CHAPTER 4. FOREIGN EXCHANGE AND GOODS PRICES

Trade, Goods Prices, and FX Rates

Let us assume that in the United States the price of a watch is $12 and the price of a bushel of grain is $4. Assume that the price of a watch in Switzerland is Sf 16 and a bushel of grain is Sf 8.

	USA	Switzerland
Grain	$ 4	Sf 8
Watch	$ 12	Sf 16

Differences in relative prices reflect differences in resources, skills, tastes, and social conditions. Let us see how these relative prices relate to trade and the FX rate. If the FX rate were below **1.33 Sf/$ (= Sf 16/$12)**, both watches and grain would be cheaper in the United States.

Example: at 1 Sf/$, a Swiss watch would be $16 and a bushel of Swiss grain would be $8. These prices are both higher than the prices in the United States ($12 for a watch and $4 for grain).

In the absence of trade barriers and shipping costs, such a low FX price of the US dollar (high FX price of the Swiss franc) would imply that Swiss citizens would import both watches and grain from the United States.

If the spot FX rate were above **2 Sf/$ (= Sf 8/$4)**, both watches and grain would be cheaper in Switzerland than in the United States, when viewed in the same currency.

Example: at an FX rate of 4 Sf/$, the price in US dollars of Swiss watches would be $4 and the price in US dollars of a bushel of Swiss grain would be $2. These prices are both lower than the prices in the United States ($12 for a watch and $4 for grain).

In the absence of trade barriers and shipping costs, such a high FX price of the US dollar would imply that US citizens would import both watches and grain from Switzerland.

If the spot FX rate is between **1.33 Sf/$** and **2 Sf/$**, there is a ***basis for trade***.

Example: at 1.60 Sf/$ Swiss watches with a price of Sf 16 can be exported to the United States to sell for $10 (under the US price of $12), and US grain bushels with a price of $4 can be exported to Switzerland to sell for Sf 6.40 (under the Swiss price of Sf 8).

We cannot say what the equilibrium FX rate is without additional information. The ***equilibrium FX rate*** is the rate that brings the value of the exports and imports of the countries into balance, and thus depends on demand levels and production capacities.

Despite the benefits of trade, grain producers in Switzerland and watchmakers in the United States would not favor the specialization and trade. They might pressure their governments for ***trade barriers***, a form of ***protectionism***. Examples of trade barriers are ***quotas***, ***tariffs*** on imports, and ***government subsidies*** to domestic producers.

In between the **no-trade** and **free trade** extremes is a spectrum of trade arrangements. For example, countries can reduce tariffs or increase quotas for trade with specific other countries in mutual preferential trade arrangements.

Absolute Purchasing Power Parity (APPP)

The price of a tradable commodity in one country should theoretically be equal to the price of the same commodity in another country, after adjusting for the FX rate. The principle is an application of the ***law of one price***. When this principle is applied internationally to a representative good or a basket of goods, it is called the ***Absolute Purchasing Power Parity (APPP) condition***.

Example: use wheat as the representative good:
Price of a bushel of wheat in the United States at time *N*: $P_N^{\$}$
Price of a bushel of wheat in the United Kingdom at time *N*: $P_N^{£}$
The **APPP** condition implies: Spot FX rate at time *N should be* $\frac{P_{N\$}}{P_{N£}}$ as in equation (4.1).

The ***p* superscript** in $X_N^{p\$/£}$ **denotes** that the **reference is to the *parity* spot FX rate**, (as opposed to the ***actual*** spot FX rate, $X_N^{\$/£}$).

Absolute Purchasing Power Parity (APPP) Condition

$$X_N^{p\$/£} = \frac{P_{N\$}}{P_{N£}} \qquad \textbf{(4.1)}$$

Example: assume at time *N* that a bushel of wheat costs $P_N^{\$}$ = \$1.60 in the United States and $P_N^{£}$ = £1.00 in United Kingdom. The APPP condition says that the spot FX rate at time *N* should be $X_N^{p\$/£}$ = \$1.60/£1.00 = 1.60 \$/£. At this FX rate, someone in the US could buy a bushel for \$1.60, or exchange the \$1.60 into £1.00 and purchase a bushel in the UK for £1.00. Either way, the cost of wheat is the same.

Assume that a bushel of wheat costs \$3.00 in the United States and €2.50 in France (in the Eurozone). What does the APPP condition say should be the spot FX rate? Express your answer in the form of the accepted FX quotation convention.

Answer: *Since the euro FX rate is conventionally expressed in American terms, we want the answer to be in \$/€. Thus,* ***$P^{\$}/P^{€}$ = \$3.00/€2.50 = 1.20 \$/€*** *is the FX rate that will make the cost of a bushel of wheat the same in both economies.*

The theoretical argument behind the APPP condition is that if a country's goods were relatively cheap internationally, ***goods market arbitrage*** would create pressure on both FX rates and goods prices to correct, and to thereby conform to, uniform international prices.

Example: in our example of Swiss watches and US grain we fix the spot FX rate at 1.60 Sf/$. Taking as given the price of a Swiss watch in the United States of $10 (= Sf 16 ÷ 1.60 Sf/$) and the price of a bushel of US grain in Switzerland of Sf 6.40 (= $4(1.60 Sf/$)), the **APPP** condition says that the price of US watches in the United States should drop from $12 to the price of a Swiss watch, $10, and the price of a bushel of Swiss grain in Switzerland should drop from Sf 8 to the price of a bushel imported from the United States, Sf 6.40.

FX Misvaluation

Despite the economic logic underlying the APPP condition, actual FX rates are often not equal to the APPP ideal. The APPP condition assumes no **frictions** to international trade, like transportation costs and trade barriers (like tariffs, quotas, and language/cultural barriers). In reality, these **frictions can be significant**.

Stickiness in goods prices, in a world where FX rates change continually for many reasons, can also be an explanation for why the APPP condition does not describe actual FX rates.

Example: suppose we assume the APPP condition at first holds for wheat prices of $P_0^{\$}$ = $1.60 and $P_0^{£}$ = £1.00. Thus the actual spot FX rate, $X_0^{\$/£}$, is assumed at first to be equal to the theoretically correct APPP rate, $X_0^{p\$/£} = \frac{\$1.60}{£1.0}$ = 1.60 $/£. Then let us say that the actual spot FX rate subsequently rises to $X_1^{\$/£}$ = 2.00 $/£.

