major exchange rate equals **μ**, then the product of those two exchange rates, which by definition equals an actual *cross* exchange rate, must equal **α X μ**. 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.

3. The trade-weighted dollar indexes

Beginning in the late 1970s, the Federal Reserve System and other central banks began to experiment with currency indexes that reflected the exchange rates of an entire basket of currencies relative to a primary currency, like the Dollar, weighted by trade flows. The intent was to develop a metric that would indicate the relative strength of any given currency against all other currencies rather than the single currency represented by any given exchange rate. After two decades of experimentation, in 1998 the Federal Reserve finally settled upon three primary trade-weighted Dollar indexes that are still used:

1. The **Broad (Trade-weighted Dollar) Index -** an inclusive index of the exchange rates of 26 currencies traded against the U.S. Dollar, weighted for trade (explained below);

2. The **Major Currencies (Trade-weighted Dollar) Index –** a trade-weighted index of the of the seven "**major**" currencies traded against the U.S. Dollar (the Euro, Canadian Dollar, Japanese Yen, British Pound, Swiss Franc, Australian Dollar and Swedish Krona;

3. By default, the politely-named **Other Important Trading Partners (OITP) Index** includes the currencies of the other 19 currencies that are not included with the majors.

Finally, all three of these indexes are calculated in both nominal and real (price-adjusted) values.

Given the purpose of such currency indexes, the nominal ***Broad*** index is the most relevant and will be the only index of the three discussed in this chapter.[11]

Generally, the ***Broad*** index is a weighted sum of 26 exchange rates relative to the U.S. dollar. All 26 exchange rates are expressed as the price of the U.S. Dollar in terms of the foreign currency (for example, as the Yen price of the Dollar ($/¥) at 100 Yen per Dollar). The weights are reset only once per year in October and, using a complicated formula, are meant

[11] The best source for understanding the derivation of the U.S. Dollar indexes is "*Indexes of the Foreign Exchange Value of the Dollar,"* Federal Reserve Bulletin, Winter 2005.

to reflect the relative important of the U.S. trade with the country in question. The formula is shown in the 2005 article referred to in footnote 11.

Figure 7 – Top 5 2018 Trade Weights for the BROAD Index

2018 Trade Weights BROAD Index (as of March 11, 2018)	
China	21.56
Euro Area	17.20
Canada	11.89
Mexico	12.82
Japan	6.52
Other 21	30.01
Total	100

Source: Federal Reserve H10 data

To be meaningful, the ***Broad*** index must be adjusted for inflation. Weaker nations with strong inflation will find their currency relentlessly devaluing which would reflect a relentlessly rising Dollar (the ***Broad*** index not adjusted for inflation shows the Dollar steadily rising in value).

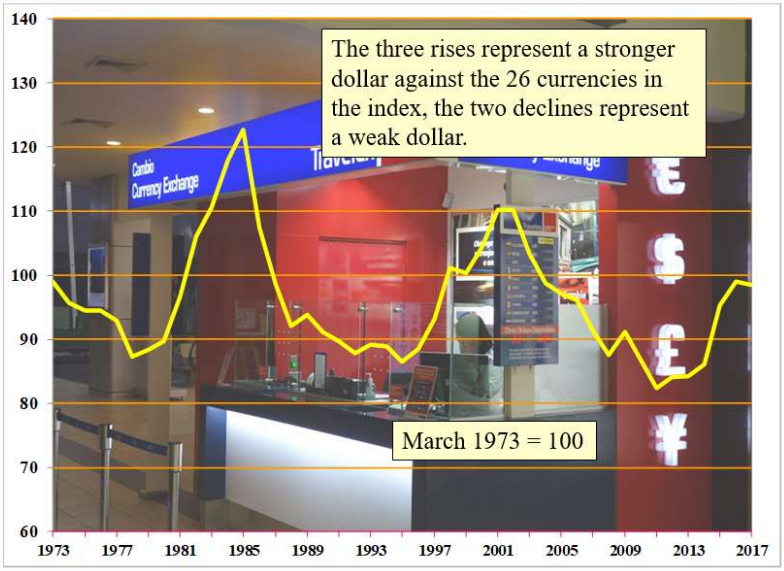
Figure 7 – Top 5 2015 Trade Weights for the Broad Index shows the level of weights for the largest five trading partners of the United States of the 26 total. China clearly outweighs the Euro area. Mexico and Canada are major trading partners because they border the United States.

Figure 8 - The Inflation-Adjusted Broad Trade-weighted Dollar Index shows annual data for the period between 1975 and 2016. The base period for the chart is March 1973 (= 100). Remembering that the Dollar is the numerator currency in each of the 26 weighted components of the index, a rising value, as is shown from 1977 (92.88) to 1985 (122.73), represents a ***stronger Dollar***, which would imply that imports were getting ***less*** expensive for American consumers and businesses and exports were getting ***more*** expensive for U.S. overseas customers. The trend from 1985 to 1995 represents a ***weaker Dollar***, inflating imports and encouraging exports.

The trend reversed twice more, in 2002 and 2011, and it can be seen that the Dollar is strengthening currently, which will be discussed in the case studies at the end of the chapter.

4. The global market for foreign exchange (FX)

Figure 8 – The Inflation-Adjusted Broad Trade-weighted Dollar Index Annual Data, 1975-2017



Source: FRED Economic Data, Real Trade Weighted U.S. Dollar Index: Broad (TWEXBPA)

