3. The competitive currency market model

1. Nominal exchange rate

The nominal exchange rate e (exchange rate, foreign exchange rate, forex rate, FX rate) between two currencies is the price of one currency in terms of the other. For instance, if $e = 2$ \$/€, then one euro can be traded for two dollars: the price in dollars of one euro is two dollars. The inverse rate $e' = 1/2$ €/\$ of $e = 2$ \$/€ shows how many euros can be traded for one dollar: the price in euros of one dollar is half a euro. Both e and e' express the same information: the price of one currency in terms of the other.

2. Importance of the exchange rate

The exchange rate allows members of an economy to make economic transactions with members of a foreign economy in which a different currency is used: thanks to the exchange rate, domestic consumers and producers can buy foreign goods or financial assets, and sell domestic goods or financial assets to foreigners. These transactions cannot be executed directly when the two economies have different currencies.

3. The currency market (or foreign exchange market)

The currency market is the market for the trading of currencies and, thus, where the exchange rate is determined. The currency market connects economies with different currencies: going through the currency market, money from one economy can be spent in another economy where a different money is used.

4. Trivia from the actual currency market

The currency market is the largest and more liquid financial market in the world. Average trading in currency markets in April 2013 was \$5.3 trillion per day (\$4.0 trillion in April 2010; \$3.3 trillion in April 2007). 70% to 90% of all the transacctions are speculative. The main traders are banks (Citi, Deutsche Bank, Barclays Investment Bank, JP Morgan, UBS AG, Bank of America Merill Lynch, HSBC, BNP Paribas, Goldman Sachs…). Interbank trading accounts for more of the 50% of all transactions.

5. Quoting an exchange rate directly

The direct quotation (or price quotation) of an exchange rate expresses the exchange rate as domestic (home) currency units / foreign currency units. When the peseta was the Spanish currency, direct quotation was the norm: $e = 150$ Pts/\$.

6. Quoting an exchange rate indirectly

The indirect quotation (or quantity quotation) of an exchange rate expresses the exchange rate as foreign currency units / domestic (home) currency units. For instance, taking the euro as the home currency, then $e = 2$ \$/€ quotes the exchange rate indirectly. The method of quoting an exchange rate e chosen determines the units of e.

7. Which quotation method is preferable?

Direct quotation is the 'natural' way of quoting. The domestic price of a good is expressed as domestic currency units per unit of the commodity (1.2 € per litre of orange juice). Considering foreign currency another good, the price of the foreign currency would be expressed as home currency units per foreign currency unit. Despite this, indirect quotation is more convenient because an increase in the value of the domestic currency (with respect to the foreign currency) is represented by a rise in the exchange rate when quoted indirectly, whereas it is (at first sight, counterintuitively) represented by a fall when quoted directly.

8. Currency appreciation

A currency X appreciates with respect to another currency Y if the number of units of Y that one unit of X can buy increases. When X appreciates with respect to Y, X becomes more valuable in terms of Y. Under direct quotation the home currency appreciates when the exchange rate falls. Under indirect quotation the home currency appreciates when the exchange rate rises.

9. Example of currency appreciation (direct quotation)

In passing from $e = 2$ €/¥ to $e' = 1$ €/¥, the euro appreciates with respect to the yen. Initially, two euros were needed to buy one yen; after the fall of the exchange rate, only one euro is required to buy one yen, and consequently the euro has increased its value.

10. Example of currency appreciation (indirect quotation)

In passing from $e = 1$ \$/€ to $e' = 2$ \$/€, the euro appreciates with respect to the dollar. Initially, one euro could be traded for only one dollar; after the exchange rate rise, one euro can be traded for two dollars, which means that the euro has increased its value.

11. Currency depreciation

A currency X depreciates with respect to another currency Y if the number of units of Y that one unit of X can buy diminishes. When X depreciates with respect to Y, X becomes less valuable in terms of Y. Under direct quotation the home currency depreciates when the exchange rate rises. Under indirect quotation the home currency depreciates when the exchange rate falls.