The reason for the rise is not important. Say it was because foreign investors moved funds into British investments, or there was some speculation by currency traders. Whatever the reason for the actual spot FX rate change, *before any adjustment of wheat prices takes place, a wheat buyer in the United Kingdom will now have the incentive to import wheat from the United States*. Given the new **actual spot FX rate of 2.00 $/£**, **it will take £1.00, the equivalent of $2.00, to buy a bushel of wheat in the United Kingdom** but only **£0.80, the equivalent of $1.60, to buy a bushel of wheat in the United States**. Correspondingly, wheat buyers in the United States will not tend to import any wheat from the United Kingdom, since $1.60 will still buy a bushel in the United States, but will convert to only £0.80, which would buy less than a bushel in the United Kingdom. In principle, goods arbitrageurs could buy wheat in the United States and sell it in the United Kingdom.

Unless and until the actual FX rate changes again or one or both wheat prices adjust to reestablish the APPP condition, the US dollar/pound FX rate is ***misvalued*** in terms of purchasing power. The **British pound** is OVERVALUED, in the sense that the pound can purchase more overseas (in the United States) than the equivalent amount of US dollars can purchase overseas (in the United Kingdom). Correspondingly, the **US dollar** is UNDERVALUED.

Using goods prices as the measure of intrinsic FX value, an overvalued currency is one

where the actual FX price of the currency is higher than the APPP FX value of the currency.

Example: above, the time-1 FX price of the pound is 2 $/£ while the APPP FX value of the pound is 1.60 $/£. Thus the pound is **overvalued** at time 1. Similarly, the time-1 FX price of the US dollar is 0.50 £/$ while the APPP FX value of the US dollar is 0.625 £/$; the US dollar is **undervalued** at time 1.

The terms ***strong*** and ***weak*** are frequently applied inconsistently in FX. Sometimes "***strong***" is intended to be synonymous with "overvalued" (and "***weak***" means "undervalued"). Other times, "***strong***" is used to describe a currency that is appreciating or has appreciated. Confusion may occur if a currency that is undervalued is appreciating (correcting); the currency would be weak in the first sense, but simultaneously strong in the second sense.

The Big Mac Index

A popular yardstick of FX valuation in terms of purchasing power is ***The Economist's Big Mac Index***. This is an index based upon McDonald's "Big Mac" hamburger prices around the globe that **tries to reflect the degree of misvaluation in current spot FX rates**. The *Economist* traditionally published its Big Mac Index annually in April. Now, the Web site http://www.oanda.com/products/bigmac/bigmac.shtml has a current version. Exhibit 4.1 shows values according to spot FX rates for October 10, 2003.

The first column in Exhibit 4.1 shows local-currency prices of a Big Mac; the second converts the local prices into US dollars using the actual spot FX rates shown in the third column. The average price of a Big Mac in the United States is $2.65. The cheapest Big Mac among the countries in Exhibit 4.1 is in China ($1.20); at the other extreme the most expensive is $4.66 in Switzerland. This is another way of saying that the Chinese yuan is the most undervalued currency (by 54.7%), and the Swiss franc the most overvalued (by 76.2%).

The last column shows APPP spot FX rates based on Big Mac prices in local currency. For instance, dividing the Japanese price (¥263) by the American one ($2.65) gives an APPP spot FX rate of 99.25 ¥/$ (which differs from the rate shown of 99.40 ¥/$ because of some rounding.) The actual spot FX rate was 111.20 ¥/$, representing a higher FX price of the US dollar, implying that the US dollar is overvalued, and the yen is undervalued against the US dollar (by 10.6%), using Big Mac prices as a standard of intrinsic FX value.

Burgers are a flawed measure of APPP value, however, because local prices may be distorted by trade barriers on beef, sales taxes, or big differences in the cost of non-traded inputs such as rents. These reasons could imply that Big Mac APPP FX rates may not be a reliable guide to future FX movements. Yet several academic studies have concluded that the Big Mac index is surprisingly accurate in tracking gradual FX changes over the longer term. Thus, the Big Mac Index may at least give a rough idea of intrinsic FX value relative to goods prices.

Example:Dividing the Japanese price (**¥263**) by the American one (**$2.65**) gives an **APPP spot FX rate of 99.25 ¥/$** (which differs from the rate shown of **99.40 ¥/$** because of some rounding.)
The actual spot FX rate was **111.20 ¥/$**, representing a higher FX price of the US dollar, implying that the US dollar is overvalued, and the yen is undervalued against the US dollar (by **10.6%**), using Big Mac prices as a standard of intrinsic FX value.

OECD and APPP

The ***Organization for Economic Cooperation and Development (OECD)*** also publishes information on FX values by APPP for OECD countries, based on countries' Gross Domestic Product (GDP). The **OECD** is an international organization that fosters economic development. The OECD has 30 member countries and active relationships with 70 others. The organization is best known for publications and statistics, including individual country surveys and reviews. The OECD promotes rules of the game in areas where multilateral agreement is necessary for individual countries to make progress in the global economy.

Figure 4.1 shows the ***undervaluation*** and ***overvaluation*** of some currencies (relative to the US dollar) using OECD's GDP approach to APPP. This chart was found on the Web page http://fx.sauder.ubc.ca/PPP.html. This Web page also has an excellent discussion of PPP.