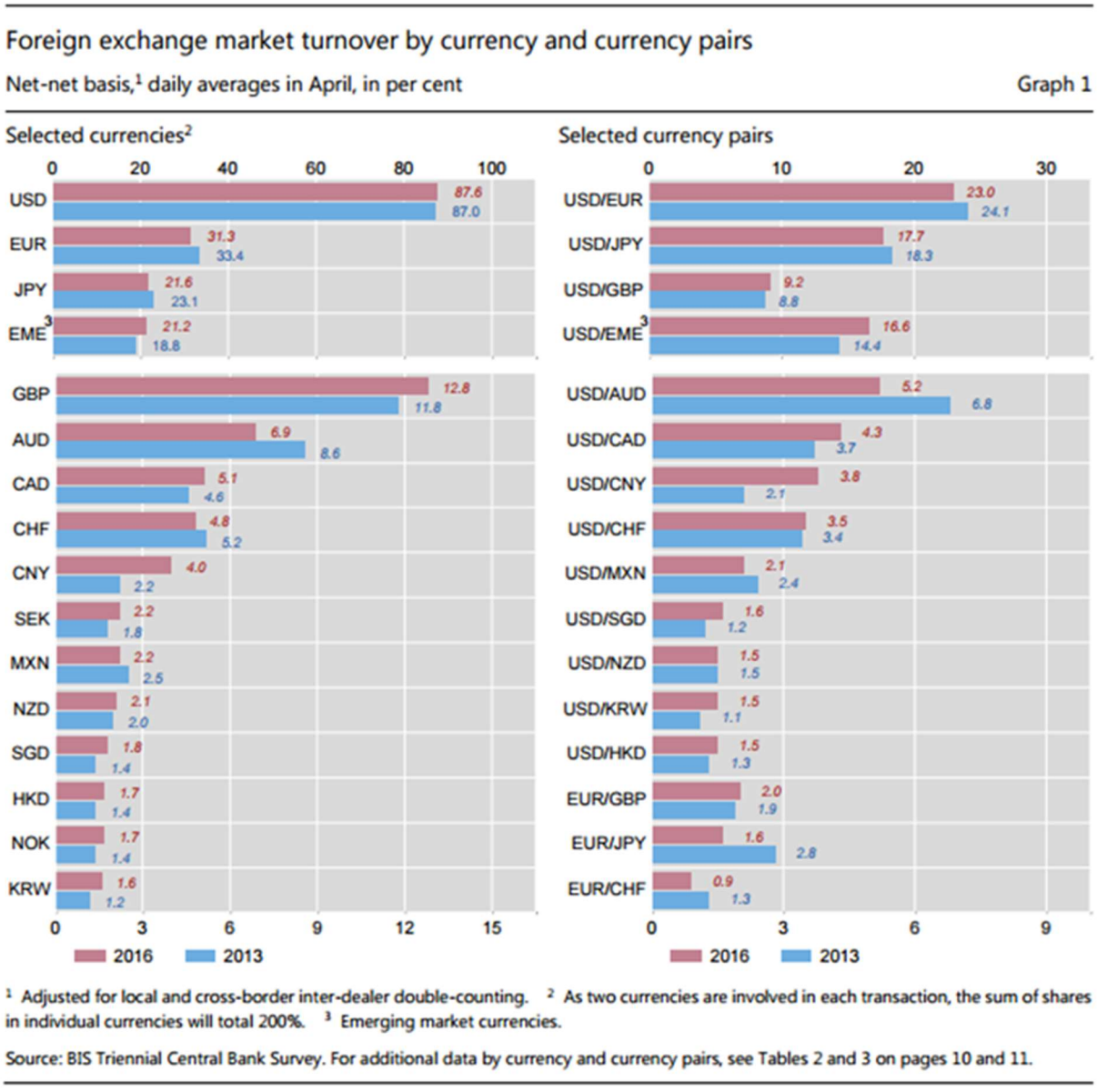
If you have ever used the foreign exchange (typically labeled ***FX***) market (and you are not a professional trader), it is likely that you did it in one of three ways: (1) you used a foreign exchange booth at an international airport (and if you did, you are probably aware that you were completely 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 calculating travel costs.

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.[12]

[12] 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.

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.

Figure 9 - Bank of International Settlement Relative Market Share, April 2016



[1] Adjusted for local and cross-border inter-dealer double-counting. [2] As two currencies are involved in each transaction, the sum of shares in individual currencies will total 200%. [3] Emerging market currencies.

Source: BIS Triennial Central Bank Survey. For additional data by currency and currency pairs, see Tables 2 and 3 on pages 10 and 11.

The FX market is also the largest finance market in the world. Global FX market activity averaged (in converted Dollar value) $5.1 trillion *per day* in April 2016.[13] Spot market trading alone represented about $1.7 trillion of this amount (another $2.4 trillion was represented by the *swap* market, a banking 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

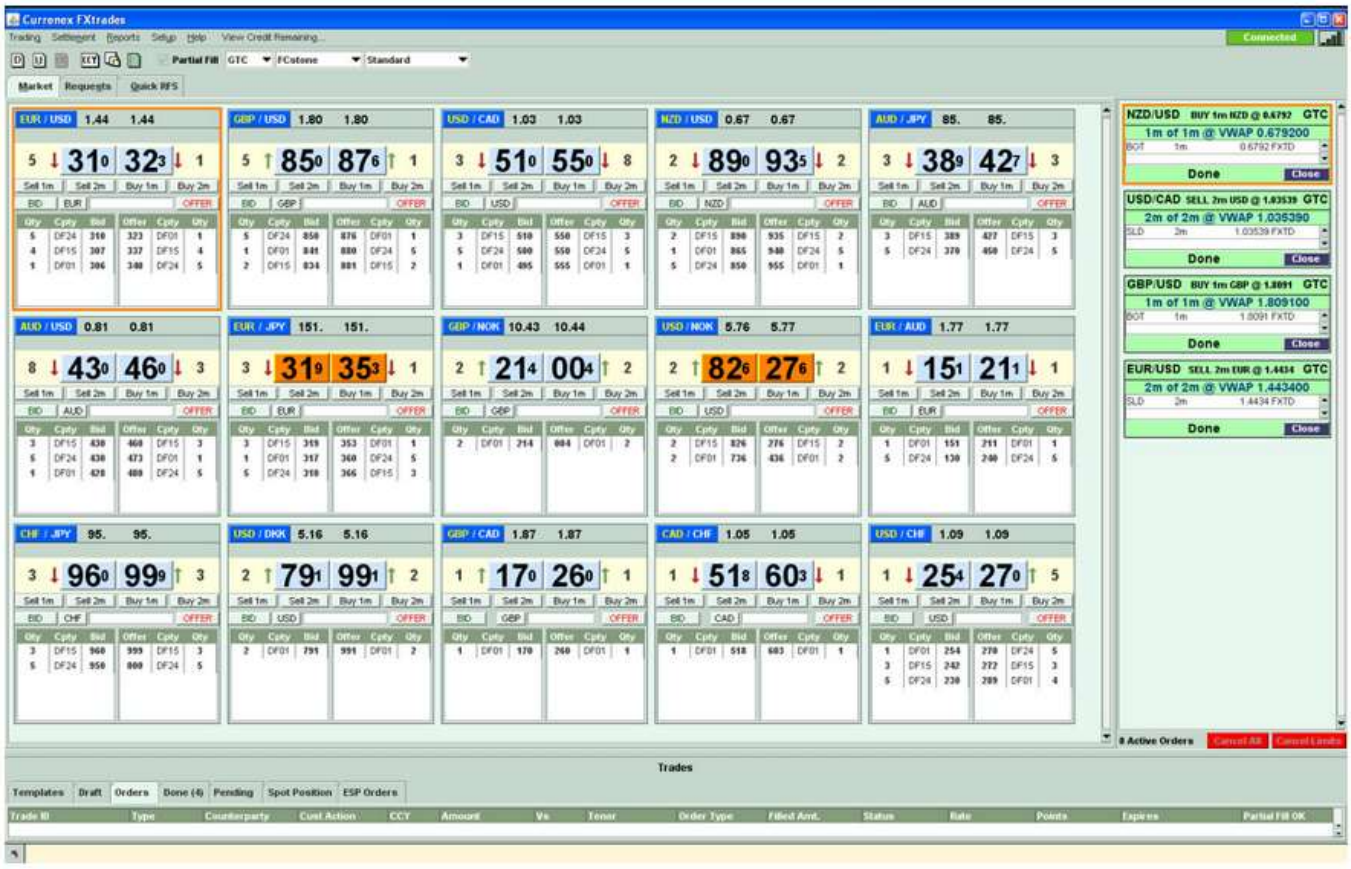
[13] Bank for International Settlements, *Triennial Central Bank Survey - Foreign exchange turnover in April 2016,* September 2016.

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.

Refer to **Figure 9 - Bank of International Settlement Relative Market Share, April 2016**[14], 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 87.6% in the upper left bar chart means that the U.S. Dollar was represented as one half the traded pair in *87.6% of all FX transactions* in April 2016! 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.

