The Determination of Exchange Rates

Supply and demand analysis shows that there are many factors affecting the exchange rate. However, most economists believe that the primary factor determining exchange rates in the long run is price differentials between countries and the primary factor determining exchange rates in the short run is interest rate differentials.

The Law of One Price (LOOP)

LOOP states that goods cost the same, when expressed in the same currency, everywhere in the world:

$$P^i_{US} = E_{\$/€} * P^i_{EUR}$$

P^i_{US}: U.S. Price of Good i

$E_{\$/€} * P^i_{EUR}$: European price in $ of Good i

LOOP is based on the idea that arbitrage will equalize prices across different countries.

Absolute Purchasing Power Parity (PPP)

PPP extends LOOP to the general price level. It states that the general price level, when expressed in the same currency, is the same everywhere in the world:

$P_{US} = E_{\$/€} * P_{EUR}$

If LOOP holds, PPP will also hold. However, PPP can hold without LOOP holding.

PPP as a Theory of the Nominal Exchange Rate

PPP assumes that

$P_{US} = E_{\$/€} * P_{EUR}$

This equation can be rearranged to solve for the nominal exchange rate.

$E_{\$/€} = P_{US} / P_{EUR}$

Example

A hotel room costs $100 in the U.S. but €80 in Paris.

$E_{\$/e} = 100/80 = 1.25$

What happens if U.S. prices double but European prices remain constant?

P_{US} is now $200

$E_{\$/e} = 200/80 = 2.5$

The exchange rate has also doubled.

Note that the cost of the Paris hotel room is now $E_{\$/€} * P_{EUR}$, or 2.5*80 = $200. Notice the dollar price of the hotel room has risen, even though the euro price is constant. The U.S. price and the European prices are the same when measured in dollars, which is required by PPP.

The Determination of the Price Level

Purchasing Power Parity states that the exchange rate is determined by the price level in two countries.

But what determines the price level?

We will the quantity theory of money to explain how the price level is determined. This will provide the ultimate determinants of the exchange rate. Since PPP is likely to hold only in the long run, this will provide a theory of the determination of exchange rates in the long run.

The Quantity Theory of Money

The quantity theory of money is a macroeconomic theory explaining the determination of the price level in the long run. It can be written as
M = L*PY, where
M = money demand
L = a constant, reflecting liquidity preference
P = price level
Y = real GDP
When real GDP is multiplied by the price level, it yields nominal GDP, which is the level of GDP measured in dollars.

The quantity theory of money therefore states that

Money demand = a constant (L) times nominal GDP (PY)

The relationship may also be written as

MV = PY, where V = 1/L

Money demand is the amount of a person's wealth that they wish to hold in the form of currency and checking accounts.

The Determination of the Price Level:

The quantity theory can be rearranged to solve for the price level:

$P = M / LY$

The price level is directly related to the money supply (M) and inversely related to money demand (L) and real GDP (Y).

The Quantity Theory of Money and PPP Combined

From PPP:

$E_{\$/€} = P_{US} / P_{EUR}$

From Quantity Theory:

$P_{US} = M_{US}/(L_{US}Y_{US})$

$P_{EUR} = M_{EUR}/(L_{EUR}Y_{EUR})$

Combining PPP and Quantity Theory

$E_{\$/€} = (M_{US}L_{EUR}Y_{EUR}) / (M_{EUR}L_{US}Y_{US})$

Why PPP does not hold in the short-run

1. Transactions costs
   Shipping costs, tariffs, legal requirements
2. Nontraded goods
   Services such as rent, restaurants, auto repair, health care
3. Imperfect competition
   Monopolies and oligopolies have the power to set different prices in different markets, also known as price discrimination
4. Excise taxes
5. Price stickiness
   Prices will not adjust instantaneously to exchange rate changes

Example – Price in U.S. Dollars

	Gasoline	Insulin
U.S.	$3.82	$98.70
Germany	$7.32	$11.00
Japan	$4.41	$14.40

The Real Exchange Rate

The ratio of the cost of a basket of goods in the foreign country to the cost in the home country, when expressed in a common currency:

$q_{US/EUR}$ = Cost of a basket of goods in Europe in \$/
Cost of basket of goods in U.S. in \$

$q_{US/EUR} = P_{EUR} * E_{\$/€} / P_{US}$

q is the relative price level between two countries
PPP assumes q = 1

An increase in q means that foreign prices are increasing relative to domestic prices. The domestic currency is therefore depreciating.