Figure 4.1: OECD APPP

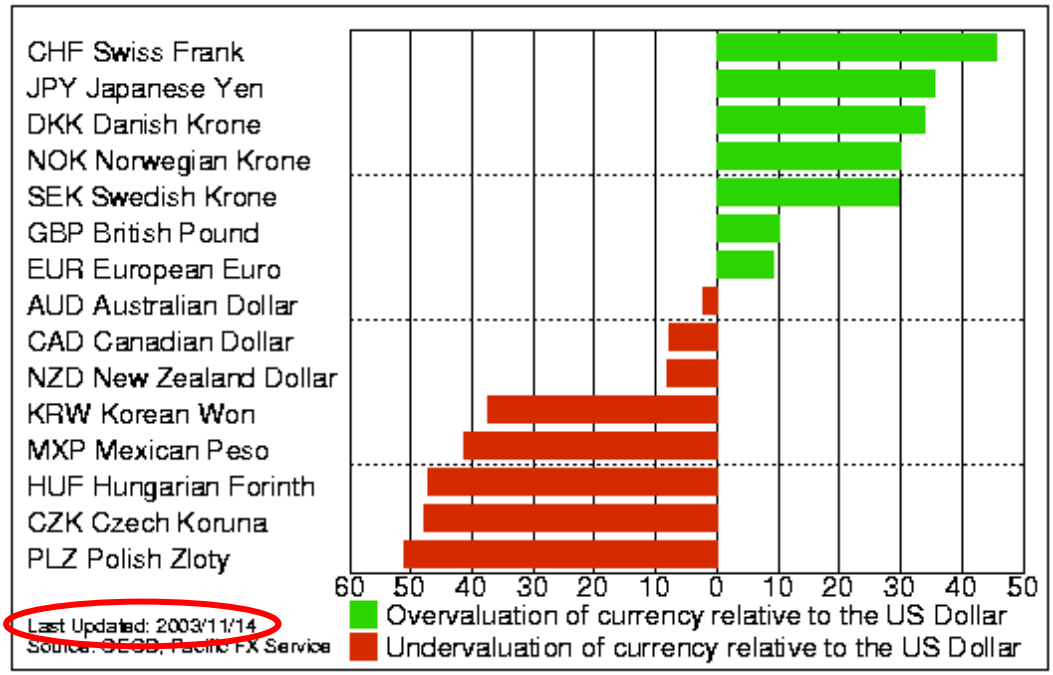


Figure 4.2 uses historical OECD data to compare graphically actual FX rates for the pound and the yen and the corresponding APPP FX rates. **One can see how the actual FX rate fluctuates around the APPP FX rate**. **We can think of the actual FX rates as fluctuating around intrinsic FX value**. The data for Figure 4.2 were obtained from the OECD Web site, http://www.oecd.org/department/0,2688,en_2649_34357_1_1_1_1_1,00.html.

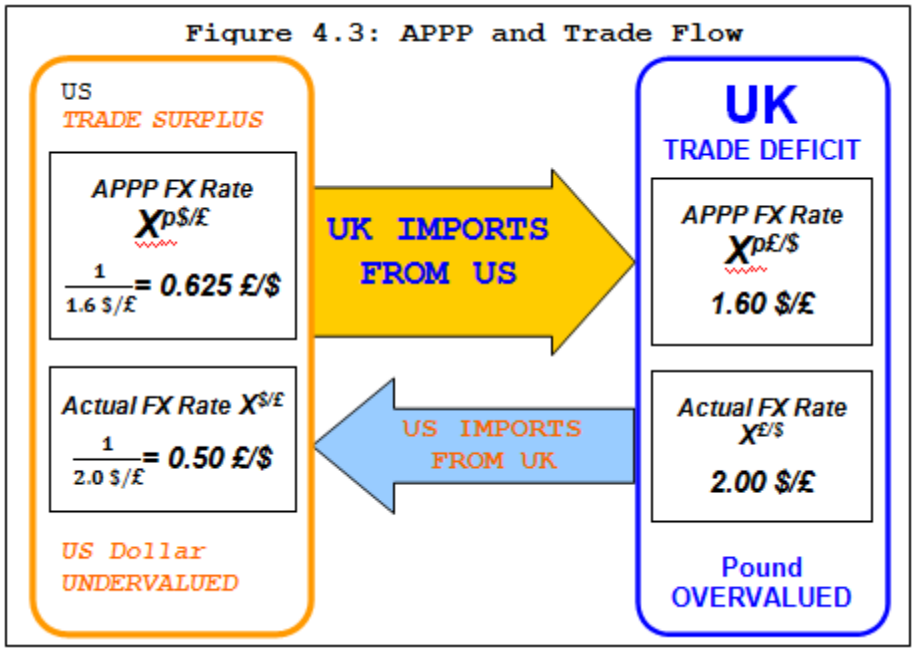
FX Misvaluation and Trade Imbalances

Other things equal, a nation whose currency is overvalued will have high demand for foreign goods, and its own goods will be in low demand, implying that **a country with an overvalued currency will tend to import more goods than it exports**.

A country that imports more than it exports (measured in a currency, i.e., billions of US dollars) over a period of time has a ***trade deficit*** for that time period. The opposite of a trade deficit is a ***trade surplus***, which is an excess of the monetary value of exported goods over imported goods over a period of time. Trade imbalances can occur for a number of other reasons too, including trade barriers, but FX values have an impact.

In the situation depicted in Figure 4.3, the actual FX rate is 2.00 $/£ (= 0.50 £/$) but the APPP FX rate is 1.60 $/£ (= 0.625 £/$). Thus **the pound is overvalued** and the **US dollar is undervalued**. The United Kingdom **trade deficit** that results is shown by **larger imports** than exports. The United States **trade surplus** is shown by **larger exports** than imports.

Figure 4.3: APPP and Trade Flow



The high relative demand for products from the country of the undervalued currency (the United States in Figure 4.3), and for that country's currency to buy the products (the US dollar), will tend to result in both higher goods prices in that country and, more immediately, an appreciation of that country's currency. Of course, the overvalued currency depreciates, and the demand for the country's goods is relatively lower as long as its currency remains overvalued.

Thus there is a built-in tendency for FX misvaluations to self-correct.
Studies have shown that the adjustment process of FX misvaluations toward APPP is very

gradual, as so many other factors affect FX rates.

Other things the same, as long as the misvaluation between an FX rate and goods prices persists there will be a tendency for the overvalued currency to continue to gradually depreciate and the undervalued currency to continue to gradually appreciate.

Note that a country with a strong economy (high productivity and growth) may experience a trade deficit as a natural consequence of the bright economic scenario. Foreign capital is likely to be invested, driving up the spot FX price of the domestic currency. As this happens while goods prices are sticky, the domestic currency becomes overvalued in purchasing power terms. Then a trade deficit may result from use of the overvalued currency to import goods from abroad relatively cheaply. In this case the trade deficit is a natural consequence of an economy experiencing (and expecting) strong productivity and growth.

The large US trade deficit in the 1980s may have been an example of this sort of scenario. During the early 1980s investment was coming to the United States from abroad. **As the foreign investment demand for the US dollar drove up its FX price, the US dollar became overvalued in terms of goods prices. Hence the US trade deficit**.