By close inspection, one can also see that the role played by the Chinese Yuan (CNY) is small but rising. That currency was represented in only 2.2% of all currency trades in 2013 (despite the fact that the Chinese economy has the largest export market in the world) but the percentage had risen to 4% by April 2016. The Chinese government is now actively supporting the use of the Yuan as true global currency.[15]

Figure 10 – Currenex Graphical User Interface



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 10 - Currenex Graphical User Interface** shows the user interface for *Currenex*, one of the more popular sites.[16] Refer to the upper left hand currency quotation in **Figure 10**, which shows a quotation for the *EUR/USD* exchange rate,

[14] This survey is published every three years, so the data are a little dated in 2018.
[15] But acceptance has been slow. The Chinese government still imposes very strict capital controls on their own currency, which means that Chinese citizens and businesses are not free to exchange the Yuan for foreign currencies like the Dollar. Such exchanges are allowed, but with severe restrictions.
[16] The examples shown in **Figure 10** and **Figure 11** are from years past when these exchange rates were higher.

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.

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 11 FXCM Trading Interface** show a portion of the interface of one of the more popular trading sites, *fxcm.com.*[17] 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 represents 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.[18]

Figure 11 – FXCM Trading Interface

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.[19]

5. 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.

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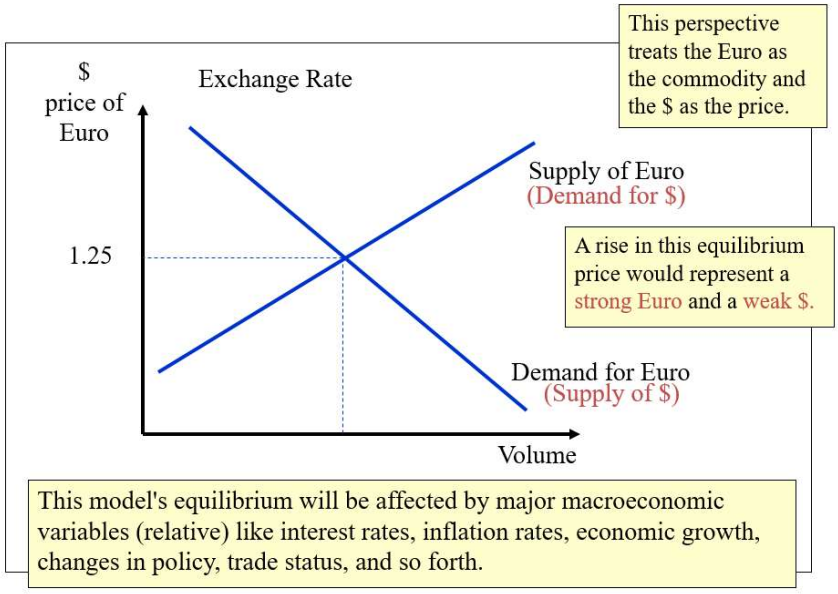
[17] To some extent on the FOREX sites smaller traders are at the mercy of large currency traders when using these popular sites and most small traders end up with losses. The spreads quoted are not the actual current spot prices in the markets in question - they are prices offered by larger trading 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.

[18] Day-traders, almost all young men, trade 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***.

[19] 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 10 ***Futures Contracts*** in the free online book used for Economics 104, found at http://palmislandtraders.com/books/finance/introfinbook.html

Refer to **Figure 12 - 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.[20]

Figure 12– An elementary model of the EUR/USD [€/S] exchange rate

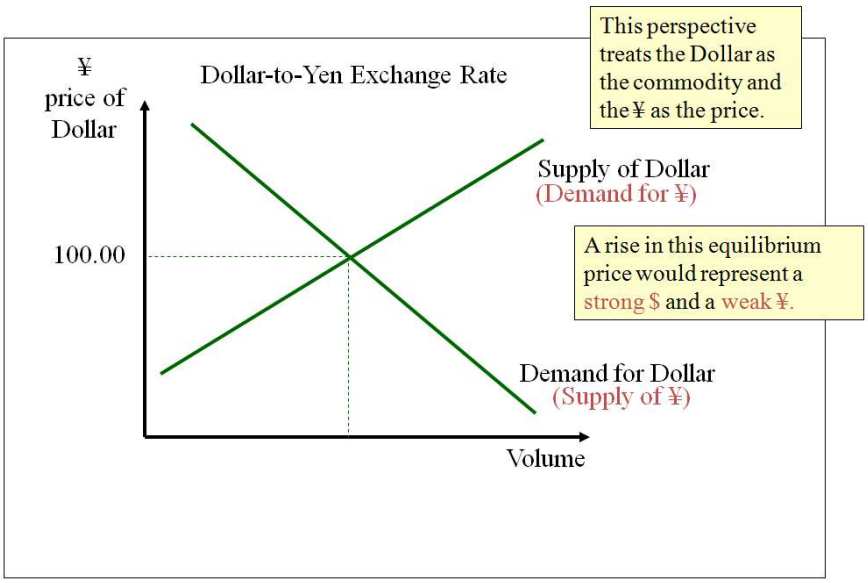


The negative slope of the demand curve implies that the higher the Dollar price of the Euro, the less the demand for the Euro.

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.

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 $12.50 at an exchange rate of 1.25 (our default value in **Figure 12**) 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.

Figure 13 – A model of the USD/JPY [$/¥] exchange rate



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 12**, 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

[20] 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.

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 12** 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/$1.25 = €0.80). 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 13 - 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 13** 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 14 – Origins of Demand for and Supply of U.S. Dollars in Foreign Exchange

Demand for and Supply of $ in Foreign Exchange
(from the perspective of the United States)

Demand for $	Supply of $
Foreign demand for U.S. exports of goods and services	U.S. demand for foreign imports of goods and services
Demand for travel to the United States	U.S. Demand for travel overseas
Foreign demand for U.S. investment assets priced in Dollars	U.S. demand for foreign investment assets priced in other currencies

Figure 14 - 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, or for financial assets like stocks and bonds. **Figure 14** 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 14 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 14** 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 12**, which begins with historical example of an equilibrium exchange rate of $1.35 (one Euro costs $1.35). This was the exchange rate around 2004.

According to **Figure 14**, 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 14**). 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 15 – The impact of a surge in demand for real estate investments in the United States

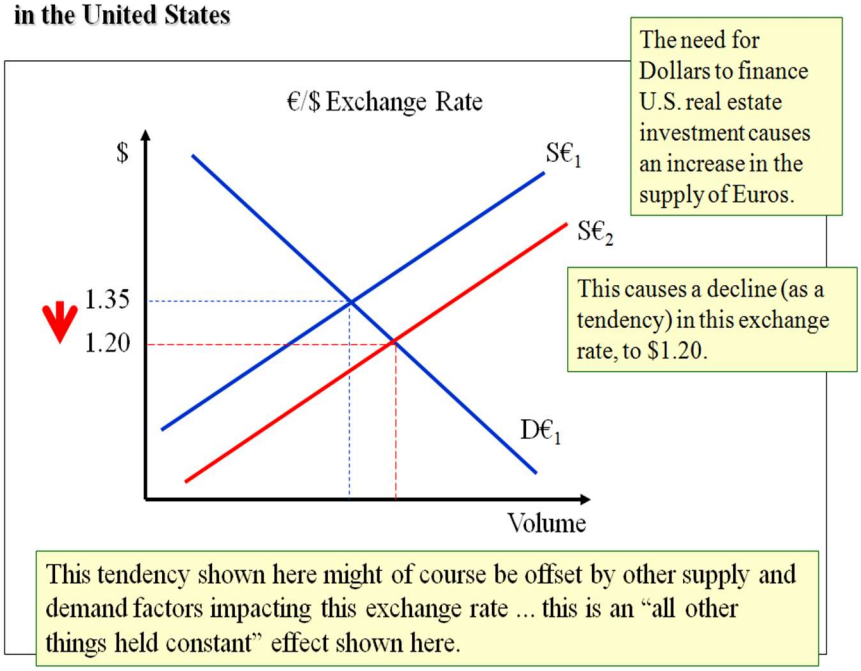


Figure 15 - The impact of a surge in demand for real estate investments in the United States shows the isolated effect of this kind of phenomenon. In this example, the Euro ***supply*** curve (which, remember, also represents demand for the Dollar) curve shifts out as shown. In other words, in order 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.