12. Example of currency depreciation (direct quotation)

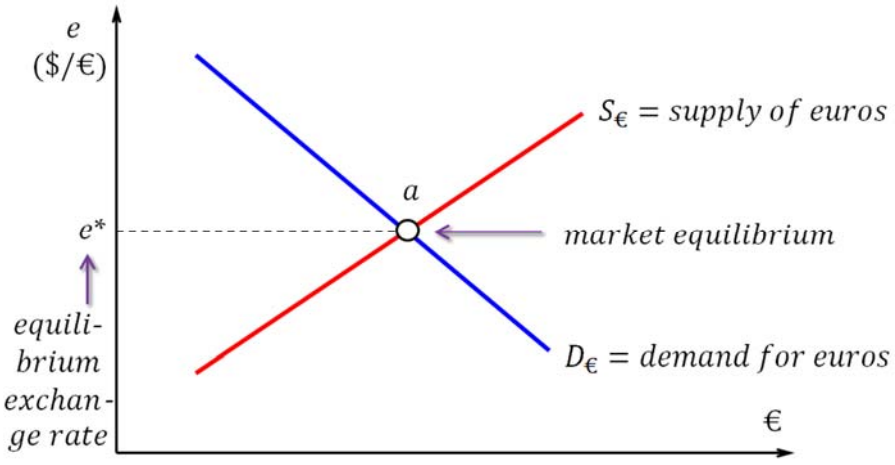
In passing from $e = 1$ €/¥ to $e' = 2$ €/¥, the euro depreciates with respect to the yen. Initially, one euro could buy one yen; after the fall in the exchange rate, one euro can only buy 0.5 yen and, therefore, the euro has lost value.

13. Example of currency depreciation (indirect quotation)

In passing from $e = 2$ \$/€ to $e' = 1$ \$/€, the euro depreciates with respect to the dollar. Initially, one euro could be traded for two dollars; after the rise in the exchange rate, one euro can only be traded for one dollar and, accordingly, the euro has a lower value.

14. The competitive currency market model

This model, graphically represented below, aims to explain how the nominal exchange rate is set: the market equilibrium is supposed to determine the exchange rate between just two currencies, the home and a foreign currency. The variable 'quantity' is the quantity of euros and the variable 'price' is the exchange rate \$/€ quoted indirectly. The interpretation is that the euro is the home currency and the dollar is the foreign currency. As in the liquidity market model, it is assumed that: (i) the supply of euros function $S_€$ slopes upwards; (ii) the demand for euros function $D_€$ slopes downwards; and (iii) both functions intersect at only one point.



15. Currency market equilibrium

The market equilibrium of the currency market model is the pair (e^*, $q_€^*$) such that, when the exchange rate is e^*, the supply of euros is $q_€^*$ and the demand for euros is also $q_€^*$. The value e^* is the equilibrium exchange rate.

16. Demand for euros function

The demand for euros function associates with each value of the exchange rate e the total amount of euros $q_€$ demanded at that value. In the model, most of the agents that will demand euros are American residents. The agents demanding euros have dollars but want to purchase European goods and/or financial assets. Hence, the demand for euros is, at the same time, supply of dollars.

17. Why the demand for euros is assumed to slope downward (to decrease with *e*)

The demand for euros function is supposed decreasing because a reduction in e means that fewer dollars are needed to purchase an euro. This makes European goods and financial assets comparatively cheaper. To buy more such goods and assets, Americans demand more euros. The argument leading from $\downarrow e$ to ↑quantity demanded of euros is summarized as follows:

$\downarrow e \Rightarrow$ fewer dollars required to buy one euro $\Rightarrow$ ↓price in dollars of European goods and financial assets $\Rightarrow$ ↑quantity demanded by Americans of European goods and financial assets $\Rightarrow$ ↑quantity demanded by Americans of euros (to buy the additional European goods and financial assets)

18. An example illustrating why a depreciation makes domestic goods cheaper for foreigners

Let the price of a European good be $p = 4$ € per unit of the good and $e = 3$ \$/€ the exchange rate. Then, for an American citizen, the price $p_\$$ in dollars of the European good is $p \cdot e = 12$ \$ per unit. If the exchange rate lowers to $e' = 2$ \$/€, then the price in dollars falls to $p \cdot e' = 8$ \$ per unit.