But **a trade deficit does not necessarily reflect a strong economy**. In the 1990s, the Thai baht was overvalued (at least compared to Thailand's main Asian trading partners), Thailand had a trade deficit, and the prospects for the economy were illusory. The baht had been supported and stabilized by the Thai central bank for the specific purpose of attracting foreign investment. But the hoped-for economic results of the investment never materialized. **As foreign investors began to realize the situation and disinvested, and as the Thai central bank** (and other Southeast Asian central bank allies helping Thailand defend the baht, like Malaysia and Indonesia) **began to run out of FX reserves and the baht collapsed initiating the Asian currency crisis**.

Sometimes we see government policy to keep the FX price of a currency undervalued, as a way to generate trade surpluses, because exporting more than importing should increase domestic employment. This is the strategy that China has followed recently relative to the United States. The box "February 2004" discusses a policy by Japan to keep the yen low in FX price. While these cases are significant, concern over trade imbalances (deficits and surpluses) is less than in the days of ***mercantilism***, where countries vie to win over others in international trade. Instead, in the integrated global economy, countries' economies are interdependent, and trade becomes imbalanced at times as part of the natural development of the global economy.

Another reason that concern over trade imbalances has subsided somewhat is the global use of hard currencies. For example, US dollars sent to countries outside the United States for imports are not always **returned for gold or official FX reserves**. Instead, US dollars serve more or less as an international currency. If US officials were to try to create a depreciation of the US dollar to correct a trade deficit, confidence in the US dollar as international currency would drop.

Is this appropriate?

The Bretton Woods System of Pegged Exchange Rates (1944-1973)

The Bretton Woods Agreement in 1944 established a system of *pegged FX rates* between countries. The pegged FX rates were maintained by direct intervention by central banks. The stability of the pegged FX rates, it was believed, was a means to promote the international trade that would lead to the world's economic recovery after World War II.

Problems with any pegged FX rate system arise when the FX rates become misvalued in terms of purchasing power, which occurred often during the period of the Bretton Woods system.

Example: assume that the actual $/£ spot FX rate is initially pegged at a correct APPP spot FX rate of 2.00 $/£. Now the United Kingdom experiences high inflation in goods prices. Assume that the price of a bushel of wheat there increases from £1.00/bu to £1.60/bu a year later, while the price of a bushel remains at $2.00/bu in the United States. The APPP condition tells us the new spot FX rate should be ($2.00/bu)/(£1.60/bu) = 1.25 $/£, but the actual FX rate is pegged at 2.00 $/£. So the APPP condition does not hold, once the price of wheat escalates in the United Kingdom while the actual spot FX rate stays fixed.

A wheat buyer in Britain will now have an incentive to import wheat from the United States. Given the actual pegged FX rate of 2.00 $/£, £1.00 will buy a bushel in the US market, compared with £1.60 to buy a bushel in the UK market. In principle, goods arbitrageurs could buy wheat in the United States and sell it in the United Kingdom. US wheat buyers will not import wheat from Britain, since $2.00 buys a bushel in the United States and converts only to £1.00, which buys less than a bushel in the United Kingdom.

At the new wheat prices, unless the actual spot FX rate is allowed to change, the pound and the US dollar are misvalued relative to one another in terms of overseas purchasing power. The pound is overvalued (relative to the dollar) in terms of overseas purchasing power; correspondingly, the US dollar is undervalued (relative to the pound) in terms of overseas purchasing power. **Since the actual spot FX price of the pound (2.00 $/£) is greater than what it should be under APPP (1.25 $/£), the pound is overvalued, so the US dollar is undervalued**.

Assume that a country tries to peg its FX rate in terms of the US dollar at a time when the APPP condition holds. But the country experiences higher inflation than the United States. After the inflation, which currency is overvalued, and which is undervalued? Which country is likely to experience a trade deficit and which a trade surplus?

***Answers**: After the inflation, the foreign currency is overvalued and the US dollar is undervalued. The foreign country is likely to be a net importer of US products and experience a trade deficit, while the United States will be a net exporter and will have a trade surplus.*

One can argue that with pegged FX rates there should be pressure on the goods prices to change in such a way that APPP holds. While there might be some such pressure, in fact **the frictions and the complexity of the real world make good price changes very slow**. Thus, **trade deficits and surpluses are likely to persist for relatively long periods**.

We can now understand why the Bretton Woods system of pegged FX rates finally collapsed in the early 1970s. **If two countries are experiencing different inflation rates, but FX rates are held fixed by the pegging arrangement, the country with the higher inflation will lose export markets for its goods because its currency is overvalued. With the loss of export markets, the country's less productive industry will support fewer jobs, and the economy suffers**. Trade deficits in this case would thus signal potential problems for the nation's economy.

During the period of the Bretton Woods system, countries did follow dissimilar national policies on inflation, and some FX rates became misvalued as a result. Some western European countries tried social policies that created high inflation, for example, which with pegged FX rates led to overvalued currencies and trade deficits. At times, these countries had to resort to official devaluation to stimulate their economies and "import jobs".

Currency devaluations were contrary to the design of the Bretton Woods system. Currency speculators compounded the problem by using a country's trade deficit figures to forecast an eventual devaluation. Then the speculators would sell the endangered currency before the devaluation, creating further pressure for the central bank to devalue. As long as the central bank delayed the inevitable devaluation, speculators were able to sell the currency and then profit at the expense of any central banks that bought it.

At Bretton Woods, the US dollar was initially pegged at an overvalued FX price to both the German mark and the Japanese yen. The purpose was to allow these two countries, which had been the most devastated by World War II, help in rebuilding their economies by making their goods relatively inexpensive in overseas markets. The plan worked so well that the German and Japanese economies became quite powerful by the late 1960s. (Both countries' economic growth was further enhanced by the absence of military expenditures.) Germany and Japan followed very strict anti-inflation policies to ensure economic recovery and development, and when the United States began to experience more inflation in the 1960s, the US dollar became even more overvalued relative to the mark and the yen. The economic consequences of misvalued currencies led the participants of the Bretton Woods agreement to dispense with the pegging system in the early 1970s and allow free market ***floating*** *FX rates.*

In addition to the pegged FX rate system, the Bretton Woods Agreement established the ***International Monetary Fund (IMF)***, an organization whose primary functions were originally to oversee the stability of the international FX system and to provide assistance to any member country in a short-term international monetary crisis. **Example**: suppose currency traders at banks decided to sell their inventories of a currency back to the central bank that issued the currency, at the pegged FX rate, and in return receive large quantities of the central bank's gold or FX reserves. If the central bank were to give up too much gold or FX reserves, confidence in that nation's economy and in its currency would decline both inside that country and outside, possibly precipitating a national or international financial crisis. The IMF's role has been to help the beleaguered central bank weather the run by lending it some funds. The IMF was also established to provide short-term monetary help to countries trying to develop modern economies for the first time or to rebuild economies after wars or revolutions, including World War II.