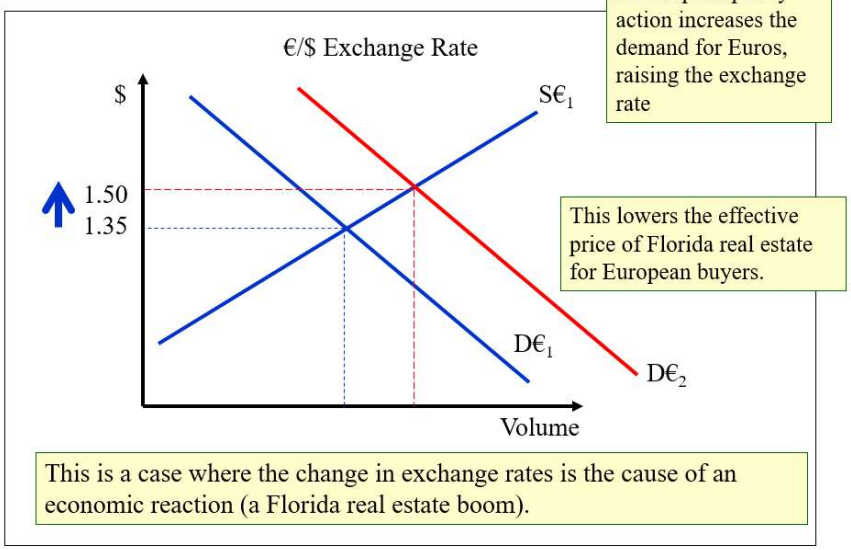
It might already be apparent to the reader that we have a potential problem in sorting out cause and effect. Demand for investments, exports and tourist travel will clearly effect the exchange rate - we just showed a theoretical example of that - which implied that the shift in supply is the cause and 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 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 15** 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.

Figure 16 – The impact of a shift in the demand for Euroes upon the exchange rate and the Florida real estate market



Equally plausible, however, would be a counter-story represented by **Figure 16 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 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 15**) the supply curve shifted, causing a new equilibrium. In the latter case (**Figure 16**), the new equilibrium reflected a shift ***along*** a *stable* supply curve.

The analysis, therefore, depends upon a clear account of the initial cause.[21]

6. 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.

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

Refer to **Figure 17 - The long-term devaluation of the Dollar relative to the Yen.** This shows the annual average of this important exchange rate between 1981 and 2012 (there is a reason for not including the years after 2012 - that comes later) 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.

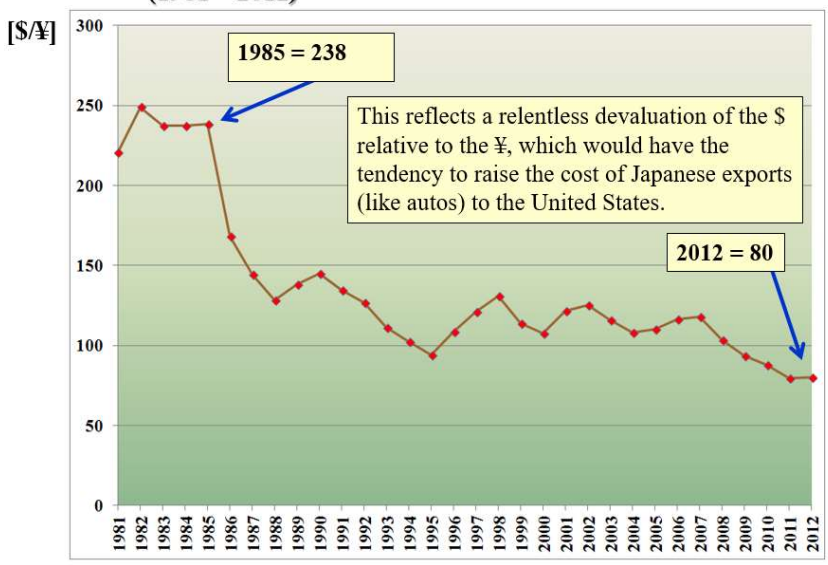
The data shows a relentless devaluation of the Dollar relative to the Yen. By now it should be clear that this would have the tendency to raise the cost of imported Japanese goods, such as autos. Compare, for example, 1985 to 2012. In 1985 a single Dollar would buy 238 Yen, but in 2012 the same Dollar 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

[21] 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). Actual exchange rate behavior during that time was dominated by other factors at work.

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.[22]

Figure 17 - The long-term devaluation of the Dollar relative to the Yen (1981 – 2012)



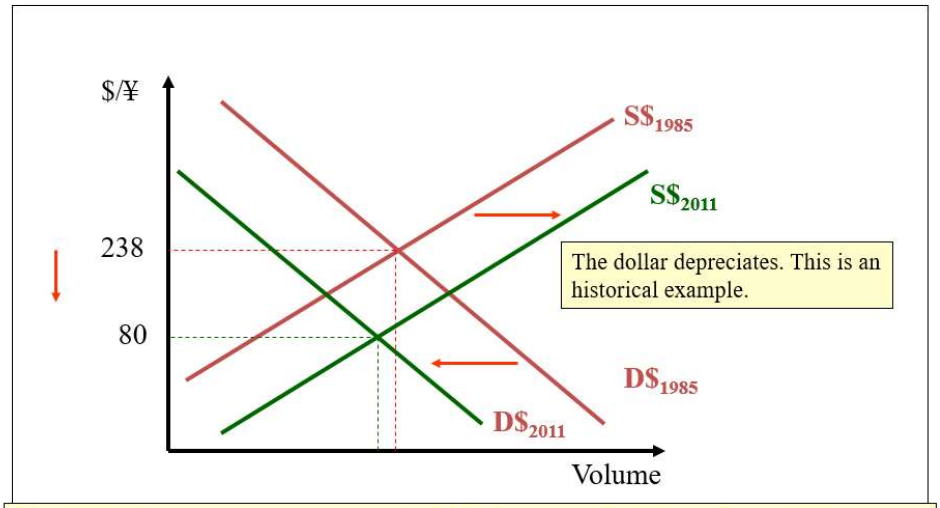
Source: Federal Reserve System Data Download Program, G.5/H.10 Foreign Exchange Rates

Figure 18 - 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.[23] 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 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.

Figure 18 - The $/¥ exchange rate: surge in US import demand



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.

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.

[22] And indeed Japanese engineering has largely succeeded at doing that over the decades, an economic story that is impressive by itself.

[23] This phenomenon has been deeply documented. The interested student might read *The Reckoning* by David Halberstam.