19. Supply of euros function

The supply of euros function associates with each value of the exchange rate e the total amount of euros $q_€$ supplied at that value. In the model, most of the agents that supply euros are European residents. The agents supplying euros want dollars to purchase American goods and/or financial assets. Thus, the supply of euros is, at the same time, demand for dollars.

20. Why the supply euros is assumed to slope upward (to increase with e)

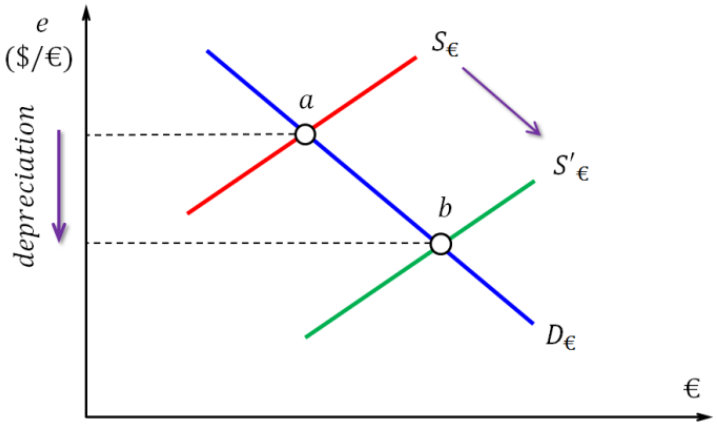
The supply of euros function is supposed increasing because a rise in e means that more dollars are given in exchange for one euro, making American goods and financial assets comparatively cheaper. To buy more such goods and assets, more dollars are needed, so European supply more euros. The following is the argument leading from ↑e to ↑quantity demanded of euros:

↑e ⇒ more dollars received for one euro ⇒ ↓price in euros of American goods and financial assets ⇒ ↑quantity demanded by Europeans of American goods and financial assets ⇒ ↑quantity supplied by Europeans of euros (to buy the additional American goods and financial assets)

21. Example I: how a rise in European income (or GDP) affects the equilibrium exchange rate

A rise in the European GDP means that Europeans have more income to spend. Spending on goods is likely to increase. In particular, Europeans will spend more on American goods (and also assets). To buy them, Europeans will demand more dollars. And since demand for dollars can be identified with supply of euros when the only currencies are euros and dollars, Europeans will increase the supply of euros. This shifts the function $S_€$ to the right, thereby causing a fall in the exchange rate: a rise in the European GDP leads to a depreciation of the euro; see graph on the right.

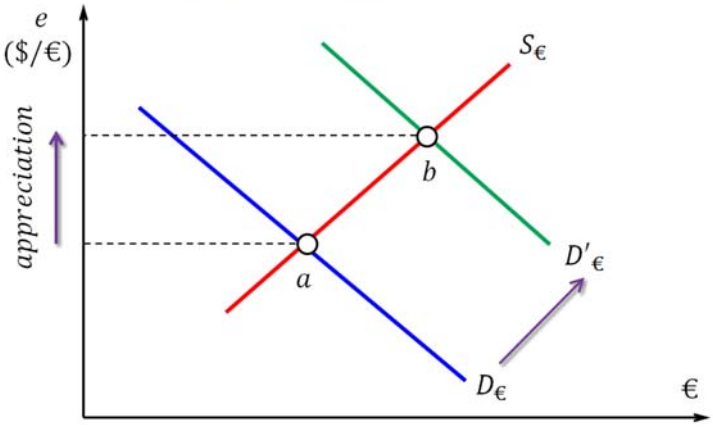
$$\uparrow \text{GDP}_{\text{EU}} \Rightarrow \uparrow \text{IM}_{\text{EU}} \Rightarrow \uparrow D_{\$} \Rightarrow \uparrow S_€ \Rightarrow \downarrow e$$