Also established at Bretton Woods was the ***World Bank***, also known as the ***International Bank for Reconstruction and Development (IBRD)***. The function of the World Bank is to provide capital to countries trying to develop or rebuild their economies. Unlike the IMF, the World Bank may issue bonds, in any currency, for purposes of raising capital.

The Euro

After the collapse of the Bretton Woods system, a number of European countries tried to stabilize their FX rates relative to each other under the ***European Monetary System***, starting in 1979. The goal of FX stability was intended to facilitate trade within the European Economic Community. The system involved a composite currency, called the ***European Currency Unit*** *(ECU)*, consisting of fixed amounts of 12 member currencies. FX rates were pegged relative to the ECU.

But problems and pressures occurred like those that led to the end of the Bretton Woods system. As we said, **pegging FX rates does not work if some countries control inflation and others do not**. **Countries with the higher inflation want to devalue their currency when it gets overvalued. This defeats the purpose of the pegged FX system**.

By 1992, the drive for monetary stability led to the ***Maastricht Treaty***, in which a number of European nations established the **European Central Bank (ECB)** and agreed to use a single currency, the ***euro***. This monetary unification was designed to overcome the problems of pegged FX rates that countries can devalue at almost any time.

In the years just prior to the introduction of the euro, it was essential to stabilize the FX rates of the existing European currencies. The reason was that the national currencies had to be converted into the euro at a fixed FX rate. In order to prevent misvaluations, countries participating in the euro had to harmonize their economic policies in terms of growth, inflation, money supply, and so forth.

In 1999, the euro was launched as an electronic currency and finally, in 2002, national currencies were replaced with the euro as legal tender. Denmark, Sweden, and the United Kingdom were the only members of the European Economic Community that did not join the euro. For the members that did join the euro, the uncertainty and transaction costs of exchanging currencies with each other has been reduced, encouraging trade and economic prosperity.

Currency Boards and Dollarization

Not all FX pegging is doomed. **A number of smaller countries with stable economies are able to maintain FX rates that are pegged to a major hard currency**. The Hong Kong dollar (HK$) is an example of a currency that has been successfully tied to the US dollar for many years.

The method used by Hong Kong is called a ***currency board***.
A currency board has four tenets:
(1) To prohibit the central bank from printing money that is not backed by FX reserves of hard foreign currencies;
(2) to permit the country's currency to be freely redeemed on demand for hard-currency FX reserves, a feature called ***free convertibility***;
(3) to peg that currency's FX price to a hard currency, often the currency of the major trading partner; and
(4) to require the government to maintain responsible economic policies.

As FX reserves, the board holds interest-bearing securities in the reserve currency. Other examples of successful currency boards are Estonia and Lithuania.

Argentina successfully operated a plan similar to a currency board for a while in the 1990s, but it gave way in early 2002 amidst economic crisis. Argentina had been plagued by high inflation until 1991. In one month in 1989, goods prices in Argentina rose by nearly 2300%. This kind of inflation caused currency depreciation and discouraged investment. **With the currency board plan, inflation was under control by 1992,** and Argentina's economy got on track. But the plan failed in the fourth tenet, to require the government to maintain responsible economic policies. By 2002, the inability of country's politicians to curb government spending and reform labor laws had brought about political and economic chaos.

Dollarization is the replacement of local currency with the US dollar. It may seem like a large loss in prestige for a country to give up its own currency, but this may be acceptable when the alternative is monetary chaos. Ecuador and El Salvador, for examples, have dollarized. **Dollarization is a legalization of the natural use of a hard currency as a store of value in soft-currency countries**, which is quite frequent.

More information on currency boards and dollarization may be obtained at http://www.dollarization.org/.

Relative Purchasing Power Parity (RPPP)

There is an extension of the APPP condition that has to do with FX movements over time. This dynamic version of purchasing power parity theory relates FX changes to relative inflation rates, where inflation rate refers to the percentage change in goods prices, is known as the
Relative Purchasing Power Parity (RPPP) condition.

Let us continue the US-UK wheat example to explain. The percentage change in the price of wheat in a country will represent the inflation rate in the country.
Denote the inflation rate in the United States as $p^{\$}$
Denote the inflation rate in the United Kingdom as $p^{£}$.
If the bushel prices of wheat at time 0 are $P_0^{\$}$ and $P_0^{£}$, then new bushel prices of wheat at time 1 are $P_1^{\$} = P_0^{\$}(1 + p^{\$})$ and $P_1^{£} = P_0^{£}(1 + p^{£})$, respectively. It may help to think of the inflation rates as pertaining to a unit of time, say, one year. For example, assume **bushel prices at time 0 of $P_0^{\$}$ = \$2.00 in the United States** and **$P_0^{£}$ = £1.00 in the United Kingdom**, and that the **inflation rate in the United States is 6%** and **in the United Kingdom 3%**. Then **the new US price of wheat in a year is \$2.00(1.06) = \$2.12** and **the UK price is £1.00(1.03) = £1.03**.

The APPP condition says that **the spot FX rate at time 0 should be:**

$$X_0^{p\$/£} = P_0^{\$} / P_0^{£} = \$2.00/£1.00 = 2.00\ \$/£,$$

and that **the new spot FX rate at time 1 should be**

$$X_1^{p\$/£} = \$2.12/£1.03 = 2.06\ \$/£$$

(derived from the given inflation rates). Despite the appreciation of the pound (and the depreciation of the US dollar), the US dollar/pound spot FX rate is correctly valued in terms of wheat prices at both the beginning and ending times. That is, if the APPP condition holds at both times, there is no FX misvaluation in purchasing power terms, despite the change in the nominal FX price of the currencies.

The **RPPP** condition in terms of spot FX rates **at time 0 and time 1** can be expressed as equation (4.2).