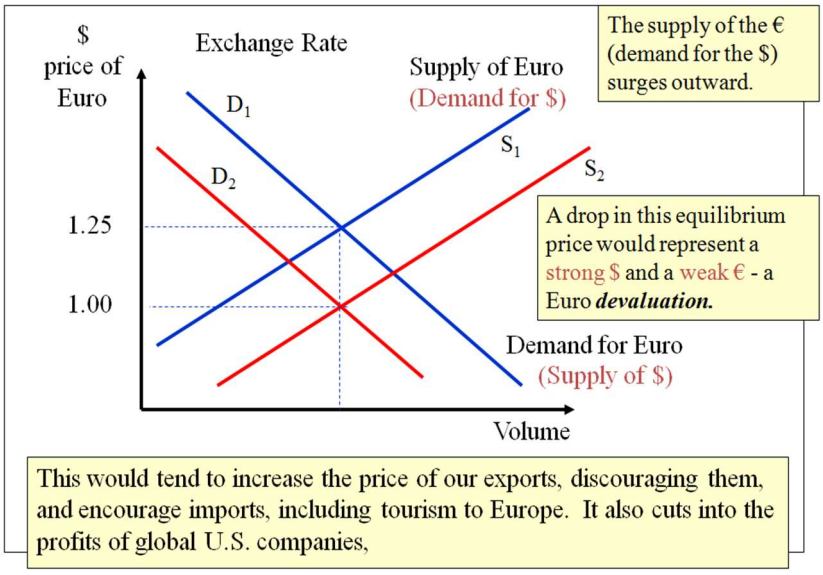
6.2 The effect of relative rising interest rates and other competitive global investment returns

Now consider the impact of global financial flows affected by relative rates of investment returns in competing countries. **Figure 14** 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 Dollar-denominated U.S. bonds, for example, without a matching increase in yields in the Europe, then investment money will leave Europe for the United States.

Figure 19 - The effect of a rise in U.S. interest rates relative to those in Europe shows the effect of such a scenario. This example is based upon developments that emerged in 2014 and accelerated through 2017. In March 2015 the European Central Bank embarked on a program of monetary easing, which lowers interest rates, at about the same time that the Federal Reserve System, which had ended its monetary easing program in October 2014, stated the intention to raise interest rates in the United States. Then after the U.S. presidential election in November 2016, the Federal Reserve System embarked on a policy to systematically raise interest rates in the United States. No other central bank was raising rates at the time except the People's Bank of China.

Figure 19 - The effect of a rise in U.S. interest rates relative to those in Europe



In **Figure 19** it is assumed that the Federal Reserve Bank decides to raise interest rates on Dollar-denominated assets to an appreciable degree. At the same time, nominal interest rates in Europe are dropping or stable. Inflation rates are the same in both areas. Because of this, the stable markets for bonds and notes at various risk levels are disturbed. Gradually, yields are higher in United States than they are in the Europe for interest-bearing investment assets of similar maturities and risk profiles.

Investment money chasing higher yields will sell the Euro-denominated securities and use the proceeds to buy the higher-yield U.S. securities like Treasury bills, notes, and bonds. To do this, the buyers have to swap Euros for Dollars. Simultaneously, some U.S. investors already invested in Europe in Euro-denominated assets, like Bundesbank notes, will liquidate those to buy financial assets at home. The effect of these transactions is shown in **Figure 19** as a shift in the supply curve for Euros to the right, from S_1 to S_2.

Likewise, demand for the Euro would weaken, shifting the demand curve to the left from D_1 to D_2.

The net effect is unambiguous - the exchange rate falls, in this example from $1.25 to $1.00, devaluing the Euro.

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 2.5% in the United States is considered higher than a yield of 2% in the Europe *only* if inflation rates are about the same in both countries. On the other hand, if the inflation rate in the Europe was 1% and inflation rate in the United States was 2%, then in our example *real* yields in the United States would be *lower* 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.

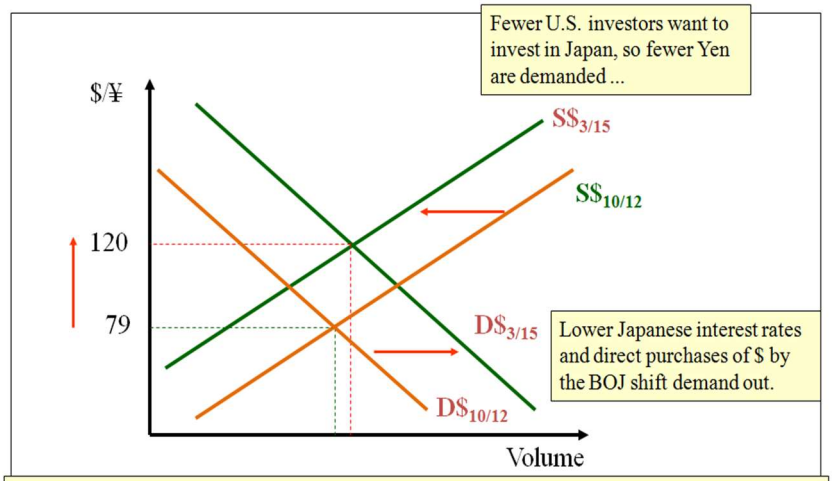
Finally, although this example draws upon relative interest rates from interest-earning assets like bonds, this analysis extends to all categories of yields for all classes of investment, including bond yields but also capital gains in stock markets, real estate investment gains (as in our earlier example) 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.*

6.3 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.

Figure 20 - The Bank of Japan Intervenes in the Foreign Exchange Market



The Bank of Japan begins an aggressive monetary policy designed to lower Japanese interest rates and devalue the currency (shown here). Demand increases partly because of lower Japanese interest rates, partly because the BoJ makes direct Dollar purchases.

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 20 - 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 2012 and continues at the time this was written. At the beginning of the policy intervention the $/¥ exchange rate was 79. By early 2015 the exchange rate had risen to 120.

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.