22. Example II: how a rise in American income (or GDP) affects the equilibrium exchange rate

This case is like §21 but adopting the foreign perspective. Americans becoming wealthier will buy more European goods/assets. To pay them, they will demand more euros. The demand for euros function shifts to the right and the exchange rate $/€ appreciates; see graph on the right. This is equivalent to the dollar depreciating against the euro, which is the conclusion in §21 with euros and dollars exchanging their roles. In sum: a rise in the American GDP appreciates the euro.

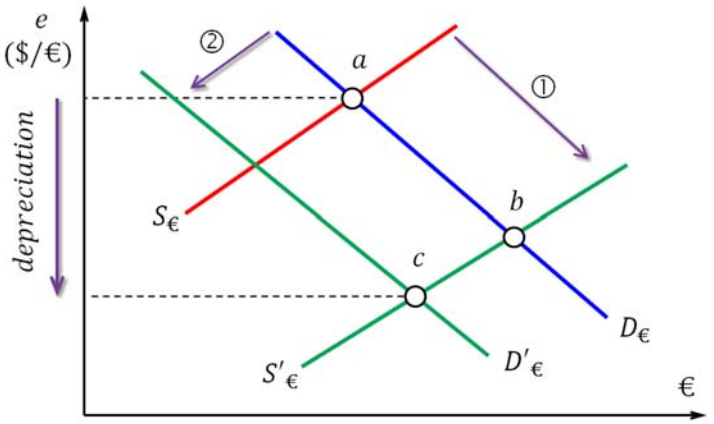
$$\uparrow \text{GDP}_{\text{US}} \Rightarrow \uparrow \text{IM}_{\text{US}} \Rightarrow \uparrow D_€ \Rightarrow \uparrow e$$



23. Example III: how a rise in the European inflation rate affects the equilibrium exchange rate

A rise in the European inflation rate (i) makes American goods comparatively cheaper than American goods to European consumers and (ii) makes European goods comparatively more expensive than American goods to American consumers. Fact (i) encourages European consumers to import more goods from the US, whereas (ii) causes a fall in the US imports from Europe. The increase in European imports from the US shifts the supply of euros function $S_€$ to the right (as Europeans ask for more dollars to purchase more American goods). The reduction in US imports from Europe shifts the demand for euros function $D_€$ to the left (as Americans ask for fewer euros to purchase less European goods). Both shifts lead to a fall in the exchange rate. In sum, a higher European inflation rate depreciates the euro; see the graph on the right.

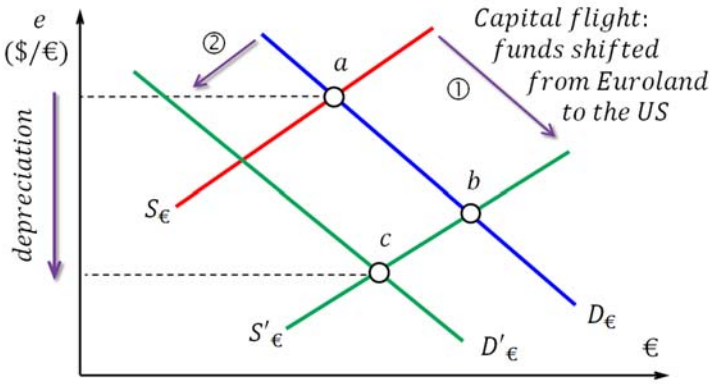
$$\uparrow\pi_{EU} \Rightarrow \begin{cases} ① \uparrow IM_{EU} \Rightarrow \uparrow D_{\$} \Rightarrow \uparrow S_€ \Rightarrow \downarrow e \\ ② \downarrow IM_{US} \Rightarrow \downarrow D_€ \Rightarrow \downarrow e \end{cases}$$