Net Exports and the Real Exchange Rate

Net exports depend more upon the real exchange rate (q) than the nominal exchange rate (E). The decision whether to purchase a domestic good or the foreign substitute depends upon their relative prices, which is given by the real exchange rate.

$q_{US/EUR}$ = Cost of a basket of goods in Europe in \$/
Cost of basket of goods in U.S. in \$

$q_{US/EUR}$ ↑ → Price Foreign goods ↑ → Quantity of U.S. Imports ↓

$q_{US/EUR}$ ↑ → Price U.S. Goods ↓ → Quantity of U.S. Exports ↑

Therefore
$q_{US/EUR}$ ↑ → Net Exports ↑ (Exports increasing, imports decreasing)

A high real exchange rate increases net exports. But it also means that your currency has low purchasing power in other countries.

Practice Question

What happens to U.S. Net Exports if U.S. prices increase by 10%, European prices are constant, and the dollar depreciates by 10% ($E_{\$/€}$ increases by 10%) ?

$$q_{US/EUR} = P_{EUR} * \underset{10\% \uparrow}{E_{\$/€}} / \underset{10\% \uparrow}{P_{US}}$$

No change in the real exchange rate, therefore no change in net exports.

Relative Purchasing Power Parity

PPP may not hold because of tariffs, non-traded services, excise taxes, etc. Relative PPP instead assumes that the relative price differences between countries is constant over time. Therefore, the real exchange (q) is constant over time.

Relative PPP is a weaker assumption than PPP. If absolute PPP holds, relative PPP must also hold. But the reverse is not true.

Example of Relative PPP

Assume that the cost of living in the U.S. and Switzerland over time is as follows:

	Year 1	Year 2	Year 3
Switzerland	$30,000	$36,000	$39,000
U.S.	$20,000	$24,000	$26,000
$q_{us/Switz}$	1.5	1.5	1.5

PPP does not hold because the cost of living, when expressed in the same currency, is different in the two countries. However, the relative difference is constant over time.

Relative PPP allows us to make predictions about the determinants of the exchange rate.

Inflation Review

Inflation is the growth rate of prices.
The price of an item in one year equals last year times one plus the inflation rate, where the inflation rate is expressed as a decimal:
$P_t = P_{t-1}*(1 + \pi_t/100)$

Example:
If gasoline currently costs $3 a gallon, and if there is 2% inflation, next year gasoline will cost $3(1 + 2/100) = $3*1.02 = $3.06

Relative PPP and Inflation

$q_{US/EUR} = P_{EUR} * E_{\$/€} / P_{US}$

Now take growth rates:

$\%\Delta q_{US/EUR} = \%\Delta P_{EUR} + \%\Delta E_{\$/€} - \%\Delta P_{US}$

Now substitute the inflation rate for the rate of growth of the price level:

$\%\Delta q_{US/EUR} = \pi_{EUR} + \%\Delta E_{\$/€} - \pi_{US}$

Under Relative PPP

$\%\Delta q_{US/EUR} = 0$

Therefore

$0 = \pi_{EUR} + \%\Delta E_{\$/€} - \pi_{US}$

$\%\Delta E_{\$/€} = \pi_{US} - \pi_{EUR}$

The percentage change in E equals the inflation differential.

Comparison of Absolute PPP and Relative PPP

Absolute PPP makes a prediction about the level of the exchange rate. Relative PPP makes a prediction about the change in the exchange rate.

Absolute PPP

$E_{\$/€} = P_{US} / P_{EUR}$

Relative PPP

$\%\Delta E_{\$/€} = \pi_{US} - \pi_{EUR}$

Numerical Example of Relative PPP

Year	(1) P_{US} ($)	(2) $E_{\$/e}$	(3) $P_{Eur}(\varepsilon)$	(4) $P_{EUR}(\$)$ (2)*(3)	(5) $q_{US/EUR}$ (4)/(1)
1	1	1	1.5	1.5	1.5

Now assume there is 10% inflation in the U.S. and 0% in Europe. The U.S. exchange rate will depreciate by 10%. In year 2, the price levels will be

2	1.1	_	1.5	_	_

What will be the exchange rate, $E_{\$/e}$?
Using our formula $\%\Delta E_{\$/€} = \pi_{US} - \pi_{EUR} = 10 - 0 = `0$
(The exchange rate increases by the inflation differential).