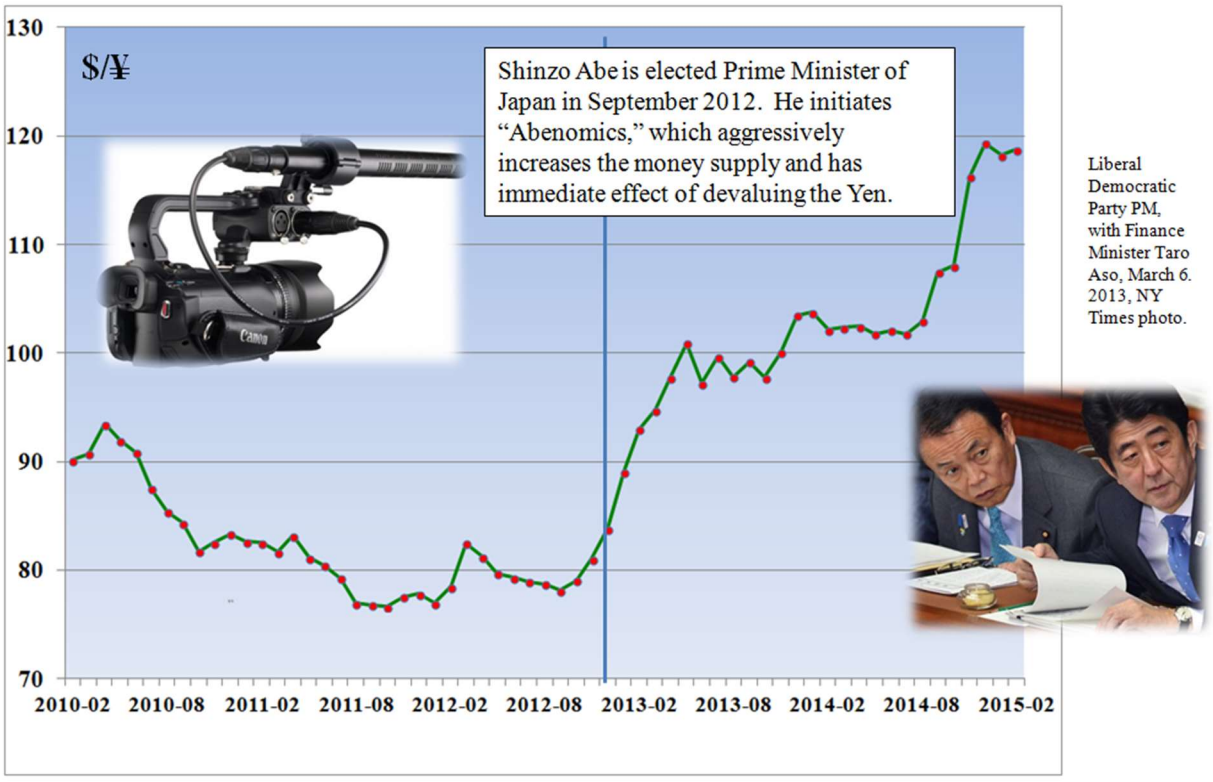
Before Abe's election, the relentless Dollar devaluation relative to the Yen described earlier (in **Figure 17**) was damaging the Japanese economy. Large Japanese corporations still manufacturing in Japan, like Sony, Cannon, Mitsubishi, Fanuc Robotics, and to a lesser extent the auto manufacturers (most 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 20**) 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 20** shows a shift outward in the demand for Dollars between December 2012 and March 2015. 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 21 - The Bank of Japan succeeds at devaluing the Yen shows that the policy was clearly successful from 2012 to 2015. The $/¥ turned immediately, shifting a decades-long trend. Since 2015 the Yen has stabilized at a range between 102 and 120 (not shown in **Figure 21** but shown earlier in **Figure 5**).

Figure 21 – The Bank of Japan succeeds at devaluing the Yen (2012 - 2015)



The potential effect upon prices of the severe devaluation of the Yen is represented in **Figure 22 - The potential impact upon prices of devaluing the Yen.** In this example we select four primary commodities that are exported and imported in trade between the United States and Japan. These are merely calculated examples but the prices are thought to be realistic. The two representative exchange rates in question are 78 Yen to the Dollar for 2011 and 118 Yen to the Dollar for 2015 (a more recent date is not used because the Yen drifted down some after 2015. **Figure 22** tells us that if a Nikon D7100 camera is worth ¥120,000, then at the earlier exchange rate is should retail for around $1,500 in 2011, but would drop to around $1,000 by 2015 simply by virtue of the exchange rate shift!

Although Fanuc Robotics, one of the largest robotics manufacturing companies in the world, has factories around the world, one of their primary production facilities is at the base of Mount Fuji. A production robot worth ¥60 million might have sold in 2011 for $770 thousand, but could have been sold for a little more than $500 thousand in 2015. But as the inset explains in **Figure 22**, the company would more likely increase their profit margins to some degree. For example, if they fattened the Yen price from ¥60m to ¥80m, which would hugely increase their profit margins, they could *still* reduce the price of the machinery for $770 thousand to $680 thousand! This may be why the ***Financial Times*** reported on February 19, 2015, that the company had operating profit margins at a staggering 40%!

On the export side (from the U.S. perspective) products get very expensive overseas. A Corvette would rise in value from about ¥5m to about ¥7.6m[24] and a bottle of California wine would rise from nearly ¥2 thousand to ¥3 thousand, an appreciable price increase.

Figure 22: The potential impact upon prices of devaluing the Yen

Examples of $ Revaluation - ¥ Devaluation Impact

		Impact upon U.S. Dollar **import** prices		Impact upon U.S. Dollar **export** prices	
Exchange rate in:		Nikon D7100 worth ¥120,000	Fanuc Robot worth ¥60m	Corvette worth $65,000	California wine worth $25
2011	78	$1,538	$769,231	¥5,070,000	¥1,950
2015	118	$1,017	$508,475	¥7,670,000	¥2,950

Because the Yen **devalued**, this will tend to cause an decrease in the prices of imported goods from Japan (which may spread to domestic goods as well). It will also raise the cost of U.S. exports in Japan. The price effect is not guaranteed because it can be mitigated. The Japanese exporters would almost certainly raise their Yen prices to some degree to fatten their operating profit margins. For example if Fanuc (which in 2015 has operating profit margins at a staggering 40% [*Financial Times Feb 19, 2015*]) raises their industrial robot price to ¥80m, it would still be priced at only $678,966!

So clearly by this example, a severe devaluation of a trading partner's currency substantially raises the prices of imports and decreases the prices of their exports to the United States. This would clearly impact the balance of trade between the two nations.

We can also generalize that the devaluation of a county's currency will have an ***inflationary effect in that country*** and a ***deflationary effect for the trading partner***. In this example, there is an inflationary impact in Japan and a deflationary impact in the United States.

Also, by the example provided, a ***devaluation can raise the profits of domestic corporations*** that rely upon an export market and lower the profits of overseas competitors.

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.

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[24] The Corvette is popular in Japan but it turns out the General Motors charges a premium for them at apparently a base price of about ¥9,290,000 in April 2014, a least according to Reno Tibke, "Welcome to Japan: General Motors Intros Corvette Stingray C7 and Cadillac CTS, **akihabaranews.com,** December 6, 2013.

Also in Japan the effects of the devaluation are inflationary - an import costing a Dollar only cost 79 Yen in 2011, but by 2015 cost 118 Yen. One immediate impact is felt on ***gasoline***, all of which Japan must import and all of which is priced in Dollars.

7. The impact of exchange rate movement on international investment financial flows

It should be clear by now that significant exchange rate movements have the potential to impact underlying rates of price inflation and deflation in the affected countries. That has been shown twice in this chapter. But what about the rates of return on overseas invested capital? For example, during the time of the comparison above in the example of the Yen devaluation, a U.S. investor could have invested in Fanuc Corporation stock, which is listed and traded on the Tokyo stock exchange. To do so, the investor would first have to convert Dollars to Yen, because the stock is listed in Yen, and then upon exit, would want to convert back to Dollars. Likewise, a Japanese investor could buy Intel stock after converting Yen to Dollars.

Look at **Figure 23 - Relative rates of return for overseas investors in Fanuc and Intel.** Prices for both stocks are shown in their respective currencies for the markets in which they traded for two dates, one in 2011 and the other in 2015.

First there is no doubt that that ***Japanese*** investor buying **Fanuc Corp** would have done just fine. **Fanuc** soared from ¥11,780 per share to ¥27,340 per share, an absolute gain of 84%.[25] The U.S. investor would have done alright by buying **Intel** as well, earning 37%. Both the Tokyo market and U.S. equity markets had strong gains over the years. But it is also apparent from **Figure 23** that the Japanese investment in the United States was effectively ***leveraged*** by the behavior of the exchange rate over the period in question, whereas the rate of return of the U.S. investment in Japan was ***diluted*** by the same force. The Japanese investor in **Intel** would have earned 76% (the **J in US** column), more or less double his U.S. counterpart, and the U.S. investor in **Fanuc** might have been happy with a 45% ROI (column **US in J**) but the earnings were clearly diluted compared to what the domestic Japanese investor made.