24. Example IV: how a rise in the American interest rate affects the equilibrium exchange rate

A rise in the US interest rate (i) makes American financial assets more attractive than European financial assets to European investors and (ii) makes European financial assets less attractive than American financial assets to American inverstors. By (i), Europeans rise the demand for American financial assets, the demand for dollars and the supply of euros, which shifts function $S_€$ to the right. By (ii), Americans reduce the demand for European financial assets and curtail the demand for euros, so the function $D_€$ shifts to the left. Thus, as shown on the right, a higher US interest rate depreciates the euro.

$$\uparrow i_{US} \Rightarrow \begin{cases} ① \uparrow D^{\text{BY EUROPEANS}}_{\text{US-securities}} \Rightarrow \uparrow D_{\$} \Rightarrow \uparrow S_€ \Rightarrow \downarrow e \\ ② \downarrow D^{\text{BY AMERICANS}}_{\text{EU-securities}} \Rightarrow \downarrow D_€ \Rightarrow \downarrow e \end{cases}$$



25. Rule of thumb for shifting the supply and demand functions in the currency market model

Any event encouraging American residents to buy more European goods or more European financial assets will shift the demand for euros function $D_€$ to the right; events encouraging the opposite move $D_€$ to the left. Similarly, any event encouraging European residents to buy more American goods or more American financial assets will shift the supply of euros function $S_€$ to the right; events encouraging the opposite move $S_€$ to the left.

26. Exchange rate regimes I: flexible (or floating) exchange rate regime

In a flexible exchange rate regime, the public authority (government or CB) lets the currency market set the value of the exchange rate e. In this case, the authority refuses to influence e.

27. Exchange rate regimes II: fixed exchange rate regime

In a fixed exchange rate regime, the corresponding public authority (government or CB) picks an official value of the exchange rate between the domestic currency and some foreign currency (or group of them) and assumes the compromise of defending that value in the foreign exchange market by buying or selling the domestic currency. If the value of the domestic currency is pegged to the value of another currency, the latter is known as the anchor currency.

28. Devaluation of a fixed exchange rate

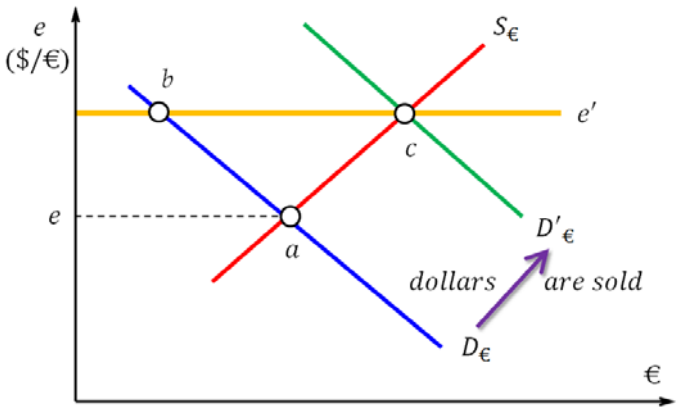
A devaluation is a reduction of the fixed exchange rate and occurs when the public authority accepts that the former fixed rate cannot be upheld as it makes the domestic currency to be overvalued with respect to its market (or sustainable or 'fundamental') value.

29. Revaluation of a fixed exchange rate

Revaluation is the opposite of devaluation: a fixed exchange rate reset at a higher level.