RELATIVE PURCHASING POWER PARITY (RPPP) CONDITION V FX RATE FORM

$$X_1^{p\$/£} = X_0^{p\$/£}\left[\frac{(1+p^{\$})}{(1+p^{£})}\right] \qquad (4.2)$$

To grasp the logic behind equation (4.2), think in terms of Figure 4.4 with time 0 on the left and time 1 on the right, and with US dollars on the top and British pounds on the bottom.

Start at the top left with an amount of US dollars at time 0 that will purchase a bushel in the United States, $P_0^{\$}$.

Moving to the right, the price of a bushel in the United States at time 1 is $P_1^{\$} = P_0^{\$}(1 + p^{\$})$.

If the APPP FX rate holds at time 0, you can convert $P_0^{\$}$ into the amount of British pounds at time 0 (downwards on the left) that will purchase a bushel in the United Kingdom, $P_0^{£} = P_0^{\$}/X_0^{p\$/£}$.

Moving to the right and thus going forward in time, it will take $P_1^{£} = P_0^{\$}(1 + p^{£})/X_0^{p\$/£}$ to purchase a bushel in the United Kingdom at time 1.

Thus if the APPP FX rate holds at time 1, then $X_1^{p\$/£} = P_1^{\$}/P_1^{£}$, which we see on the right is equal to $X_0^{p\$/£}(1 + p^{\$})/(1 + p^{£})$, the FX rate form of the RPPP condition in equation (4.2).

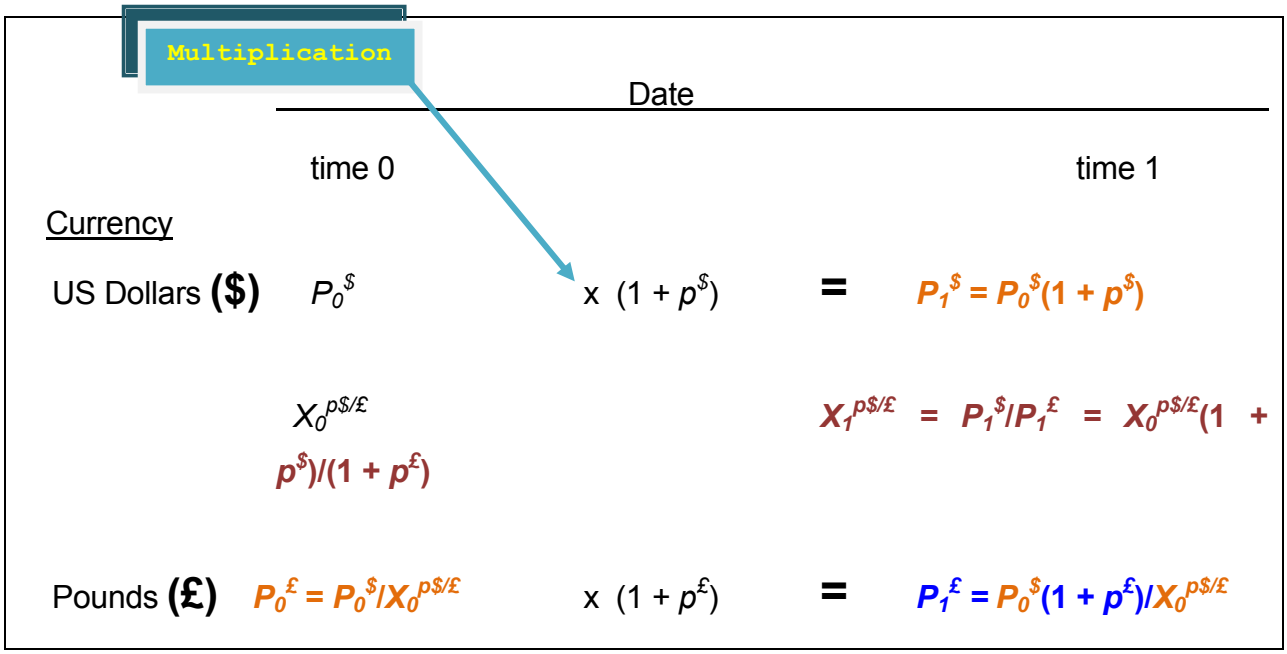


Figure 4.4 Logic flow of the RPPP condition, equation (4.2).

We can also express the RPPP condition in an equivalent (and popular) percentage form. We **compute the percentage change in the spot FX price of the denominator currency**.

Example: if the spot FX price of the pound at time 0 is $X_0^{\$/£}$ = 1.60 \$/£ and appreciates to 2.00 \$/£, then the percentage change in the spot FX price of the pound is (2.00 \$/£ – 1.60 \$/£)/(1.60 \$/£) = 0.25, or 25%.

In general, the percentage change in the spot FX price of the pound over the period from time 0 to time N is $(X_N^{\$/£} - X_0^{\$/£})/X_0^{\$/£}$, or $X_N^{\$/£}/X_0^{\$/£} - 1$, denoted $x_N^{\$/£}$.

(Often **lower case letters to denote percentage change variables**.)
For now, we add a superscript *p* to indicate that we are dealing with PPP values.
Thus, $x_1^{p\$/£}$ denotes the:

RPPP percentage change in the FX rate = $x_1^{p\$/£} = \dfrac{X_1^{p\$/£}}{X_0^{p\$/£}} - 1$

Thus an *alternative expression* of the RPPP condition is in equation (4.3):

RELATIVE PURCHASING POWER PARITY (RPPP) CONDITION

(PERCENTAGE FORM)

$$1 + x_1^{p\$/£} = \frac{(1+p^{\$})}{(1+p^{£})} \quad \textbf{(4.3)}$$ (this is lower case x)

As seen in the RPPP equation (4.3), the percentage change in an **FX rate** that is **correctly valued** in terms of goods prices is based on the ***inflation rate differential***.

Example: to apply equations (4.2) and (4.3), assume that the spot $/€ FX rate at time 0 is 1.15 $/€, and that the APPP condition holds. Assume that over the next year, the inflation rate in Europe is 5% and in the United States 3%.

Using equation (4.2), the time-1 spot FX rate, according to the RPPP condition of equation (4.2), should be (1.15 $/€)(1.03/1.05) = 1.128 $/€.

Using equation (4.3), the percentage change in the $/€ FX rate, if the RPPP condition holds, should be $x_1^{p\$/€}$ = 1.03/1.05 – 1 = – 0.019, or – 1.9%.