Figure 23: Relative rates of return for overseas investors in Fanuc Corp and Intel Corp, select dates

	Exchange	Stock Prices			
Dates	rate	Fanuc	(in $)	Intel	(in ¥)
12/30/11	80	11,780	147.25	21.69	1,735
3/20/15	118	27,340	231.69	31.31	3,695
	ROI Gain:	0.842	0.453	0.367	0.756
	WHO?:	J in J	US in J	US in US	J in US

ROI gains are calculated as absolute natural log continuous growth rates.

Generally speaking, a ***currency devaluation in any country will lower (dilute) the investment rate of return for overseas investors in that country*** and ***will raise (leverage) the investment rate of return for overseas investments.***

To be more precise, when the both the absolute ***Return on Investment*** (***ROI***) and currency revaluation are calculated as continuous rates of return, and when the exchange rate is expressed as the foreign currency value of the Dollar (with the Dollar in the numerator), then for the U.S. investor the ***Net Return on Investment*** (***NROI***) on an investment in a foreign market is equal to

$$NROI_t = \ln(P_t/P_0) - \ln(ER_t/ER_0)$$

In our example in **Figure 23** the NROI = 0.453 = ln(27,340/11,780) - ln(118/80).

This would mean that for the foreign investor in low-yield U.S. Treasury Bills - even those yielding essentially zero percent as they were in 2015, the return on investment is equal to the rate of devaluation of the investor's home currency. To make this clear, if the Yen or the Euro devalues against the Dollar by 10% per year during a period of a strong Dollar, even if such funds are invested in safe but low-yield U.S. Treasury Bills, the Japanese and European investors are earning 10% on their investment just from currency appreciation alone.

[25] To avoid compounding bias, all growth rates are continuous log growth rates, which is obtained by taking the natural log of the ratio of the two values. The formula for adjusting ROI for exchange rate movements works only when using continuous log growth rates.

That phenomenon can cause a bull market in the U.S. securities markets.

If one combines this reality with the implications of rising interest rates as discussed in **Figure 19**, this could have important implications for global economies and financial markets in 2017 and beyond.

8. Topical Case Studies

The remainder of this chapter will be dedicated to discussions of emerging topical issues, treating them as instructive case studies. In March 2017, when this revision was written, interest rates in the United States were rising because of monetary policy promoting that goal and, at the same time, the People's Bank of China was having trouble supporting the exchange rate of the Yuan. These two cases are discussed below.

8.1 The possible effect of rising U.S. interest rates in 2017, 2018 and after

The success of the Japanese Yen devaluation makes it clear that a currency devaluation, whether engineered or accidental, can be beneficial to a struggling economy. Although a devaluation can provoke domestic inflation because of the impact of the rising prices of imports, it will usually promote exports and possibly tourism, while often fattening the profits of domestic businesses that cater to global markets. And the effect unrolls rather quickly.

In 2014 a long list of currencies, including the Euro, began to devalue relative to the Dollar. The Euro, which had been trading above $1.50 in 2007 but had drifted down since, began an accelerated slide in late 2014, trading below $1.07 in March 2017, at the time this chapter was revised.

Figure 24 – The BROAD index accelerates into a very strong Dollar by 2017

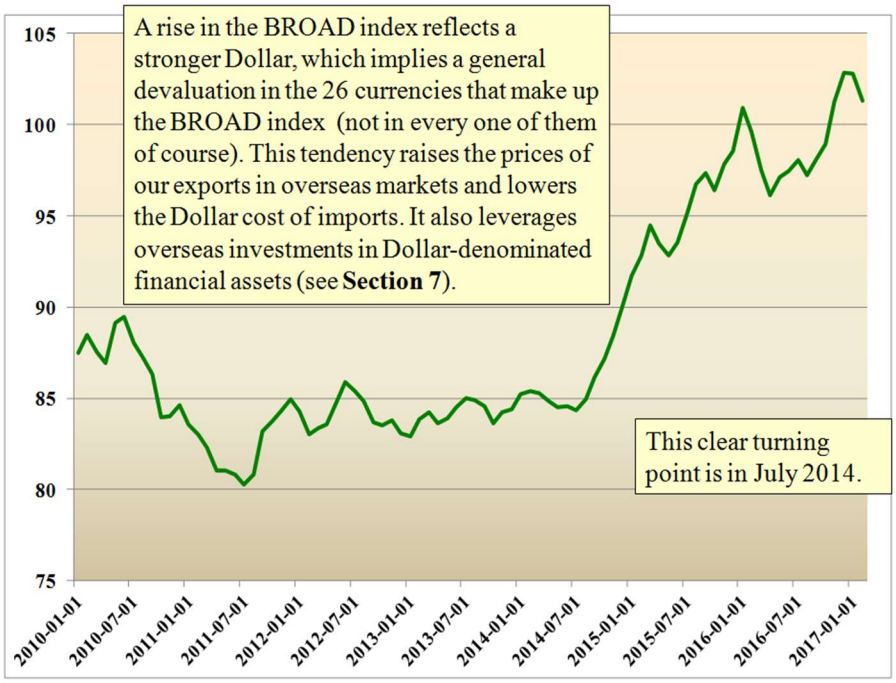


Figure 24 - The BROAD index accelerates into a very strong Dollar by 2017 makes it clear that the experience of the Euro and the Yen was not isolated. Remembering that the inflation-adjusted BROAD index includes 26 currencies weighted by trade, where a rise in the index represents an appreciating Dollar, it is very clear that many currencies are devaluing relative to the Dollar. This will discourage U.S. exports and encourage U.S. imports because of the price effect, which in turn could shave a percentage or two off of the 2017 GDP growth rate for the United States.

Whereas the Japanese devaluation was largely intentional, the devaluation of the Euro was instead an accident caused by changing monetary policies in Europe and the United States. In the summer of 2014, the Federal Reserve System made it clear that the central bank would discontinue the years-old monetary easing policies that had been in place and they began to talk publicly about a return to "normalization," which implied the intention to raise interest rates. At the around the same time the European Central Bank (ECB) made it obvious that they were going to embark on a program of quantitative easing much like the program that was being ended by the Federal Reserve System. The ECB actually began their much-anticipated easing program on March 9, 2015. So by late 2014 and into 2015, European interest rates were on their way down (many government yields were nominally negative in those years), while it was anticipated that rates would rise in the United States. Finally, in late 2016 and early 2017 rates did rise, confirming those expectations.

Earlier in this chapter **Figure 19** warned us that such a spread in rates would devalue the currency of the nation with the lower rates, and that has happened and probably for this reason.

This phenomenon also appears to be encouraging financial flows into the United States for the reasons discussed above in **section 7** - these rising yields are leveraged into even higher yields if investing in an economy that has an appreciating currency. This could have a positive influence upon bond and stock markets in the United States.

What impact will this have upon the trade deficit - the difference in value between our total imports and exports (where currently we import in value far more than we export)?

We know that $ strength will raise foreign currency prices of U.S. goods overseas and will lower the $ cost of imports.

If the Dollar continues its rise that should discourage our exports because it raises the overseas price of exported goods. Therefore, the total $ value of exports will decline.

Likewise, the $ price of each imported good and service should fall. But will the summed $ value of all imports fall? There is not a clear-cut answer because *quantity demanded* will be rising because of falling $ prices. Because for imports we have a tradeoff - Q↑P↓, the answer depends upon which moves the most in percentage terms, the price going down or the quantity going up?