30. Currency market intervention by the central bank

Let e' be the fixed exchange rate and $e < e'$ the market exchange rate; see point a in the graph below. Having e' as a fixed exchange rate means that the CB must intervene to place the market equilibrium along the horizontal line with value e'. The solution is to demand more euros to raise its market value. It may appear that the CB may shift $S_€$ to reach point b or $D_€$ to reach point c. The first option is not available, since the CB cannot force a reduction in any market function. What the CB can do is to expand the demand for euros. Thus, to reach value e' from point a, the CB must demand enough euros to shift the market demand function from $D_€$ to $D'_€$. But the purchase of euros to raise the value from e to e' must be paid in dollars. Thus, in passing from a to c, the CB spends dollars. Obviously, to sell dollars the CB must have them (or arrange a dollar loan, in general granted by other CBs).



31. Exchange rate regimes III: managed float exchange rate regime

In the managed float exchange rate regime (or "dirty float") the authority seeks to influence the exchange rate by buying and selling currencies at will, without any specific commitment.

32. The impossible trinity (or open economy trilemma)

Due to Nobel Prize in Economics recipient Robert Mundell, the impossible trinity is the trilemma according to which it is not sustainable to simultaneously

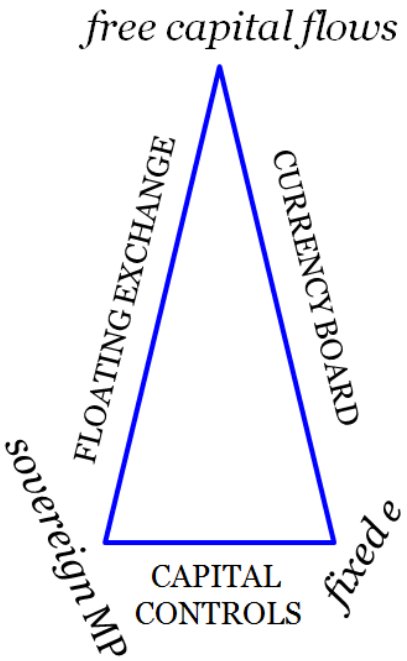
- have a fixed exchange rate,
- choose the domestic interest rate (or to have an independent monetary policy) and
- allow free international capital mobility (that is, impose no capital control).

The trilemma makes clear that monetary policy and exchange rate policy are interdependent.

33. Justification of the open economy trilemma

Suppose e is fixed and that, exercizing the independence of the monetary policy, an expansionary monetary policy that increases **M1** is implemented. The increase in **M1** expands the supply of liquidity and, as a result, the domestic interest rate i decreases. The fall in i makes financial investment in the domestic economy less attractive and, therefore, encourages financial investment in the foreign economy. Thus investors reduce financial investment in the domestic economy by selling domestic financial assets in the domestic liquidity market, use the proceeds of the sales to obtain foreign currency in the currency market and spend the foreign currency so obtained in the purchase of foreign financial assets. The sale of domestic currency in the currency market lowers the exchange rate e. Since e is fixed, to defend the desired value of e, the central bank has to buy domestic currency in the currency market. The purchase of currency by the central bank reduces the monetary base and, subsequently, **M1**. The final result is that the domestic authorities are not free to implement the monetary policy they wanted.

34. Policy options consistent with the open economy trilemma



- **Option 1. Floating exchange rate.** If having an independent monetary policy and adopting no capital control are the policies chosen, then the exchange rate must float (UK, Canada).

- **Option 2. Currency board.** Fixing the exchange rate and allowing the free mobility of capital imply that monetary policy cannot be independent. It can be interpreted that the eurozone countries chose this option: their monetary policy was handed to a supranational authority, the European Central Bank. When a single country takes this option, the resulting monetary authority is called a currency board and its goal is merely to adopt the monetary policy of the country (or countries) to which the exchange rate is pegged and be willing to convert into the pegged currency any request of conversion of any amount of domestic currency. Argentina had a currency board in the 1990s when the exchange rate was fixed at one Argentinian peso per US dollar.

- **Option 3. Capital controls.** Capital controls must be established (like China until recently) when the policy options chosen are to control both the foreign value of the domestic currency (by fixing the exchange rate) and, by conducting a sovereign monetary policy, its domestic value (the interest rate).