That is, **the spot FX parity price of the euro should drop by 1.9%.** As a consistency check, we verify the new FX rate found using equation (4.2) with the percentage FX change found using equation (4.3): (1.15 $/€)(1 + $x_1^{p\$/€}$) = (1.15 $/€)(1 – 0.019) = 1.128 $/€.

In this scenario, the euro depreciates from 1.15 $/€, to 1.128 $/€, offsetting the higher inflation in Europe. **The only way for the APPP condition to hold after the higher goods price increase in Europe is for the US dollar to buy more euros, so the US dollar appreciates and the euro depreciates**.

Of course, the RPPP conditions may be expressed in **European terms**: $X_1^{p£/\$} = X_0^{p£/\$}[(1 + p^{£})/(1 + p^{\$})]$ *and* $1 + x_1^{p£/\$} = (1 + p^{£})/(1 + p^{\$})$.

Remember: Put the inflation rate of the numerator currency of the FX

expression in the numerator when using equations (4.2) and (4.3).

Assume that today's spot FX rate for the Swiss franc is 1.60 Sf/$. What will be the spot FX rate a year from now, and what will be the percentage change in the spot FX price of the US dollar, after 5% inflation in Switzerland and 10% inflation in the US, assuming the RPPP condition holds?

Answer: *Using equation (4.2), the time-1 spot FX rate should be (1.60 Sf/$)(1.05/1.10) = 1.527 Sf/$. The RPPP percentage change in the spot FX price of the US dollar is found using equation (4.3): 1 + $x_1^{pSf/\$}$ = (1.05/1.10) = 0.9545. Thus $x_1^{pSf/\$}$ = –0.0455.*

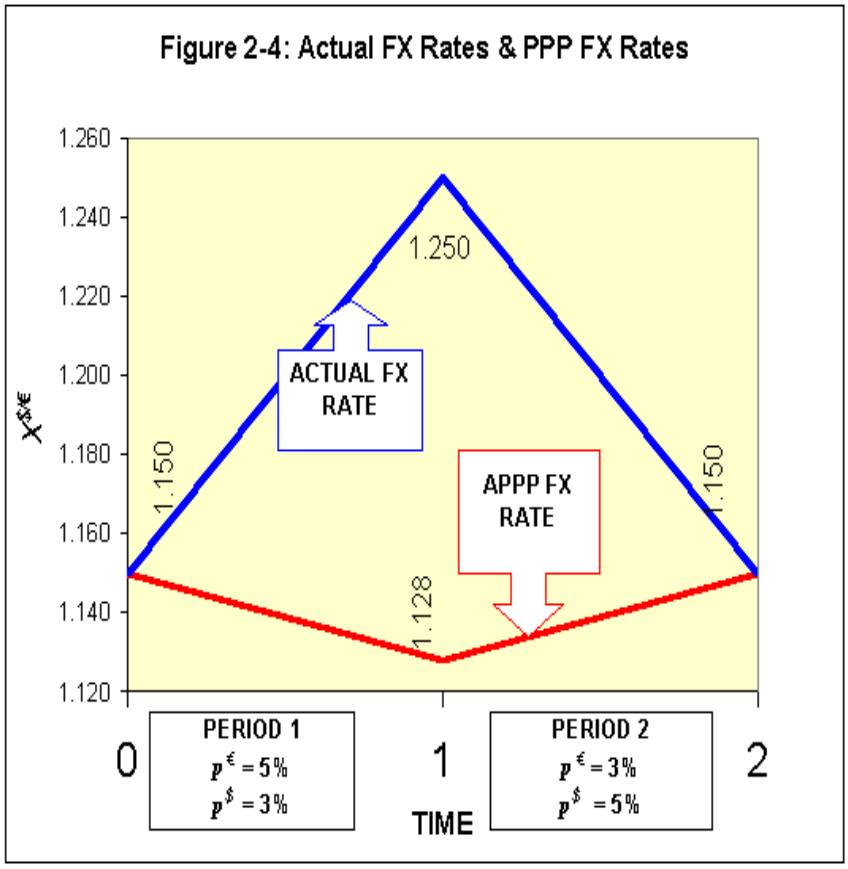
The RPPP condition is a simple theory of how FX rates *should* move in a system of market-determined FX rates and goods prices, **assuming that the APPP condition is valid**. Of course**, it is possible for the RPPP condition to hold even though the APPP condition does not. Two currencies could be misvalued at both time 0 and time 1, yet the change in the FX rate could be driven exactly by the inflation rate differential, just as RPPP says**.

But **given that the APPP condition does not fit actual real-world spot FX rates, as we discussed earlier, it should not be surprising if RPPP failed to hold too**. To see why this can happen, consider a hypothetical two-period example.

Let us assume again that at time 0, the APPP condition does hold, and the actual spot FX rate is equal to the APPP FX rate, 1.15 $/€, and that over period 1, the inflation rate in Europe is 5% and in the United States 3%. So using equation (4.2), the time-1 spot FX rate, according to the RPPP condition, should be (1.15 $/€)(1.03/1.05) = 1.128 $/€.

Let us say that in period 1 foreign investment into the Eurozone drives up the spot FX price of the euro from 1.15 $/€ to 1.25 $/€. We see that the euro appreciates in period 1 when the RPPP theory says it should depreciate. Thus research with FX data and inflation rate differentials will r**eject the RPPP theory in period 1, because a force other than the differential goods price change caused the actual spot FX rate change**. **At time 1, the euro is overvalued and the US dollar is undervalued**.

In period 2, we may observe the built-in correction tendency for the overvalued euro to drop in FX price, and for goods prices in the United States to rise in response to the overseas demand created by the undervalued US dollar. Say that in period 2 the inflation rate in the United States is 5% and in Europe is 3%. Thus **data from period 2 will again show the exact *opposite* situation from that predicted in the RPPP condition**: The country with the rise in goods prices (United States) will have the currency that *appreciates* as the demand for the US dollar corrects its undervaluation. So **data from period 2 will also reject the RPPP condition**. Figure 4.5 shows the dynamics of the example graphically.



The top line shows the actual spot FX movement. The actual spot FX price of the euro appreciates from 1.15 $/€ to 1.25 $/€ during period 1 due to US investments into the Eurozone. The actual spot FX price of the euro depreciates from 1.25 $/€ to 1.15 $/€ during period 2 due to the correction of the FX misvaluation at Time 1. The bottom line shows the RPPP movement, where the spot APPP FX value of the euro depreciates from 1.15 $/€ to 1.128 $/€ during period 1, when inflation in Euroland is 5% and in the United States is 3%. The spot APPP FX value of the euro appreciates from 1.128 $/€ to 1.15 $/€ during period 2, when inflation in the Eurozone is 3% and in the United States is 5%.