In economics jargon, the impact upon the $ value of imports arising from the strong Dollar depends upon the ***price elasticity of demand for imports***. By definition,

The price elasticity of demand = absolute value (%ΔQ / %ΔP), also expressed as $E_D = \left| \partial Q / \partial P \right| \times P / Q$

If this value is ***less than one***, which is called ***inelastic***, then the ***value*** of imports will drop even as the ***quantity*** of imports rises. This would have a positive effect upon GDP growth (because the value of imports *subtracts* from GDP). Many imported products, like crude oil and distillates, are known to be inelastic, so for those commodities, the U.S. would have the beneficial effect of lower fuel prices with declining value of fuel imports.

On the other hand, if the value is ***greater than one***, which is called ***elastic***, the value of imports will rise, which would clearly contribute to a rising trade deficit.

In summary, the model predicts that rising U.S. interest rates will (a) strengthen the Dollar, which in turn will, (b) raise the overseas prices of our exports and decrease the prices in Dollars of our imports, which will (c) decrease the Dollar value of our exports in the GDP accounts with (e) no predicted effect upon the Dollar value of our imports (because that depends upon the price elasticity of demand for imports). Also we have some theoretical reasons to believe that (f) overseas investments in U.S. Dollar-denominated financial assets might rise because of the leverage embodied in the effects of a stronger currency.

Although we know that other variables act upon exchange rates, in a year or two we might still be able to judge whether these theories had any predictive power.

8.2 Is China a currency manipulator, or is something else going on?

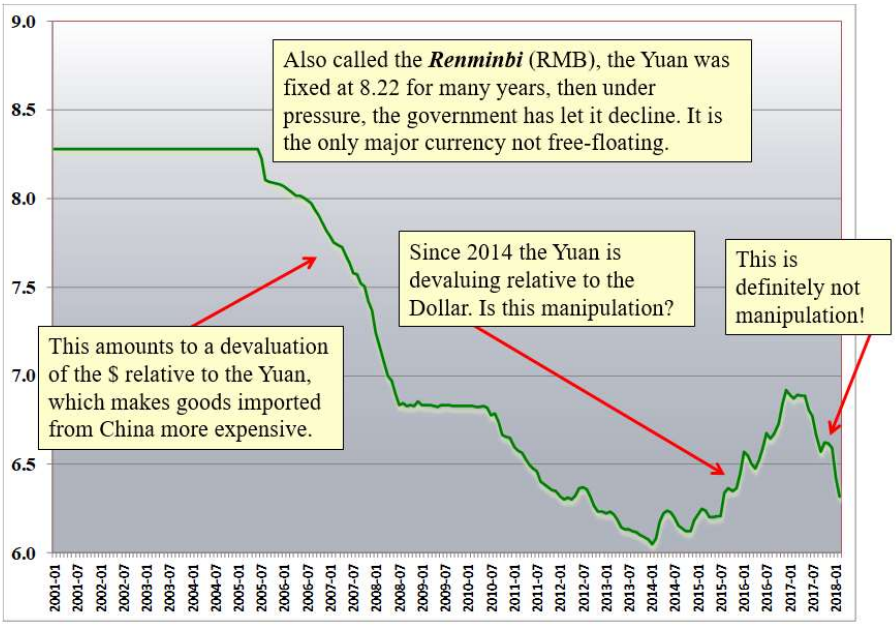
As anyone who reads a newspaper would know, the Chinese economy is emerging as one of the largest and most powerful in the world, and much of that strength has been built upon an export trade with the United States. China runs an enormous trade surplus on goods and services with the United States. For example, in 2017, the United States exported $186.8 billion in goods and services to China, but imported a staggering $524.0 billion in the same year, producing a huge trade deficit of $337.2 billion.

The persistence of this deficit has given rise to the charge that the Chinese central bank, the People's Bank of China (PBC), has been a "currency manipulator,"[26] intentionally devaluing the Yuan to encourage exports.

[26] For example, U.S. President Donald Trump, in an interview with Reuters News Service, declared that "... they're [the Chinese] the grand champions at manipulation of currency." *Reuters Politics,* "Exclusive: Trump calls Chinese 'grand champions" of currency manipulation," February 24, 2017, http://www.reuters.com/article/us-usa-trump-china-currency-exclusive-idUSKBN1622PJ

At a first glance of **Figure 25**, which shows the history of the exchange rate (from the same perspective as the Yen), showing how many Yuan one gets for a Dollar, it is clear that the Yuan has devalued since 2014. But a longer time horizon shows a more complicated picture.

Figure 25 - The Dollar($)/Yuan (元) exchange rate, monthly 2001-01 to 2018-02



The Yuan is the only major currency that is not a free-floating currency. In fact, prior to June, 2005 the Yuan was fixed at 8.22 Yuan to the Dollar. After June 2005, the People's Bank of China initiated a policy called (by the Western media) a "*managed float rate*" which allowed the exchange rate to drift down as a gradual appreciation of the Yuan in a slow and managed way. After the 2008 global recession, the downward drift was stalled for a few years, then in summer of 2010 the appreciation resumed.

It is clear up until 2014 that the Chinese were not devaluing their currency. One might argue that the currency would have appreciated *faster* had the government not been using their managed float rate, which might be construed as currency manipulation. The Chinese economy ran a massive trade with the United States all during this period, and market forces might have forced the Yuan much, much lower over this period.[27]

Between 2014 And 2017 the Yuan changed direction and was clearly devaluing. Was this evidence of intentional currency manipulation?

In this case, probably not. First, looking at the Broad index in **Figure 24** reminds us that nearly *every* major currency in the index was devaluing because of expected rising interest rates in the United States (although unlike the European nations, the PBC has been raising rates in China).

Something more complicated has been at work since 2016. It is clear from the frequent execution of Chinese monetary policy that the PBC is doing everything in their power to *prevent* a further depreciation of the currency.

The Yuan is still not a free currency because the Chinese government has very stringent *capital controls* on the Yuan. Unlike the currencies of the majors, Chinese citizens and businesses are not free to swap the Yuan for Dollars or Euros - they can do so only if they follow very strict rules in relatively limited quantities. But wealthy Chinese families and Chinese businesses have effectively developed an enormous black market swapping the Yuan for foreign currencies and *this* activity is devaluing the Yuan. And because of the Yuan's unsanctioned devaluation, this activity appeared to be accelerating at the time this chapter was revised.

The Chinese government was so determined to stop devaluation in 2015 and 2016 that the PBC squandered nearly 25% of the nation's Dollar foreign reserves (from approximately $4 trillion in early 2015 to $3 trillion in early 2017) to bolster demand for the Yuan, largely to no avail.[28]

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[27] Your teacher consistently made this argument through the period in question. In his analysis, the managed float rate, although it allowed an appreciation of the Yuan, slowed that appreciation down considerably and prevented the adjusting exchange rate from allowing more balance in the terms of trade.

[28] This is much discussed in the financial media in 2016 and 2017. A typical article; Scott Cendrowski, *Fortune,* "How much more China's Foreign Reserves Can Fall," February 7, 2017.

Finally, in 2017, the aggressive policies of the PBC began to take effect. Through 2017 and into 2018 the Yuan has strengthened relative to the Dollar. There is certainly no case for Chinese currency manipulation at the present.