35. Real exchange rate

The real exchange rate e_r is the relative price of the basket of goods in the CPI (consumer price index) in two economies**:** e_r is the price of the basket in one economy in terms of the basket of the other. Formally, letting e be quoted indirectly, P be the domestic CPI and P^* the foreign CPI,

$$e_r = e \cdot \frac{P}{P^*}.$$

36. Interpretation of the real exchange rate

Loosely speaking, the real exchange is the nominal exchange rate expressed in terms of goods, where the term 'goods' is interpreted as the basket of goods in the CPI. The real exchange rate expresses the rate at which domestic goods can be traded for foreign goods. Equivalently, the real exchange rate e_r is the nominal exchange e adjusted by price indices of the two economies. The above formula of e_r implies that e_r is measured in foreign baskets/domestic basket.

37. Numerical example on the real exchange rate

Let $e = 4$ \$/€, $P = 100$ €/basket$_{EU}$ (domestic price index) and $P^* = 200$ \$/basket$_{US}$ (foreign price index). How many baskets$_{US}$ could then be obtained from one basket$_{EU}$? As $P = 100$, a basket$_{EU}$ can be sold for €100. At the rate $e = 4$ \$/€, €100 exchange for \$400. With \$400 and $P^* = 200$, 2 baskets$_{US}$ can be purchased. Hence, the purchasing power of 1 basket$_{EU}$ is 2 baskets$_{US}$. That is, $e_r = 2$ baskets$_{US}$/basket$_{EU}$. Using the formula, $e_r = 4 \cdot 100/200 = 2$ baskets$_{US}$/basket$_{EU}$.

38. Real exchange rate and competitiveness

The real exchange real can be considered a measure of the competitiveness of an economy: the smaller e_r, the higher the competitiveness of the domestic economy. In passing from $e_r = 1$ to $e_r = 2$ domestic competitiveness is eroded: with $e_r = 1$, foreigners could obtain a domestic basket with just one of their baskets; with $e_r = 2$, they must deliver 2 of their baskets to get a domestic basket. Going from $e_r = 1$ to $e_r = 2$ means that it is more expensive for foreigners to purchase the other economy's basket, so the domestic economy becomes less competitive.

39. Real appreciation and real depreciation

A real appreciation is an increase of e_r (a loss of domestic competitiveness). A real appreciation of the exchange rate means that the domestic basket can buy more foreign baskets: the purchasing power of the domestic basket rises. A real depreciation is a decrease of e_r (an improvement of domestic competitiveness). A real depreciation means that the domestic basket can buy fewer foreign baskets: the purchasing power of the domestic basket falls.

40. Purchasing power parity (PPP) exchange rate

The purchasing power parity exchange rate e_{PPP} is the nominal exchange rate e making $e_r = 1$; that is, $e_{PPP} = P^*/P$. When the nominal exchange rate e equals e_{PPP}, the domestic and foreign baskets have the same price, when all prices are expressed in the same currency: if $e = e_{PPP}$, then $e \cdot P$ (the price in dollars of the domestic basket) equals P^* (the price in dollars of the foreign basket). Hence, $e = e_{PPP}$ means that both currencies have the same purchasing power.

41. Overvaluation and undervaluation of an exchange rate (with respect to its PPP value)

If $e > e_{PPP}$, then the domestic currency is overvalued against the foreign currency and with respect to its PPP value; if $e < e_{PPP}$, it is undervalued. The percentage of overvaluation is $\frac{e - e_{PPP}}{e_{PPP}} \cdot 100$. For example, if $P^* = 100$, $P = 50$ and $e = 4$ \$/€, the euro is a 100% overvalued. In fact, $e_{PPP} = P^*/P = 100/50 = 2$ \$/€. Thus, given $e = 4$ \$/€, one euro can buy more dollars (\$4) than the amount (\$2) making the euro have the same purchasing power at home and abroad.