In the *theory* of purchasing power parity, FX rates are supposed to adjust immediately to changes in goods prices and vice versa, enforcing the APPP and RPPP conditions. In a country where inflation is high (and thus where goods prices are not sticky), and the FX rate is not controlled by the government, the RPPP condition is often a reasonably good description of reality, because the main factor affecting FX rates is inflation. A visit to the http://www.fx4casts.com Web site is instructive. The Web site relates to a service that sells FX forecasts. Of course, one cannot obtain up-to-date forecasts free of charge, but the demos are interesting. Exhibit 4.2 shows inflation rate forecasts.

In other cases, however, there are other factors (especially asset markets) that affect FX rates and goods prices are also sticky. Thus, FX rates often become misvalued in terms of goods prices, and neither APPP nor RPPP is an accurate descriptor of the behavior of *actual* FX rates, especially in the short run, because too many other factors affect FX rates. When inflation rates are not high, researchers tend to reject the RPPP condition as a description of actual short-term FX changes.

Nevertheless, the two PPP conditions depict important factors of correct FX value and are thus useful in FX forecasting. The APPP condition is useful because a deviation from APPP may be forecasted to gradually correct itself. The RPPP condition is useful because inflation rates are somewhat forecastable and are at least a factor that should be considered. Many other factors also affect FX rates, but the two PPP conditions are fundamentally important.

*Forecasts of Corrections of FX Misvaluation

Suppose the current actual **spot FX rate is 1 $/€** and the correct FX rate (APPP) is **1.25 $/€**, so the euro is currently undervalued (in terms of the US dollar) by 20%. What is the best forecast of future spot FX rates from this information? The answer depends on the rate at which we forecast the misvaluation to correct itself.

To capture this idea, we assume that the *prior year's* misvaluation will be corrected each year by a constant percentage. The **correction rate** for the spot FX price of the euro is denoted $c^{\$/€}$. A gradual correction of an FX misvaluation by 10% to 15% per year is consistent with the consensus of empirical researchers that the half-life of convergence to parity is three to five years.

Example: assume $c^{\$/€} = 10\%$. Since the euro is presently undervalued by 20%, we forecast the euro to be undervalued a year from now by only 90% of 20%, or 18%. By the same token, our forecast for two years from now is that the euro will be undervalued by only 90% of the prior year's undervaluation of 18%, or 16.2%, and so forth.

To apply this idea, we need to forecast the correctly valued spot FX rates based on the APPP and RPPP conditions.

Assume the **INFLATION RATE DIFFERENTIAL** and the **RPPP CONDITION** tell us to forecast the rate of change in the correctly valued spot FX rate at **2%** per year.

Since the APPP spot FX rate is **1.25 $/€**, the **FORECASTED CORRECTLY VALUED SPOT FX RATE** for the next year would be:

YEAR 1 FORECASTED CORRECTLY VALUED SPOT FX RATE=(1.25$/€)(1.02)=1.275$/€

The forecasted correctly valued spot FX rate for the **following year** would be:

YEAR 2 FORECASTED CORRECTLY VALUED SPOT FX RATE=(**1.275$/€**)(1.02)=**1.30$/€**

and so forth. We can combine the **forecasted correctly valued spot FX rates** and the **forecasted percentage misvaluations** to forecast **actual spot FX rates**.

Example: given that the forecasted correctly valued spot FX rate next year is 1.275 $/€, the forecasted actual FX rate for next year is 1.275 $/€(1 – 0.18) = 1.046 $/€. Given that the forecasted correctly valued FX rate for the following year is 1.30 $/€, the forecasted actual FX rate is 1.30 $/€(1 – 0.162) = 1.09 $/€.

In the first year, the spot FX rate is forecasted to increase from 1 $/€ to 1.046 $/€, a change of 4.6%. In the second year, the expected increase from 1.046 $/€ to 1.09 $/€ represents a change of 4.2%. The actual spot FX rate is forecasted to change at a non-constant rate that gradually converges downward to the RPPP condition rate of change of 2%.

Although the actual spot FX rate is projected to change at a non-constant rate, **there is a useful pattern**: **The *difference* between the forecasted correctly valued spot FX rate (by the RPPP condition) and the forecasted actual spot FX rate changes at a constant rate**. The difference gradually diminishes, changing at the constant rate approximately equal to the forecasted rate of change in the spot FX rate minus $c^{\$/€}$.

In our example, the difference starts at 1.25 $/€ – 1 $/€ = 0.25 $/€,
declines to 1.275 $/€ – 1.046 $/€ = 0.229 $/€,
and then to 1.30 $/€ – 1.09 $/€ = 0.21 $/€, and so on.
The difference changes at a constant rate of approximately 2% – 10% = –8%.

Assume that the RPPP condition tells us that the correctly valued spot FX price of euro will change at the rate of –1.50% per year. Currently, the actual spot FX price of the euro is 1 $/€, whereas the correctly valued spot FX price of the euro is 1.25 $/€. Find the forecasted actual spot FX rates for the next two years assuming that the misvaluation correction rate is 12% per year.

Answer: *First, consider the correctly valued spot FX forecasts. The forecasted correctly valued spot FX rate for next year would be 1.25 $/€(1 – 0.015) = 1.23 $/€. The forecasted spot FX rate for the following year would be 1.23 $/€(1 – 0.015) = 1.21 $/€,*

and so forth. Since the euro is undervalued at the present time by 20% and since $c^{\$/€}$ = 12%, then we forecast the actual spot FX price of the euro to be undervalued a year from now by only 88% of 20%, or 17.6%. By the same token, we forecast the euro to be undervalued by only 88% of 17.6% or 15.5%, two years from now, and so forth. Given that the forecasted correctly valued spot FX rate next year is 1.23 $/€, the forecasted actual spot FX rate for next year is 1.23 $/€(1 – 0.176) = 1.014 $/€. Given that the forecasted correctly valued spot FX rate for the following year is 1.21 $/€, the forecasted actual spot FX rate is 1.21 $/€(1 – 0.155) = 1.022 $/€, since the euro is forecasted to be undervalued at that time by 15.5%.