2	1.1	1.1	1.5	_	_

Now complete the rest or the table. The European price in dollars is just the Euro price (3) times the exchange rate (2) :

2	1.1	1.1	1.5	1.65	_

Finally calculate q as the ratio of the European price in dollars (4) divided by the U.S. price (1). This equals 1.5. The real exchange rate has not changed! This is an assumption of relative PPP.

2	1.1	1.1	1.5	1.65	1.5

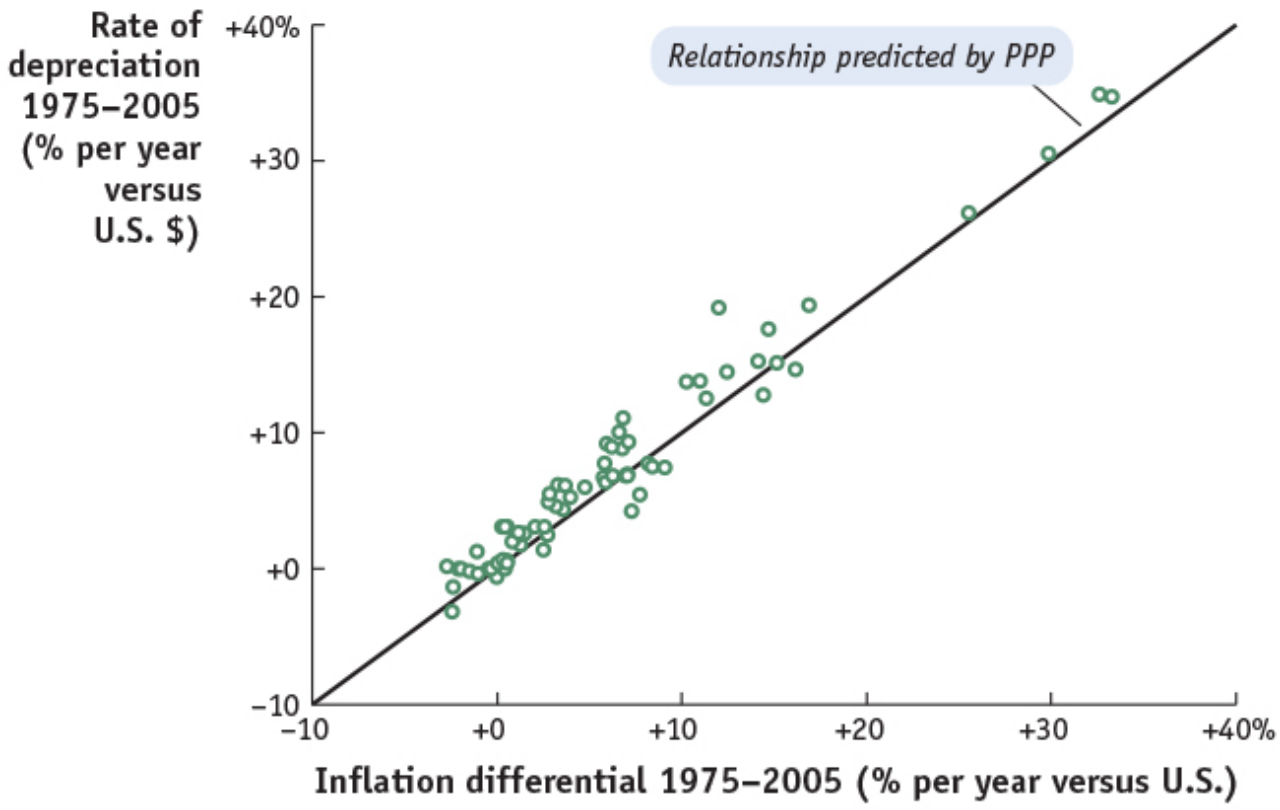

Figure 14.2
Feenstra/Taylor, *International Economics,* 4e, © 2017 by Worth Publishers
Data from: IMF, International Financial Statistics.

Relative PPP Graphically

If there is 10% inflation in the U.S. and 0% inflation in Britain, the demand for British pounds will shift rightwards because U.S. goods are now more expensive compared to British goods. U.S. consumers will consume more British goods. In order to buy British goods they need British pounds, which shifts the demand curve for pounds rightwards.

U.S. goods are also more expensive compared to British goods for British consumers. British consumers will buy fewer American goods. They will exchange fewer pounds for dollars, shifting the supply curve for pounds leftwards.

The combination of a rightward shift of demand and a leftward shift of supply will increase the equilibrium price of the pound.